UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

Analytical Survey

THE USE OF ICTs IN TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

UNESCO Institute for Information Technologies in Education

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The Use of ICTs in Technical and Vocational Education and Training. Analytical Survey

The analytical survey was prepared within the framework of the project *Information and Communication Technologies in Technical and Vocational Education and Training* launched by the UNESCO Institute for Information Technologies in Education in 2002.

The survey provides a comprehensive review of ICT usage in TVET. It focuses on the use of ICTs for administrative purposes, communication, teaching and learning, curriculum development and assessment, career education and guidance, labour market information, job placement, and systems control, displaying specific features of various types of ICTs commonly applied in different spheres of vocational education. A brief survey of the most significant experience of a number of UNESCO Member States as well as several most interesting case studies are provided to give a global perspective of ICT penetration in TVET.

The materials presented in the survey will be of interest to a wide range of specialists from high-level policy- and decision-makers to teachers, researchers, programme product developers and evaluators, and in general, to all educators involved in this subject.

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PREFACE

The UNESCO Institute for Information Technologies in Education (IITE) had a mandate for conducting an analytical survey focused on the usage of information and communication technologies (ICTs) in technical and vocational education and training (TVET). An international expert meeting was held in April 2002 at IITE to launch this project. This meeting was chaired by Dr Chris Chinien, Director of the National Centre for Workforce Development Canada. The following experts participated in the meeting:

Yuri Balyberdin (Russian Federation, Head organization of prelicense education)
Pavel Belkin (Russian Federation, Federation of Internet Education)
Tjerk J. Busstra (Netherlands, University of professional education)
Chris Chinien (UNEVOC-Canada)
Alexandre Dolgorukov (Russian Federation, Centre of Intensive Technologies in Education)
Alexandre Giglavy (Russian Federation, Lyceum of Information Technologies # 1533
Sergey Gorinskiy (World ORT Representative Office for the CIS and Baltic States)
Odd Henning Johannessen (Norway, Technical and Vocational College of Haugaland)
Piet Kommers (Netherlands, University of Twente)
Boris Kotsik (IITE)
Julieta Leibowicz (International Training Centre of the ILO)
Valery Meskov (IITE)
Mikhail Rychov (UNIDO Centre in Russian Federation)
Krishnamurthy Subramanian (India, National Informatics Centre, Ministry of Comm.& IT)
Alexander Zimin (Russian Federation, Bauman Moscow State Technical University)

Following the expert meeting, Dr Chinien was invited to conduct the analytical survey.

Objectives

This analytical survey had two main objectives:

- To review and classify the usage of ICTs in TVET within UNESCO's Member States;
- To familiarize the specialists from UNESCO's Member States with research on ICT usage in TVET.

Target audience

This analytical survey will be of interest to all key stakeholders involved in TVET, and to the following groups in particular:

- Policy- and decision-makers;
- Managers and administrators of education and training institutions;
- Instructional designers and developers;
- Programme planners;
- Teachers, trainers, workplace educators, tutors, mentors and coaches;
- Teacher educators and trainers of trainers;
- researchers;
- programme and product evaluators;
- ICT specialists and e-learning experts.

Process

Key informants were invited to provide input for this analytical survey. Key informants were contacted through the assistance of specialized listservs in TVET such as the UNESCO-UNEVOC e-Forum. All the UNEVOC centres and associate UNEVOC centres were also requested to provide country information on the use of ICTs in TVET. A thorough literature search was performed to access current publications from library systems and the World Wide Web.

Limitations

This analytical survey had the following limitations:

- Literature searches were limited to English and French publications.
- In reviewing the literature and research for this section every attempt was made to locate publications related to TVET. However, publications focused on general education were reviewed when no suitable TVET publications could be found. This allows the reader to make inferences regarding the relevance of the discussion to TVET.

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- Mr Ian Ponce for conducting numerous hours of library and Internet research, reviewing and summarizing the literature and research.

EXECUTIVE SUMMARY

Globalization has created a new world order for doing business. New information and communication technologies have dramatically changed the way we live, learn, and work, and even think about work. The synergy of combining globalization with new technology has had dramatic economic and social impacts. It has created new opportunities as well as new challenges and uncertainty. Many workers have been dislocated, while a significant number of young people are structurally unemployed or underemployed. Skills polarization between so-called mind or knowledge workers and unskilled-low-knowledge workers has widened the gap in income inequalities. Youth, women, and older workers are the groups most affected. While these changes have brought about considerable challenges to TVET, they have created new opportunities for change and innovation. In the past the status and condition of vocational education did not match the importance of its potential contribution to society. However, in this new environment where human capital has become the most critical element in achieving a competitive advantage, TVET can now aim to reach its full potential.

Information and communication technologies drives the new economy and human capital is its fuel. In fact, the ICT revolution makes knowledge a competitive resource. In this economic era, economic prosperity depends on brains rather than brawn and value is created by employing knowledge workers and continuous learning. The need for recurrent education and the changing labour market conditions, call for flexible access to TVET. Continuing education models that will meet workers' lifelong learning needs have to be relevant and flexible to provide just-in-time learning without distance. ICTs can play a crucial role in removing distance from education and in developing a lifelong learning culture in TVET. In spite of these potentials little is known regarding the usage of ICTs in TVET within UNESCO's Member States. The purpose of this analytical survey is to bridge this knowledge gap.

This survey focuses on the usage of ICTs in TVET. More specifically it focuses on the use of ICTs for administrative purposes, communication, teaching and learning, curriculum development, assessment, career education and guidance, labour market information, job placement, and systems control.

This analytical survey provides a comprehensive review of issues such as the advantages and disadvantages of various types of ICTs commonly used in teaching and learning. These include audiocassette tapes, radio, videotapes, CD-ROM, Internet/web-based training, audioconferencing, audiographics, interactive television, videoconferencing, and wireless technology.

The analysis also focuses on certain specialized applications of ICTs in TVET, namely teaching attitudes and practical skills, learning at the workplace, studying at home, developing informal skills, and participating in virtual internships. The discussion is also extended to the various ways in which ICTs are being used to support the delivery of TVET programmes. The specific features examined include the use of ICTs for administrative purposes, programme design and development, learning assessment, control of technical systems, information search and retrieval, career education and guidance, placement of graduates and assistive technologies for people with disabilities. A brief survey of seventeen countries is provided to give a global perspective of the extent of ICT penetration in TVET.

Major issues related to the integration of ICTs in TVET such as the digital and cognitive divide are discussed along with a proposed framework for establishing the effectiveness of ICT-mediated learning. Three critical indicators of effectiveness are identified: achievement,

attitude, and study time. A brief overview of research on the effectiveness of ICT-mediated learning is presented along with discussion of cost-effectiveness issues.

The ICT literacy for TVET teachers is analysed in light of two critical elements: occupational ICT literacy and pedagogical ICT literacy. The essential ICT literacy skills for learners are also examined. Finally, a framework for policy formulation and a working model for integrating ICT-mediated learning in TVET are presented.

SECTION 1 ICTs in TVET – NEW TIMES, NEW CHALLENGES, AND NEW OPPORTUNITIES

The purpose of this section is to demystify the new economy, to the highlight industrial and occupational changes brought about by the synergy of combining the information and communication technology revolution with the globalization of our economic system, and finally, to consider the changes in workplace requirements, unemployment, underemployment and the need for lifelong learning in TVET.

1.1 The New Economy: Challenges and Opportunities

ICT is the driver of the new economy. Therefore an analysis of the use of ICTs in TVET would be incomplete without a discussion on the new economy. The purpose of this section is to demystify the new economy. It is based on the recent work of Chinien, Moratis, Boutin, and Van Baalen (2002).

In recent years, the term “new economy” has increasingly been accompanied by negative connotations. Whether they see it as “an Internet bubble that is about to burst” (or that has already burst) or blame it for “the worldwide collapse of economies”, adversaries have tried to demonstrate the negative effects and even the non-existence of the new economy. It is undeniably true that discussions on the new economy have in many aspects been dominated by near adulation, often by business gurus and fad-chasing politicians. The new economy, they claim, is a true and unprecedented economic revolution.

Meanwhile, different authors have posed the questions “What is new about this economy?” and “What is this new economy about, really?” (For example, see Webber, 1993) Now that the limits of the economy seem to have been reached, it is time to realistically reflect on what this “new economy” has brought and, indeed, what it is about.

1.1.1 Defining What This New Economy Is

Several conceptions of what has become widely known as the new economy have surfaced over the years. Many of these conceptions seem to acknowledge that this new economy refers to an economic era that is characterized by a new set of economic activities, economic volatility, new organizational architectures and paradoxes. It has engendered economic industriousness of a totally different nature and of distinct dimensions. What makes it not so radically new, however, is that, according to the theory of Kondratieff cycles, such a transition takes place about every 40 to 60 years. This new economy is not the first new economy. Agricultural activity dominated wealth creation for about eight thousand years before largely coming to its end with the first industrial revolution, which took place at around the end of the eighteenth and the early nineteenth century. The new economy may be represented as a comparable economic transition driven particularly by revolutions in technology. As illustrated by Norton (1999), global development unfolds through the succession of new economies, underpinned by the Schumpeterian process of creative destruction. The new economy that people have been talking about over the past few years is more a reborn economy than a totally new economy, meaning it has successfully weathered what could be termed as a maturity crisis and has challenged relatively recent predictions of economic decline (Norton, 1999). Table 1 illustrates this.

Table 1: Five "New Economies"

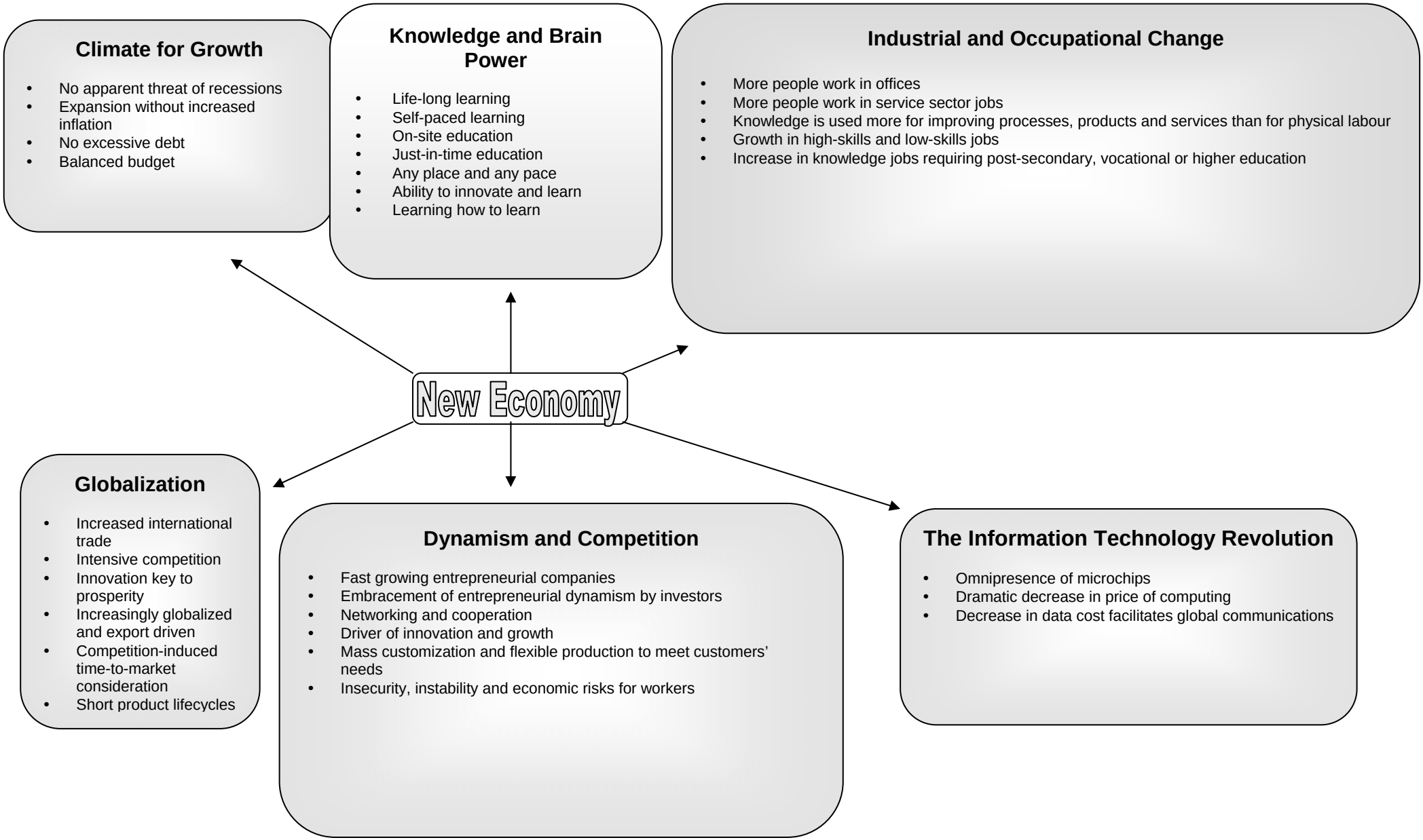
	Also known as	Period	Main symbols
New Economy #1	The Industrial Revolution	1787–1842	Cotton textiles, iron, steam power
New Economy #2	The Bourgeois Kondratieff	1842–1897	Railroads
New Economy #3	The New-Mercantilist Kondratieff	1897–1939	Electricity, automobile
New Economy #4	The Cold-War Kondratieff	1939–1989	Defence, television, mainframe computers
New Economy #5	The Information Age	1989–????	Personal computers, telecommunications, entertainment

Source: Norton (1999)

Two global trends seem to particularly explain this new economy: globalization and the widespread use of ICTs. Globalization has led to the proliferation of market forces, freer trade, and widespread deregulation, while ICTs are creating new companies and new industries before our eyes (Shepard, 1997). Castells speaks of the prevalence of intertwined global and informational features. They are informational because productivity and competitiveness of units or agents fundamentally depend upon their capacity to generate, process, and apply knowledge-based information; they are global because the core activities of production, consumption, and circulation are organized on a global scale (Castells, 1996: 66). But what structural features are these drivers of this new economy bringing with them? A good starting point for exploring the more structural features of the current new economy is found in *Wired* magazine's *Encyclopaedia of the New Economy*:

> When we talk about the new economy, we're talking about a world in which people work with their brains instead of their hands. A world in which communications technologies create global competition – not just for running shoes and laptop computers, but also for bank loans and other services that can't be packed into a crate and shipped. A world in which innovation is more important than mass production. A world in which investment buys new concepts or the means to create them, rather than new machines. A world in which rapid change is a constant. A world at least as different from what came before it as the industrial age was from its agricultural predecessor. A world so different its emergence can only be described as a revolution.

Figure 1: Today's New Economy



In light of this encompassing definition, this latest new economy (Figure 1) can be defined as a knowledge and idea-based economy where the keys to job creation and higher standards of living are innovative ideas and technology embedded in services and manufactured products; it is an economy where risk, uncertainty, and constant change are not the exception but the main rule (adapted from The *New Economy Index* web site).

1.1.2 Structural Economic Features of the New Economy

Weinstein (1997) identified some structural features of this new economy in the form of macroeconomic traits, contending that the new economy is an economy that grows without apparent threats of recession; that continues to expand without an increase in inflation; that is constantly restructuring itself for greater efficiency and productivity; that replenishes and revitalizes itself through new technology and capital investment; that functions without excessive debt, either public or private; that maintains a balanced budget; and that is increasingly globalized and export-driven. These attributes are the fundamentals on which a prospering economy can be built. The *New Economy Index* mentions four themes (industrial and occupational change, globalization, dynamism and competition, and the information technology revolution) encompassing 13 indicators that illustrate the emergence of these structural roots. (The following elaboration is based on the *New Economy Index* and was adapted from Baalen and Moratis, 2001).

1.1.3 Industrial and Occupational Change

Within this first theme, several trends can be witnessed. First of all, more people work in offices and provide services. Decreasing amounts of time are spent on physical labour, whereas knowledge-intensive work, requiring analytical and interpretive skills, is increasing. This is linked with the rising importance of the service sector in Western economies. For instance, in the US 80% of the workforce do not spend their days making things; they work in jobs that require them to move things, process or generate information, or provide services to people. Second, high-wage and high-skill jobs have grown, as have low-wage and low-skill jobs. Knowledge-based jobs (requiring post-secondary, vocational or higher education) are growing as a share of total employment both in the US and Europe. In the US, managerial and professional jobs increased as a share of total employment from 22% in 1979 to 28.4% in 1995.

1.1.4 Globalization

With globalization, trade assumes an increasing share of the new economy, which means more intense competitive structures. As a consequence, firms have to innovate at a constant rate in order to be successful. Innovation means “coming up with new ideas about how to do things better or faster. It is about making a product or offering a service that no one had thought of before. It is about putting new ideas to work in our business and industries and having a skilled work force that can use those new ideas.” (Government of Canada, 2002, p. 3). The value of the world economy that is “globally contestable” – meaning open to global competition – will rise from approximately 4 trillion dollars in 1995 (which equals about one-seventh of the world’s output) to over 21 trillion dollars by the year 2000 (half of the world’s output) (Frazer and Oppenheim, 1997). A usually revealing indicator of globalizing tendencies is foreign direct investments (FDI). FDI is an essential condition for business if it is not to become outperformed by future competition in this globalizing world.

1.1.5 Dynamism and Competition

The theme of dynamism and competition poses six trends in the observation of a new economy. First, there is the spawning of new, fast-growing entrepreneurial companies, which indicates the degree of the economy's innovative capacity. The so-called "gazelles", or companies with a sales growth of at least 20% per year for four straight years, are an important indicator of this trend. In addition, investors are increasingly embracing entrepreneurial dynamism by, especially in the sector of information and communications technologies. Second, there is a general increase in and intensification of competition. For example, in 1965, IBM faced 2,500 competitors for all its markets. By 1992, it faced 50,000. Stable industries have become dynamic and global, while at the same time numerous mergers and acquisitions have taken place, including mergers between corporate giants and acquisitions of the most innovative small- and medium-sized enterprises. Third, just as merging and acquiring are ways of coordinating corporate activity, cooperation among competitors has become ubiquitous. The dynamics of organizing through network structures and "co-opetition" have been labeled the prominent organizing principle in the new economy (for example, see Drucker, 1999). Firms are looking for opportunities to establish partnerships with suppliers, consumers, and universities to enhance product and service development and technological innovation. Fourth, the new economy is constantly churning, indicating the balance between job creation and job destruction (this is called "flux"). Though this constant churning confronts workers with insecurity, instability, and thus economic risk, it is also a major driver of innovation and growth. Fifth, consumer choices are exploding and consumer needs are more specifically addressed. Due to the fact that mass customization and flexible production have replaced mass production and standard products ("one-size-fits-all"), customers now can choose, and order at a fraction of previous prices tailor-made products and services ("one-size-fits-(n)one"). Variety and diversity at low cost are conjoined in the new economy. Sixth, and last within the theme of dynamism and competition, speed is becoming the standard. Competition-induced time-to-market considerations and short product life cycles are characteristic of the new economic order. A well-known example is Moore's Law: every 18 months, the processing speed of microchips is doubled, while prices are cut by half. Business has to run just to stay in place in an economy where people talk about technological development in "web years", which is a quarter of a normal year. Greater consumer choice and the sophisticated nature of interaction between business and customers are just two examples of the possibilities the increase in speed brings.

1.1.6 The Information Technology Revolution

This fourth and final theme concerning the rise of the new economy entails three trends. First, there is the omnipresence of microchips, which is the foremost characteristic of the digital era. In 1984, worldwide shipments of semiconductors totalled 88 billion units, and by 1997 world shipments had nearly tripled. By 2003, the number is expected to pass the 400 billion unit mark. Second, the costs of computing are dramatically decreasing. Computing costs are dropping nearly 25% per year. Since information technology is expected to increase efficiencies, enabling cost cutting, customizing products and services, and increasing the speed of commerce, all sectors of business are investing in ICTs. Therefore, this trend is important as it enables the transformation of business and even whole industries. The third trend co-depends on the previous trend: data costs are plummeting. Global communication is, undoubtedly, one of the major enablers of the economy.

The impacts of this information technology revolution and the fact that ICTs can be seen as one of the major driving forces of the new economy have caused authors to coin the term "digital

economy". This term arose from the observation that the relatively smooth transition from the old economy to the current new economy has been caused by the emergence of information goods, which can be digitised. The prominence of information commodities entails three landmark events: the invention of the microprocessor in 1971, the introduction of the IBM personal computer (PC) in 1981 and the commercialization of the Internet in 1994 (Norton, 1999). The microprocessor switched the world from an analog to a digital mode in which virtually every person, company, and government is a customer for technology products, mostly because of the introduction of PCs in 1981. The definition of technology industries has expanded from large computers to include personal computers, software, semiconductors, semiconductor equipment, communications (both telecommunications and data communications), and medical technology (biotechnology and medical devices) (Murphy, 1998). The coming of the PC thus rendered anything and everything subject to the power of the computer, while retaining the crucial dimensions of human scale, decentralized decision making, customized design, and creativity.

1.1.7 Climate for Growth

Weinstein (1997, cited by Baalen Van & Moratis, 2001) examined the new economy form a microeconomic perspective. He identified some conditions that were essential for growth in the new economy, namely, an economy:

- that grows without apparent threats of recession;
- that continues to expand without a pickup in inflation;
- that functions without excessive debt; and
- that maintains a balanced budget (p. 14).

1.1.8 Knowledge and Brain Power

Technology is said to be the driver of this new economy and human capital is its fuel (Moe and Boldget, 2000). In the new economy, human capital is defined as workers' knowledge that results in effective and efficient performance. Knowledge is not only beneficial to the well-being of the worker, but is also viewed as a major competitive advantage for the company and a key element to ensure the country's national prosperity and social development. The perception of the role of human intervention in the economic transactions has also changed. Keursten and Kessels (2002) noted that the "focus is shifting from appreciation of physical labour and the ability to coordinate and regulate to the ability to contribute to knowledge generation and application" (p. 1). This recognition of the importance of knowledge and brainpower for economic prosperity and competitiveness has drawn considerable attention to the following concepts: lifelong learning, self-paced learning, on-site education, just-in-time education – any place and any pace, innovation, and learning to learn.

1.1.9 Human Capital and Knowledge as a Wealth Creator

These structural or macro economic roots outline what the new economy seems to comprise and how value is created in this new economy. Technology plays a central role, but the one thing in particular everyone seems to agree on is the belief that this era will differ to the extent to which it will be dominated by knowledge and skills. In fact, the ICT revolution makes knowledge a competitive resource. In this economic era, economic prosperity depends on brains rather than

brawn and value creation is realized by means of employing knowledge workers and continuous learning.

In the nineteenth century, capital equipment was seen as the single decisive factor in driving economic growth; knowledge and skills only played a supporting role. Thurow (1999) notes that Adam Smith barely mentions education in his *Wealth of Nations* and when he does mention it, he disqualifies it as an antidote to the mind-numbing boredom of factory work. Thurow argues that in an economy dominated by knowledge-based activities, two interlocking but differing sets of skills related to the creation and the deployment of knowledge are required. Knowledge creation requires highly educated creative skills at the very top of the skill distribution. Knowledge deployment requires widespread high-quality skills and education in the middle and bottom of the skill distribution. Burton-Jones (1999) comments:

> Future wealth and power will be derived mainly from intangible, intellectual resources. This transformation from a world largely dominated by physical resources, to a world dominated by knowledge, implies a shift in the locus of economic power as profound as that, which occurred at the time of the Industrial Revolution. We are in the early stages of a **"**Knowledge Revolution", the initial impact of which is becoming apparent in the volatility of markets, uncertainty over future direction within governments and businesses, and the insecurity over future career and job prospects felt by individuals.

When the new economy is compared with the "old economy", that is, the economic transformations that followed the second industrial revolution or the New Economies #3 and #4 shown in Table 1, a number of differences stand out. These differences are depicted in Table 2.

Table 2: Differences between the Old and the New Economies

Issue	**Old Economy**	**New Economy**
Economy-wide characteristics		
Markets	Stable	Dynamic
Scope of competition	National	Global
Organizational form	Hierarchical, bureaucratic	Networked
Industry		
Organization of production	Mass production	Flexible production
Key drivers of growth	Capital/labour	Innovation/knowledge
Key technology driver	Mechanization	Digitization
Source of competitive advantage	Lowering cost through economies of scale	Innovation, quality, time-to-market, and cost
Importance of research/innovation	Low/moderate	High
Relations with other firms	Go it alone	Alliances and collaboration

Workforce		
Policy goal	Full employment	Higher real wages and incomes
Skills	Job-specific skills	Broad skills and cross-training
Requisite education	A skill or degree	Lifelong learning
Labour-management relations	Adversarial	Collaborative
Nature of employment	Stable	Marked by risk and opportunity
Government		
Business-government relations	Imposed requirements	Encouragement of growth opportunities
Regulation	Command and control	Market tools, flexibility

Source: The *New Economy Index* web site

In the "former new economies", distinctive competencies have included access to raw materials, natural resources, and fertile lands. In an era in which knowledge is the important intangible asset, a national competitive advantage will increasingly be derived from an educated and empowered workforce able to adapt quickly to the dynamic requirements of a changing world (Ives, 1992). From this point of view, knowledge, learning, and education become ever important and move centre stage in developing a competitive advantage, not only at the level of the nation-state, but increasingly at the firm level and, of course, the personal level. Knowledge workers will be valued for their creativity, ideas, flexibility, and adaptability, which requires intelligent and thoughtful human resource management.

This is backed by Robert D. Atkinson, director of the Technology, Innovation and the New Economy Project at the Progressive Policy Institute (PPI), who proposes three main foundations to sustain the growth of the new economy: speeding the transformation to a digital economy, investing in research and innovation, and improving skills and knowledge. The number of engineers, he notes, has grown, but not at the rate the new economy requires. Moreover, intensified competition, churning of firms, and low employee tenure has led companies to spend less on skill training. PPI therefore proposes that companies collaborate in networks, partnerships, and consortia to invest in training, to ensure innovation and growth (Atkinson and Court, 2000).

1.2 Effects of Globalization and ICTs on Skills

Contrary to popular belief, the decline of industrial jobs in advanced economies is only partially related to globalization; technological change has had more profound impact on the labour market: "today's workplaces are often in multi locations characterized by cultural diversity" (Lynch, 2002,

p. 7). Furthermore, in many organizations, relationships among competitors, suppliers and customers "are complex and boundaries have blurred between organizations and their environments" (Hiniker and Putnam, 2002, p. 8). Advances in technology have helped to de-massify production, reduce economies of scale and boost industrial productivity to the extent of de-industrializing the economies, thus causing a movement of labour from industry to the service sector. There is a public perception that all service sector jobs are low-skill and low-paid. In reality however, many good and well-paid jobs for highly skilled workers have also been generated by the service sector, especially in more advanced countries (Camdessus, 1997). Therefore, Toffler and Toffler (1995) argued that the current trend for denigrating the service sector as "hamburger flipping" must stop.

In their attempts to become and remain more competitive in this new world order brought about by globalization and technological developments, many enterprises have adopted different approaches to human resource management and organizational practices, such as the following: hiring and layoffs, altering hours of work, using part-time and contract workers, subcontracting and outsourcing work, reducing hierarchical structures, adopting more fluid job designs, as well as implementing multi-tasking, multi-skilling, self-managed teams and multi-functional teams (Human Resources Development Canada, 1996). There seems to be no consensus regarding the impact of technological change on the workplace and its effects on jobs and skills. Some believe that technology is de-skilling jobs, while others argue that technology is up-skilling jobs. Tenets of up-skilling would argue that in this emerging knowledge-intensive economy the proletariat is being replaced by a cognetariat where work is increasingly shifting away from manual tasks toward symbolic processing (Toffler and Toffler, 1995). The concept of "mind workers" or knowledge workers has emerged from this transformation of work and it appears to be the fastest growing type of worker. The country studies cited by the International Labor Organization (2001, a) indicate that the introduction of ICTs can contribute both to up-skilling and de-skilling of workers. "On the one hand, ICTs can downgrade skills and competence to single-task machine-tending and, on the other, it can upgrade skills and competence to multi-task work relying on greater creativity" (p. 9). The European Union's *Livre blanc sur l'éducation et la formation* (1995) also indicates that with the advent of new technologies Europe is moving toward a "cognitive society" in which work content will be limited to tasks requiring initiative and flexibility on the part of the worker. The re-engineered workplace expects workers to perform "more complex tasks, use new technologies, involve less direct supervision of workers, and acquire the use of higher skill and knowledge levels in making decisions and solving problems individually and as members of collaborative work teams" (Frantz, Friedenberg, Gregson and Walter, 1996, p. 1-2). As Johnston and Parker predicted in 1987, in the US there were some indications that 42% of new jobs were going to require high-level reasoning in the new millennium. Lynch (2002) reporting today's figures indicated that "less than 20% of the workforce is in jobs classified as unskilled" (p. 8) as opposed to 60% in 1959; the remaining 80% of the job market are skilled occupations (60%) and professions (20%).

The synergy of combining new technologies with human skills in the post-industrialized society has created a controversy regarding the effects of technology on skills. Those who posit that technology has augmented skill requirements, advocate increased specialized job skill training. On the other hand, proponents of the de-skilling concept argue that many trade skills traditionally imparted in Technical and Vocational Education and Training (TVET) are no longer valued in the high performance workplace. Instead, they recommend the development of solid basic foundation skills as well as generic, broadly transferable employability skills (Budke, 1988). This trend is more apparent in the service sector where entry requirements are less well defined (Quebec, Ministry of

Education, 1998). This conflict in views "exacerbates a traditional split among educators and policy-makers concerning the appropriate role and function of job training and vocational education" (Budke, 1988, p. 11). There is evidence that ICTs have polarized jobs into highly skilled and unskilled.

1.2.1 Dignity of Work and Fair Pay

For some people, work over the past decade has become technologically complex, demanding sophisticated work skills. Others, as a result of unemployment, have been denied the satisfaction that comes from the challenge of work, and the sense of achievement gained. The job market and jobs have become sharply polarized by a simultaneous increase in jobs requiring post-secondary education and casual jobs for unskilled workers. This polarization of the labour force is widening the inequalities between the haves and the have-nots and between the educated and less educated. Tuijnman (1997) noted: "Alienation, social exclusion, unemployment and slow productivity growth are among the consequences of limited capacity of some countries to adapt and fully exploit the opportunities offered in the global knowledge economy" (p. 4).

The ILO estimated there were 160 million unemployed workers at the end of year 2000; most of them were first time job seekers, with as many as 50 million coming from industrialized countries (ILO, 2001). Moreover, many people are currently forced to accept low-skill, low-paid, part-time and non-permanent jobs. ILO (2001, a) reported that about 500 million workers, mostly from developing countries, do not earn enough to keep their families above the poverty line. Technological innovations, which call for highly skilled workers, are contributing to widening inequalities in income and employment prospects between the skilled and less skilled workers (Camdessus, 1997). Even the developed countries have not been spared. Maxwell (2000) noted: "Despite all the talk about the explosion of knowledge-based economic activity and its contribution, two million adult Canadians work for less than $10 an hour–about one in six employed people" (p. 1). Surprisingly, many of these people are well educated. One-third has a post-secondary diploma or degree. The US is experiencing the same kind of phenomenon. The results of a number of recent surveys indicated that the rate of underemployment among four-year college graduates in the country range from 40% to as much as 50% in the social sciences. The underemployed are found among the young highly educated workers (Gray, 2002).

Hobart (1997) noted that: "unemployment is one of the most pressing problems facing the world today…every government around the world has to grapple with this issue" (p. 7). This economic dislocation is having a devastating effect on young people who enter the labour market without any marketable skills. Young people are being disproportionately affected by high unemployment, underemployment, and credential inflation. In the OECD countries many young people work in "non-standard" part-time and insecure jobs primarily in hotels and restaurants, wholesale and retail trade, and automotive repair to acquire experience that they hope will lead to better jobs (Quebec, Ministry of Education, 1998). While traditionally youth unemployment has just been considered "a rite of passage in growing up and making one's way in the world of work" (Canadian Youth Foundation, 1995, a, p. 1), it has now reached such a tragic proportion that it has become the number one priority on governments' agenda. According to ILO (2001, a), the youth unemployment rate in OECD member countries in 1999 was 11.8 per cent. In the US, it is estimated that as much as 30% to 50% of students enrolled in pre-baccalaureate technical education across the country are underemployed college graduates or college drop-outs (Gray, 2002). According to Gray (2002) "there is a surplus of individuals with degrees but also a shortage of university graduates with skill"

(p. 8). Although the full economic, social, and psychological impacts of chronic youth unemployment are not fully understood, its perceived threats to social stability are drawing considerable attention.

Various initiatives are being implemented to facilitate the transition of young people from school to work. A "school-to-work" plan can be defined as a "system that would equip all young people with high levels of academic and occupational knowledge and skills to find employment that uses their capacities" (Stern, Bailey and Merritt, 1996, p. 6). Many successful school-to-work programmes have been implemented in Austria, Canada, Germany, Japan, Switzerland, and the US. Common types of programmes implemented in Canada include mentoring programmes, programmes targeted to special needs groups, career counselling and job placement, school-business partnerships, co-operative education, restructured programmes, youth apprenticeship programmes, and supervised work-based learning. The Norwegian Youth Guarantee programme is perhaps the most comprehensive approach to address youth alienation to the labour market. Under this programme, unemployed youth are offered a job (with or without training) for a six-month period (Quebec Ministry of Education, 1998). Research shows that women and older workers have also been severely affected by the economic change and workplace transformation (Human Resources Development Canada, 1996).

While a sound school-to-work policy is a step in the right direction, by itself it will not solve youth unemployment. All social partners should work together to create economic climates favourable to job creation (Association of Canadian Community Colleges, 1998). The Canadian Youth Foundation study (1995, b) concluded that at the rate at which new jobs are being created in Canada, self-employment remains the only entrance to the world of work for many young Canadians. The Jua Kali programme in Kenya is an excellent example of how self-employment can also alleviate poverty in developing countries (Mbugua, 1997).

TVET should play both a reactive and proactive role with regards to unemployment. Reactively, TVET must collaborate with its social partners in helping the unemployed, especially youth and other disadvantaged groups, to acquire the critical academic and occupational skills necessary for employment. Research shows that people with inadequate skills, females, young people from disadvantaged regions, migrants and people with handicaps tend to have a more difficult time during the transition to the post-industrialised society (Reubens, 1981). Proactively, TVET should focus on the implementation of school-to-work programmes to facilitate the transition of young people to the workplace. An analysis of recent international initiatives identified the four underlying principles of effective school-to-work programmes: new curricula should be created that integrate vocational and academic studies; occupational and educational performance standards should be explicitly related to each other; initial education and training should include a certain amount of work-based learning for all students; employers and educators, including both vocational and academic educators, must share both responsibility and power in new school-to-work systems (Stern, Bailey and Merritt, 1996, p. 4).

1.2.2 Need for Flexible Access to TVET throughout Life

Workers of the future may expect to work on short-term assignments, on a contract basis, or within several project teams. They may have to work for more than one employer at any given time or even in new careers several times. Additionally, the Canadian Labour Market and Productivity Centre (1993) estimates that fifty per cent of technical workers' skills become obsolete within three to

seven years. Lifelong learning is the only way to prevent obsolescence and remain competitive in a job market where work is becoming increasingly knowledge-intensive (Pritchett, 1995). One of the challenges with regards to lifelong learning is to provide recurrent opportunities for access to education and training throughout the life of a person (IITE, 2001a).

The need for recurrent education and the changing labour market conditions call for flexible access to TVET. Continuing education models that will meet workers' lifelong learning needs have to be relevant and flexible to provide just-in-time learning without distance (Manitoba Education and Training, 1998). In response to this need some institutions are implementing open-entry/open-exit programmes in TVET. For example, UNEVOC (1998) reports that Sweden has a very extensive system of adult education, one that is flexible enough to allow adults to acquire their education at different stages in life through various modes of delivery.

While there is an official discourse about the need for lifelong learning, accessibility still remains a major issue. John Daniel, Assistant Director-General for Education, UNESCO recently noted:

> The problem in education today is that hundreds of millions of the world citizens do not receive it. Many more do not get enough of it…. Over 100 million children never see the inside of a school. As many more do not stay in school long enough to gain useful skills. 800 million adults have their lives blighted by illiteracy (2002, p. 1).

In the context of TVET, Stevens (2001) pointed out that: "distance education is believed by many to hold promise in addressing critical problems facing skills development at present, namely: a lack of qualified instructors, the need to greatly increase the delivery of skills training on a wide scale, and the need to deliver training at a much lower unit costs owing to constraints on financing" (p. 3).

In commenting on the use of ICTs to increase access to education, Haddad and Draxler (2002) noted:

> It is going to be very difficult-if not impossible for countries to meet the objective of *effective learning, for all, anywhere, anytime*. Our inability to meet this challenge, however, is self-inflicted because we tend to think of linear scaling, that is, using the same model of education (a school constrained by space and time) but more of it and on a larger scale. What we really need is to think differently and radically. The education model developed for the Industrial Age cannot achieve educational empowerment effectively in the Information Age. With ICT tools, we should be able to evolve the components of the conventional model into the corresponding components of the new model (p. 8).

Limited access to TVET particularly in rural areas and for disadvantaged groups continues to be a major issue for most countries in Asia-Pacific region. The following suggestion was made to address this issue at a Regional Planning Meeting of TVET experts (UNESCO-UNEVOC meeting, 2002):

> The TVET system should introduce poor-friendly training, delivered at their doorsteps at times convenient to them through appropriate modes of training. It may take the form of mobile training, distance learning, strengthening training by master craftsmen and such other innovative modes of training delivery (p. 1).

While ICTs hold promises for improving access to education there is also growing concerns regarding the divide that is creating among people. CONFINTEA V (Fifth International Conference on Adult Education) "warned about the emerging form of exclusion created by the development of new ICTs" (UNESCO, 2003).

TVET has an important role to play in developing the computer literacy of students. Most vocational students are from disadvantaged working class or minority students having limited access to home computers. The integration of computer-based technology in TVET would provide equality of opportunity for these students. Passmore (1983) notes:

> Vocational education classrooms are where large proportions of low-income, minority, and female students (home economics and business education programmes typically have high female enrolments) can be found. It therefore seems appropriate to educate these students in the computing skills, which will be necessary in their employment and in the work of the household (p. 3).

SECTION 2 ICTs FOR TEACHING AND LEARNING

The increased use of ICTs in TVET has resulted in a major paradigm shift, from a total dependence on the objectivist paradigm to a growing adherence to the cognitivist and constructivist paradigms. For example the use of ICTs in distance education has resulted in a pedagogy, which is constructivist, collaborative and interactive (Wonacott, 2001).

This section provides a brief discussion on the different types of ICTs in common use for teaching and learning, namely: audiocassette tapes, radio, videotapes, CD-ROM, the Internet, wireline technology, wireless technology, web-based training, audioconferencing, audiographics, interactive television, videoconferencing, and open and distance learning. The advantages and disadvantages associated with the use of each of these technology-based learning strategies are reviewed. Whenever appropriate, a case study is provided to support the discussion.

2.1 Role of ICTs for Teaching and Learning in TVET

ICTs are revolutionizing education by removing distance from education and making knowledge more accessible to all (Industry Canada, 1997). Technology-enhanced learning will play a crucial role in the development of a lifelong learning culture and has the capacity to empower learners by providing them with multiple pathways that offer choices and channels to meet their education and training needs (Human Resources Development Canada, 1998). It is not surprising therefore to see a growing interest in Technology-Based Learning (TBL) across the world. TBL may be defined as the array of hardware and software used in the teaching and learning systems that include computer-based training systems, multimedia systems, electronic performance support systems, telecommunications systems, as well as the Internet with World Wide Web systems. The rate at which the Internet is being accessed keeps increasing at lightning speed. TBL can enhance teaching and learning; it has the potential to become cost-effective as it offers greater flexibility regarding time and location of training delivery (Furst-Bowe, 1996). Additionally, TBL may facilitate institutional policy regarding access and equity (Lafreniere, 1997). Technology also provides greater flexibility to adapt teaching and learning to meet learners' cognitive and learning styles.

Although ICTs are by far the most significant element undergirding the foundation of TVET, there is a paucity of literature and research regarding its implementation and use in this field of education and training. Attwell (1999) noted: "whilst there is a wealth of studies and debate on the use of information and communication technologies in university and higher education, there has been only limited work on the potential impact for vocational education and training". Even the database of UNESCO-UNEVOC International Centre for Technical and Vocational Education contained very

limited information on the current use of ICTs in TVET. Consequently, in reviewing the literature and research for this section, every attempt was made to locate publications related to TVET. However, publications focused on general education were reviewed when no suitable TVET specific publications could be located. The reader can make appropriate inferences regarding the relevance of the discussion to TVET.

Imel (1998) identified four different application of ICTs in adult education, namely: technology as curriculum, technology as a delivery mechanism, technology as a complement to instruction, and technology as an instructional tool. Following is a brief description of each approach.

Technology as curriculum

When using technology as curriculum the focus is on developing ICT literacy skills. There are two types of ICT literacy skill sets. The first is generic ICT literacy skills such as keyboarding, word-processing, using databases, using spreadsheets, desktop publishing and using the Internet for research and communication (Kasworm and Londoner, 2000). In this network economy every graduate from TVET programmes needs to possess these essential and generic ICT literacy skills. The second ICT skill sets are the occupationally specific ICT literacy skills. Examples of these skills include the ability to use CNC equipment, work with CAD/CAM, and operate equipment with digital system controls.

Technology as delivery mechanism

When technology is used as a delivery mechanism the focus is on packaging course content for digital delivery. Common approaches in current use include: computer-assisted instruction (CAI), computer-based instruction (CBI), and web-based or online instruction. Open and Distance Learning programmes make extensive use of technology as their delivery mechanism.

Technology as a complement to instruction

When technology is used to complement instruction the emphasis is on providing opportunities to practice skills taught and extending learning by working with specific software applications (Kasworm and Londoner, 2000). Simulators are often used in TVET to address safety concerns during the initial phase of training and to offset cost in renting equipment for training crane operators and truck drivers. In its simplest form, technology can be used for drill and practice to complement instruction.

Technology as an instructional tool

Human learning is a very complex process. In spite of years of research in education, our understanding of how human learn is still limited. For this reason educators strive to use the little that is known about human learning whenever they engage in the act of teaching and learning. The learning process can be divided into two broad categories. The first relates to learning conditions that are internal to the learners. While this is the area where the potential to improve learning outcomes is the highest, it is undoubtedly the area that is most difficult to affect. Refer to section 6.3 on Cognitive Divide.

The second condition of learning is external to the learners. People learn through the five senses and the contribution of each to the amount that we learn varies. Following is estimated amount of learning from the five senses (Kupsh and Mason, 1986):

- Taste: 1%
- Touch: 1.5%
- Smell: 3.5%
- Hearing: 11%
- Seeing: 83%

The amount of information that people retain is also an important aspect of learning. Kupsh and Mason (Ibid) provide some interesting insights regarding the amount of retention through the various senses over time:

	After 3 hours (%)	After 3 days (%)
Material heard only	70	10
Material seen only	72	20
Material both heard and seen	85	65

Analysis of the retention rate through the various senses indicates that ICTs can be used to create a variety of external conditions that are conducive to learning and retention. Following is a list of different types of audiovisual aids that can be used to maximize learning outcomes in TVET.
Audiovisual Aids:

Over head projector	World Wide Web
Television	Slide projector
VCR	Film strip projector
Video Projector	Simulators
Digital Cameras	Graphical interfaces
Scanners	Online publishing
Telephone	Printed materials
Radio	Chalk board
Tape recorder	Electronic board
Computer	One or two way video
CD player	Satellites
Internet & Local area network (LAN)	Interactive television

Imel (1999) proposed the following additional guidelines for using ICTs in TVET:

- Let learning outcomes drive the process of technology choice-Technology is only a tool therefore teachers must use technology as part of a total instructional plan;
- Strive to infuse and/or integrate technology into instruction and curriculum;
- Use the technology to shift the emphasis from teaching to learning;
- Be prepared to modify the role of the instructor- the teacher is not the only source of information; and
- Use technology to move the focus away from low-level cognitive tasks to higher order thinking skills.

The following application software are also used by TVET teachers:

Productivity software	Graphics software
Word processing	Presentation software
Integrated software	Desktop publishing
Spreadsheet	Discipline-specific programmes
Database	Simulations
Graphics applications	Authoring software

CASE STUDY 1: ICTs in TVET: IITE Expert Meeting

In April (2003), the UNESCO Institute for Information Technologies in Education hosted an expert meeting in Moscow, dealing with ICTs in technical and vocational education and training (TVET). Fifteen experts form six countries attended the meeting. The two major discussion topics were:

- Usage of ICTs in TVET;
- Issues related to the use of ICTs in TVET.

The final report of that meeting can be obtained from the IITE web site: www.iite-unesco.org

This analytical survey represents the final outcome of this initiative. It had two main objectives:

- To review and classify the usage of ICTs in TVET within UNESCO's Member States;
- To familiarize the specialists from UNESCO's Member States with research on ICT usage in TVET.

2.2 Common Types ICTs for Teaching and Learning

The evolution and development of ICTs has resulted in a paradigm shift in the educational system. ICTs are changing the way people learn, offering new alternatives to the traditional classroom. In this new economy, it is essential for learners to have access to education anytime and anywhere. Haddad and Draxler (2002) state, that "lifelong learning and training for the workplace cannot be confined to the traditional classroom. It is unrealistic and unaffordable to continue to ask learners to come to a designated place every time they have to engage in learning" (p. 7). ICTs allow the delivery of education to adapt to an individual needs as opposed to having the individual adapt to how the education is delivered. Education will not be confined to the four walls of a classroom but to wherever and whenever the learner deems appropriate. "Education will not be a location anymore, but an activity: a teaching/learning activity" (Haddad and Draxler, 2002, p. 8). ICTs have the capability of providing "personalized, just-in-time, up-to-date, and user-centred education activities" (Haddad and Draxler, 2002, p. 12).

Besides their potential to providing education to anyone, anytime and anywhere, ICTs have encouraged new research and development in teaching and learning techniques. As stated by Dean (2002), Schank, the founder of Cognitive Arts, believes that educational institutions must adopt a new way of teaching. He claims that students "learn better through experiential and emotional learning rather than through memorizing names and dates" and thus educators must simulate real-world environments (Dean, 2000, p. 1). Technology can be used to facilitate these types of environments. An example of this is using flight simulators to train novice pilots (Dean, 2002). On the other hand, Aldrich argues that this type of learning is restrictive and instead believes in "the ant on the basketball model" where learners have the freedom "go wherever they want but stay in a finite world". Courses would be customized to each user and provide a wide array of options, "like a computer game" (Dean, 2002, p. 2). Although these two methods offer two conflicting views of learning, the fact that this discussion is taking place and experiments are being done to determine new methods of learning has intrinsic benefit of its own; experimentation will eventually lead to new and innovative methods being developed.

There are a variety of different technologies that can be used in TVET. Each of these technologies has its own redeeming qualities and limitations, and different situations call for different technologies.

2.2.1 Audio-Cassette Tapes

Audiotapes can be played by any standard cassette player. Through audio, the tapes can convey information that may be easier to illustrate with sound than simply through text or diagrams. It can accompany other means of instruction (print-based material, classroom teacher, etc.) and provide detailed information step-by-step (Perraton et al., 2002).

Advantages and disadvantages

Tapes are recordable and thus can be reproduced easily and cheaply. Tapes provide a permanent and flexible storage of information. The tapes can be stopped to allow for classroom interaction and discussion and they can be replayed in instances where it might be beneficial to repeat parts of lessons. Radio programmes can be recorded to allow the lessons to be replayed at a later date (Perraton et al., 2002). Since tapes are relatively small they are portable and can be transported to different areas through the postal service or other delivery service.

A development team is required to develop the lesson plans, edit and record the tapes, and integrate the tapes appropriately with accompanying print-based material or other media. Audiotapes provide only one-way communication where an external instructor cannot interact directly with students and they cannot gauge the progress of the students. The lessons on the tape must also be interactive. To increase effectiveness, the lessons must contain pauses that allow students to think and discuss. Tapes lose their effectiveness if the information is presented as one long lecture (Perraton et al., 2002). It is difficult to present complex concepts using tapes (Nunes and Gaible, 2002). Another limitation with tapes is that the sound quality depends on the quality of cassette player and the "age" of the tape. The sound quality on tapes degrades after repeated use and recording (Perraton et al., 2002).

2.2.2 Radio

Radio is one of the oldest technologies used for distance education (Stevens, 2001). Radio programmes can be broadcast or interactive (Oujo, 1999). Broadcast radio mirrors the traditional classroom-based model where an instructor lectures through the radio programme and students typically follow with print materials (Oujo, 1999). It can be thought of as "strict" one-way communication where students are not expected to respond and therefore it is hard to gauge the progress of the students (Oujo, 1999). Interactive radio instruction (IRI) can be described as an interactive lesson where an external teaching element is involved in classroom activities via radio (Dock et al., 1999). IRI allows the students to participate as the lesson progresses. To be interactive, a lesson can have spaces or pauses where students can think, develop responses, discuss with other students, or have time to let information sink in.

Radio instruction involves the production, transmission, and reception of the radio programmes (Dock et al., 1999). There are different types of radios available to learners: electric radios (e.g. transistor radios), battery-powered radios, and solar-powered crank radios (Oujo, 1999). Thus, students and the educational organizations can choose a radio that best suits their situation based on the availability of electricity and the supply of batteries. In some cases it may be more cost-effective in the long term to use a solar-powered crank radio. A local or national broadcaster is required to transmit the programme at a particular frequency and specific time (Perraton et al., 2002). The production and development of a programme involves planning, scriptwriting, radio production, and piloting of the programmes by a development team (Dock et al., 1999).

Advantages and disadvantages

Radio is advantageous since it is relatively inexpensive for learners in developing countries and it is accessible for the illiterate and the poor (Oujo, 1999). Due to the availability of inexpensive radio receivers, it has the potential to reach a large number of learners (Stevens, 2001).

Although radio instruction is considered to be interactive, it is still a one-way communication medium from the external teacher to the learner. The interaction is with printed materials, other students, and the classroom teacher. The material presented in the lesson is only available at the time of the broadcast unless it is recorded. Some other limitations of radio instruction include the inconvenience due to the rigidity of programme schedules and the dependence on "regular and reliable transmission facilities and broadcasting infrastructure" (Perraton et al., 2002). As with cassette tapes, radio is audio-based and thus not always the most effective means for presenting complex concepts.

2.2.3 Videotapes

Videotapes can be produced and edited by using a portable video camera and a home video editing suite. The technology for video production continues to improve with the emergence of digital video cameras and new computer software that can facilitate the editing process. Videotapes can be viewed by using a TV and VCR combination. It is recommended that videotapes be no longer than 10 minutes with short segments of less than three minutes (Hampton, 2002).

Advantages and disadvantages

Videotapes appeal to both audio and visual senses. Real-life situations can best be presented and described using video as opposed to using text or audio (Nunes and Gailbe, 2002). Videos can be used when "introducing a new theme to motivate and contextualize learning, after a topic has been

addressed in a few class periods to aid students in applying the knowledge they acquired, or after an entire module is completed to show connections to other subjects and disciplines" (Nunes and Gailbe, 2002, p. 98). The learner has the flexibility to replay, pause, and rewind videotapes and can repeat lessons as often as they wish (Hampton, 2002). Videotape can support the teaching of practical skills delivered through open and distance learning. Other benefits include "ease of use for the learner, low duplication costs, relatively wide access to the playback technology, and educational effectiveness for imparting practical information" (Stevens, 2001, p. 85). Another advantage is that captions and visual cues can be used in the videotapes to help the hearing-impaired.

Caution must be exercised when developing videotapes so as not to include too much information as that could degrade the learning experience. Practical skill must be taught in a clear, concise manner. This strays from the typical teaching model where instructors are taught to provide plenty of explanations and examples. These extra explanations and examples are better served in a face-to-face environment rather than on videotape.

CASE STUDY 2: Agricultural Officer Extension Training Using Video in Jamaica and Ghana

The agriculture industry is fundamental to both countries' economies. Approximately two-thirds of Ghana's exports are from agriculture while in Jamaica agriculture is responsible for 10% of the GDP and employs roughly 30% of the workforce (Stevens, 2001). There have been initiatives in both countries to sustain and improve the agriculture sector by improving the skills and knowledge of workers in new methods and techniques (Stevens, 2001). Included among these initiatives are the agricultural projects spearheaded by The Commonwealth of Learning in both Jamaica and Ghana through the Commonwealth of Learning Media Empowerment (COLME) programme. It was determined that digital video training could be effective in demonstrating farming techniques in Jamaica and food processing methods in Ghana (Walker, 1999).

The technology used included digital camcorders, tripods, wireless microphones, videotape, VCR, and a non-linear editing system (Stevens, 2001). Recent innovations in video production and equipment have made it viable for people in extension services and non-formal education to be involved in the process of video production. The process is more "economical, efficient, and effective" (Walker, 1999).

In Jamaica, the delivery strategy includes loaning or selling the videos to farmers, having copies in video stores, showing the videos at meetings, seminars, and field days, giving copies to the Ministry of Agriculture to include in national productions, and distributing to the television broadcaster (Walker, 1999). Extension workers use videos for "just-in-time training". The information in the video can be specific to a particular parish, valley, and/or field. Videos are particularly useful for illiterate farmers for whom print information is not an option (Walker, 1999). Videos act as a motivational device since workers see themselves and colleagues on these videos.

In Ghana, where televisions and VCRs are not common to each household, the videos are shown at meetings, seminars and field days using a communal television and VCR, and they are also sent to the Ministry of Agriculture to be included in national productions. The programme assists in training women in agriculture and agro-food processing.

Women are involved from shooting the video to producing and editing the video using computer-based programmes (Walker, 1999). This allows them to become involved in not only actual farming but also training their colleagues in best practices and procedures.

2.2.4 CD-ROM and DVD

CD-ROMs (Compact Disc-Read Only Memory) store information digitally and they can be used on any computer equipped with a CD-ROM drive (Hampton and Bartram, 2002). DVDs (Digital Video Disk or Digital Versatile Disk) are similar to CD-ROMs and can be used the same way as CD-ROMs but contain more information. Most CD-ROMs have 650 or 700 megabytes storage space whereas most DVDs have room for 4.7 gigabytes, which equals approximately seven times more storage space than a CD-ROM. DVDs are not widely used yet, mainly because of different standards for writing to DVDs. Once the problem of conflicting standards is resolved, DVDs will probably supplant CD-ROMs as the preferred portable storage medium.

Advantages and disadvantages

CD-ROMs have a large capacity and can support the storage of information in a variety of formats including text, animation, video, audio, and graphics. Thus, learning materials can be presented in different ways. This allows the material to cater to multiple styles of learning (Hampton, 2002). For example, Hampton (2002) states:

> Learners might first view a video, which provides an overview both visually and audibly of the practical skill they are acquiring. The video could be followed by clear digital photographs of the step-by-step procedure with either text prompts or a voice-over to provide additional explanation. An overview of the complete process could occur in an animation, and then the whole process summarised in dot points using text (p. 86).

Since the material is stored digitally on CD-ROM or DVD, it is very durable and the quality does not degrade after repeated use. However, scratching the surface or other abuse of the medium may prohibit it from being read by the CD-ROM drive.

A major limitation with CD-ROM and DVD is that a computer with CD-ROM drive (in the case of DVDs, a DVD-drive) is required to access the information. This equipment may not be available to learners in developing countries. Depending on the complexity of the instructional content, a team of experts may be required to develop high quality product. The development team could include a computer programmemer, graphic artist, content specialist, and instructional designer.

CASE STUDY 3: Using CD-ROMs at the Onkaparinga Institute of Technical and Further Education (TAFE)

The Onkaparinga Institute of TAFE in South Australia offers courses in various fields ranging from community services and health, to horticulture and agriculture, to transport engineering. One of their transport engineering courses offers training in Heavy Vehicle Mechanics. In 1997, the institute began to use interactive CD-ROMs as a learning tool for their students enrolled in this programme. These CD-ROMs encapsulated both practical and theoretical components of the course material. The materials were presented using text, audio, graphics, and video and were geared for students who prefer less text and more user-friendly and interactive presentations including diagrams, photographs, and

video. Some of the modules developed on the CD-ROMs are being used in the workplace where the computers are located at the end of the workbench and provide step-by-step instruction to complete the tasks (Hampton and Bartram, 2002).

Source: http://www.tafe.sa.edu.au/institutes/onkaparinga/courses/courlist.shtml#comm

2.2.5 Internet/Web-Based Training

Internet/Web-Based training provides an environment where students access and study course materials online. It may involve the use of live e-learning tools such as application sharing, Internet telephony, online whiteboards, break-away rooms, discussion boards, and chat and messaging programmes that allow real-time interaction between instructors and learners. It can also be used to transmit text, graphics, images, animation, or video. The required tools for online learning include a personal computer and an Internet connection. There are several ways a user can connect to the Internet: standard analog modem (for example, 56 Kbps), Digital Subscriber Line (DSL), cable modem, Integrated Services Digital Network (ISDN), Local Area Network (LAN), cellular, and wireless broadband (fixed wireless and satellite). All connections except for a standard analog modem connection are considered broadband connections. All of these methods allow connection to an Internet Service Provider (ISP) that provides a gateway to the rest of the Internet. An analog modem and ISDN required a "dial up" connection where a user must dial in to connect to the ISP, whereas the other Internet access methods, denoted as "always on" connections, required no dialling.

Wireline technologies

Analog Modem: This is the original device that allowed computers to connect to the Internet. Analog modems can be internal to the computer or an external device that connects through a serial port on the computer. The standard modems have the capability of transmitting at 56 Kbps. Since this relies on older transmission technology, analog modems provide the slowest connection speed of all other Internet access methods. However, it is relatively inexpensive and it is still widely available to most people. (Comparing…, 2001).

ISDN: Similar to DSL, ISDN uses a normal copper telephone line to connect to the Internet. The copper line must be "converted" to a digital ISDN line, after which one can connect to the Internet and have a phone conversation over the same line. Basic service enables connection speeds up to 128 kbps. An ISDN modem is used to interface a computer to the telephone network. The modem is either an internal card or an external device that connects to a computer's serial or USB (Universal Serial Bus) port (ISDN, 2000) (broadband 101 - ISDN…, 2001). ISDN is also a "dial up" service and users must dial in to their ISP (broadband 101- ISDN…, 2001).

DSL: DSL uses a normal copper telephone line (a pair of copper wires) to provide a high-speed connection to the Internet. Thus, it is telephone companies that typically provide DSL connections. When connected to the Internet, the phone line can still be used for normal voice calls. A DSL transceiver (modem) is the interface between the computer and the phone line. The computer is connected to the modem either through a USB or 10 base-T Ethernet. If using an Ethernet connection, the computer must have an NIC installed where the NIC connects to the modem through an Ethernet cable. If the computer has a USB port, it can connect to the modem via a USB cable. There are two different categories of DSL: asymmetric and symmetric. For asymmetric DSL, the

downstream speed is faster than the upstream speed whereas for symmetric DSL, the downstream and upstream speeds are the same. Connection speeds vary from country to country and they also depend on the particular DSL provider within that country. In OECD countries, downstream (Internet to customer) connection speeds range from 128 kbps to 8 Mbps (where speeds of 256 kbps and 512 kbps are the most common) and upstream (customer to Internet) connection speeds range from 64 to 740 kbps (where a speed of 128 kbps is the most common) (Paltridge, 2001).

Cable: A cable connection uses the same coaxial cable used for television signals to send and receive data to and from the Internet. A cable modem acts as the interface between the computer and the coaxial cable. The computer is connected to the modem either through USB or 10 base-T Ethernet. If using an Ethernet connection, the computer must have a NIC installed where the NIC connects to the modem through an Ethernet cable. If the computer has a USB port, it can connect to the modem via a USB cable (broadband 101 – cable, 2001). As with DSL, connection speeds depend on the cable provider within the particular country. In OECD countries, the advertised downstream connection speeds range from 128 kbps to 2 Mbps (where speeds of 256 kbps and 512 kbps are the most common) and the advertised upstream connection speeds range from 64 to 768 kbps (where a speed of 128 kbps is the most common) (Paltridge, 2001).

LAN: The computers in businesses and educational institutions are usually connected to a LAN. A LAN connects computers and peripheral devices using the same transmission line, allowing for applications, devices (for example, printers), and data storage to be shared among the members of the LAN. There are three different methods for connecting computers in a LAN: cables, wireless, and power line systems (Rusten and Hudson, 2002). Cabled LANs use cables and hubs to physically connect the computers and devices. A hub controls the flow of network traffic between individual computers and the system's server, usually in clusters of 20 to 30 cables. Wireless LANs do not use cables but rather a wireless network adapter (receivers) that is either an internal network card or an external device that connects to the computer through USB. As well, "one or more wireless network hubs/transmitters are connected to the server" (Rusten and Hudson, 2002, p. 86). Power line LANs use the existing power lines in an institution for the transmission of network traffic (Rusten and Hudson, 2002).

LANs are typically connected to an ISP through a high-speed T1 line provided by a local telephone company. A T1 line is either a fibre optic cable or a copper line and can carry a data rate up to 1.544 Mbps. All the users that connect through the same T1 line share this bandwidth. Larger companies need higher capacity lines such as T3, OC3, OC12, OC48, and OC192. The higher capacity lines run on fibre optic cables.

Optical fibre: Optical fibres provide a huge amount of bandwidth that is ideal for high-performance applications such as videoconferencing or web-based applications that rely on a large amount of graphics (Rusten and Hudson, 2002). As mentioned previously, telephone companies provide these high capacity lines. They are typically installed for "institutional customers such as hospitals, schools, and businesses" (Rusten and Hudson, 2002, p. 89).

Wireless technology

Cellular: A cell phone with a cellular modem can be used to connect to the Internet. In some developing countries (such as Cote d'Ivoire, Gabon, Rwanda, Tanzania, Uganda, Cambodia, and the Philippines), cellular telephones are more widely used than wireline phones. However, cellular

access can be expensive and the bandwidth is limited. Thus, it is more suitable for "short bursts of use" such as e-mail than running web-based applications (Rusten and Hudson, 2002).

Wireless Broadband: There are two types of wireless broadband service: fixed wireless and satellite (*Wireless*, 2003).

Fixed Wireless **–** A fixed wireless broadband connection uses a ground-based antenna system. A small rooftop antenna communicates with transmission towers, which are directly connected to the Internet (Keizer, 2001). A modem or receiver connects to the exterior antenna via coaxial cable and also connects to a NIC installed on the computer through an Ethernet cable (Wireless, 2003). (Broadband 101 – Wireless…, 2001). Downstream connection speeds can reach 5 Mbps but are usually around 1 – 2 Mbps. Upstream speeds are around 256 kbps (Keizer, 2001).

Satellite – For high-speed satellite Internet connections, a satellite dish and a "satellite modem" are required. Data signals are sent from the satellite dish to satellites orbiting the Earth. The dish is about 2-foot by 3-foot in size and the modem acts as the interface between the satellite dish and the computer. A coaxial cable connects the dish to the modem (*How does…*, 2001). The latest satellite technology allows for downstream and upstream speeds up to 400 kbps. For older satellite service, one may also require an analog modem and another ISP for upstream data transfer. Using an analog modem degrades upstream rates to the speed capability of the modem. As mentioned previously, analog modems have a maximum data transfer rate of 56 kbps.

CASE STUDY 4: Mobile Learning Project at the Northern Alberta Institute of Technology (NAIT) and Seneca College

At the NAIT in Edmonton, Canada and Seneca College in Toronto, Canada, a mobile learning project is providing approximately 120 accounting students with Personal Digital Assistants (PDAs) as a course tool. With the PDAs and wireless technology, students can:

- access accounting materials such as textbook chapters, audio, and video;
- keep up with, research, and complete assignments;
- complete assignments, tests, and quizzes;
- update journal entries;
- study and practice new concepts;
- share information and contact other learners through a student chatter mobile messaging tool.

(Accounting Students…, 2002) (NAIT/Mobile Learning, no date)

The purpose of the project is to determine the educational benefit of using wireless technology. In particular, the goal is to "assess handheld wireless technology in a first-year post-secondary accounting course as a value-added tool that: enhances student success, increases student access to the Institutes' services, (and) expands the body of teaching and learning strategies available to faculty" (NAIT/Mobile Learning, no date, para. 4). Studies will be done to analyse the "effectiveness and efficiency of using mobile computing to achieve learning outcomes, enhance student success and provide access to student services on and beyond classrooms" (NAIT/Mobile Learning, no date, para. 3).

Advantages and disadvantages

The major advantage of web-based training is that students can study anytime at their own pace and anywhere as long as there is a computer connected to the Internet (Hampton and Bartram, 2002). If designed properly and with the students' needs kept in mind, online learning can be a very powerful, interactive, and virtual learning environment that can stimulate and enhance the learning experience.

Effective online learning, however, requires appropriate infrastructure support and properly designed applications. In developing countries, the infrastructure may not be readily available. People may not be able to afford or have access to the Internet or quality computers (Lizardi, 2002). According to the most recent statistics from Nua Internet Surveys, as of May 2002 only 9.57% of the world's population are using the Internet and roughly only 37% of those users live outside Canada, the US, and Europe (*How Many Online?*, 2002). Without adequate infrastructure, the quality of graphics, audio, and video may be sub par. If the application is not designed properly and the quality is degraded, the applications may hinder learning instead of enhancing it. The learning materials may be reduced to simply a text on a screen. Hampton and Bartram (2002) pointed out that it has been shown that people read 25% slower from the screen, and Delio (2000) indicated that retention is 30% less than from printed materials. Another obstacle for online learning is that the development of quality applications requires a team of moderately to highly skilled individuals in computer applications and instructional design (Stevens, 2001). The team may need to include a computer programmemer, graphic artist, content specialist, and instructional designer.

CASE STUDY 5: Singapore Polytechnic Virtual College

The Singapore Polytechnic Virtual College relies on Intranet/Internet technology to deliver its programmes. The Virtual College operates and administers a large collection of interactive, online learning modules. It promotes flexible learning where students can log on to the Polytechnic networks from a computer on- or off-campus using the Internet. The two major goals of this college are "to provide continuing education and lifelong learning for graduates and professionals in industry" and "to supplement conventional lectures and improve teaching and learning through Information Technology for full-time students" (Cheong et al., 2000, para. 4). There are online learning modules for several departments: School of Business (Diploma in Accountancy, Diploma in Media and Communication, etc.), School of Chemical and Life Sciences (Diploma in Biotechnology, Diploma in Chemical Process Technology, etc.), School of the Built Environment and Design (Diploma in Architectural Technology, Diploma in Building and Property Management, etc.), School of Electrical and Electronic Engineering (Diploma in Electrical Engineering, etc.), School of Mechanical and Manufacturing Engineering (Diploma in Mechanical Engineering, Diploma in Manufacturing Engineering, etc.), Singapore Maritime Academy (Diploma in Marine Engineering, Advanced Diploma in Maritime Transportation, Diploma in Nautical Studies), and Student Affairs (Healthy Lifestyle course).

The virtual college caters to two sets of learners: working professionals and on-campus students. By using the Internet, working professionals can re-train themselves in different areas whenever they feel the need to do so. On-campus students can use the Virtual College as a resource to supplement the conventional learning environment. They can use online materials to reinforce concepts and retrieve lecture information that they may have

missed. The Virtual College online materials consist of seven components: For Your Information, Lecture, Tutorial, Assignment, Virtual Laboratory, Digital Resources, and Assessment Centre (Cheong et al., 2000).

Eighty percent of students surveyed found the Virtual College useful for "supplementing their course work, revision, remedial learning, and making up missed lectures" (Cheong et al., 2000, para. 16). These students preferred being taught by instructors and it is believed that these students were weaker and needed special assistance that required face-to-face contact. The bulletin board, assessment centre, lecture, tutorial, and digital resources were found to be useful by most students whereas only half of the students found the Virtual Laboratory useful, since it was not used extensively by module developers due to the difficulty in developing simulations and experiments (Cheong et al., 2000).

The following problems have been encountered with the Virtual College:

- Technical problems – Initially, the internal computer network was very slow. There were problems with playing audio and video files. The network was upgraded and the modules were re-designed to execute more efficiently. Additionally, many students did not have access to online and the necessary bandwidth to use the Virtual College from home. The fees for a broadband connection are currently high for the everyday student (Cheong et al., 2000).
- Pedagogical problems – When the modules were used to supplement in-class lectures, some students viewed this as extra work and were not motivated to put in the extra effort. When the modules were used as a substitute for particular lectures, some instructors and students were unhappy since they would rather have had in-class lectures. When the modules were used for remedial students, they did not suffice since their problems could only be addressed through face-to-face contact with the instructor. Some advanced students did not view the modules as constructive but instead found them a bother (Cheong et al., 2000).
- Copyright problems – Most of the graphics, diagrams, and video clips that module developers would like to use are copyright protected, along with the assignments and tutorial questions that are based on a textbook. It is a major hindrance to apply for the copyright release of the materials (Cheong et al., 2000).
- Customer problems – There is not one absolute view of how the Virtual College should be used and presented. The various departments at Singapore Polytechnic have different requirements and needs so it is a challenge to come up with one "consistent and easily updateable Virtual College" (Cheong et al., 2000, para. 29). Module development takes a significant amount of time due to lack of experience and the need for constant support. It is sometimes difficult to find tutors since lecturers are busy with traditional classes. Also, online tutoring differs from normal face-to-face tutoring and thus requires additional training (Cheong et al., 2000).

2.2.6 Web-Based Training (WBT) Programmes

Many course development tools are now available, which allows instructors with no computer programmeming skills to develop high-quality web-based training programmes. The three most

commonly used platforms are: Blackboard (http://www.blackboard.com), Desire2Learn (http://www.desire2learn.com), and WebCT (http://www.webct.com). All three solutions are server-based and allow access through a web browser to provide
e-learning solutions through the Web.

All three platforms have the capacity to:

- provide course materials;
- manage enrolment and registration;
- develop evaluation material such as quizzes, tests, or assignments;
- communicate with instructor(s) and students online through an announcement section, discussion boards, e-mail, real-time chat sessions or "class rooms", and an interactive whiteboard;
- take and save notes about a course;
- manage grades and provide the grades to the students;
- present important dates through a calendar tool;
- provide links to related web sites.

The Blackboard Learning System provides course management capability. Some of the other key features include a faculty and student profile, and the ability to "create groups of students for collaborative work and enable protected discussion boards, virtual class rooms, and file exchanges for each group" (Yaskin and Gilfus, 2002). Blackboard allows students to navigate through the different parts of the course such as staff information, course documents (learning materials and aids), reading lists, assignments, communication tools, discussion board, and external links.

The Desire2learn Learning Platform allows instructors to create and manage courses and course offerings. It also allows for setting up and editing an organizational structure (that is, organization's name, departments, courses, course offering, modules, topics, etc.). The learning environment contains key areas such as "My Home" (a central location for an individual's courses), "My Calendar", "My Notes" (a student's note-taking area that can be linked to specific content pages), and My Locker/Briefcase (a personal storage area of files and documents). A "document sharing" feature allows documents to be shared with classes or specific groups. Other features include progress tracking, survey tools, feedback systems, journals, portfolios, web pages, shared file storage, and a glossary. Desire2Learn also offers a learning object repository to store and manage learning objects.

WebCT "can be used to create entire courses online or to complement face-to-face instructions. Some of the other key features of WebCT include the ability to create a course syllabus, provide self-tests for students, and develop a searchable glossary. WebCT allows students to navigate through the different parts of the course such as staff information, course documents (learning materials and aids), calendar, syllabus, reading lists, assignments, communication tools, discussion board, grades, and external links. WebCT also provides e-Packs, which are a "set of customisable online course materials developed and formatted for use in WebCT" (WebCT 2002).

Advantages of Web-Based Platforms

- decrease developmental time;
- reduce skill requirement for developing learning materials;
- reduce development cost;

- provide consistency in format;
- facilitates maintenance and support;
- updating is done by suppliers.

Disadvantages of Web-Based Platforms

- institution has no control over licensing cost;
- difficulties when supplier goes out of business;
- platform may provide more unnecessary features;
- platform may not be available in the preferred language;
- platform may require high-end systems.

2.2.7 Audioconferencing

Audioconferencing allows two-way, real-time communication between instructors and learners through audio (Stevens, 2001). Older audioconferencing technology uses the telephone system infrastructure, where the key component is an electronic device called an audioconferencing "bridge". The bridge acts as the main hub for the conference where the participants simply dial into the bridge to connect to the conference. Calls can also be made from the bridge itself. All the calls are combined so all the connected callers can converse simultaneously (Rao, 1994). The maximum number of participants depends on the number of telephone lines terminated at the bridge. All that is needed at each participating site is a standard telephone (Rao, 1994). Radio transceivers combined with the necessary antennas, masts, and cable can also be used as the transmission medium.

Audioconferencing can also be carried out using Internet telephony where digitised voice packets are sent between individuals over the Internet. Individuals can use computer programmes such as AOL Instant Messenger, Microsoft NetMeeting, or MSN Messenger to converse with individuals. As well, some telephone and cable companies are beginning to provide Internet telephones.

Older audioconferencing technology simply includes local or long-distance telephone costs (depending on the location of the participants), and the cost for the bridge itself or the bridging services. Internet audioconferencing incurs the cost of Internet access and the Internet telephony equipment and/or programmes.

Advantages and disadvantages

The main advantage of audio conferencing is that it allows for direct, two-way interaction between participants. Discussions occur in real-time where learners can ask questions and instructors can respond immediately. Another advantage is its low set-up and operating cost.

The main disadvantage of audioconferencing technology is the absence of visual interaction between the instructors and students. No visual cues or visual materials can be used, so any accompanying learning materials must be pre-distributed (Stevens, 2001).

2.2.8 Audiographics

Audiographics is essentially audio conferencing accompanied by visual and graphical aids. "Graphics can be transmitted by facsimile (fax) machine, still video system, computers (text or graphic display), or electronic drawing systems (such as electronic whiteboard) which allow a

participant to draw or write on an electronic screen which is transmitted to a remote site where other participants may see it" (Audiographics, no date, para. 1).

Along with the equipment required for audio conferencing, other components can include a PC with audiographics software, an interactive white board, overhead projector, or still video projector (Stevens, 2001; *Audiographics*, no date). For example, a lesson or tutorial can be taught by an instructor through an audio conference and the students may have pre-distributed materials such as Microsoft PowerPoint™ slides that accompany the lesson. The material may also be available on the Web in the form of images, text, video, or applets on a web page. Another option is to have the instructors and students interact graphically through interactive white boards during the lesson: "The computer is used as a blackboard. The graphics appear immediately on students' screens, and the students may either respond by using their own drawing pads or by speaker phone" (*Audiographics*, no date, para. 1). Fax machines can be used to rapidly transmit learning materials, assignments, or test (*Audiographics*, no date, 2003).

Advantages and disadvantages

Audiographics provide the same advantages of audioconferencing (two-way audio interaction and low set-up and operating costs,) while having an additional benefit of a visual aid for learners. The limitation of audiographics is that the visual aids such as text, slides, still video, images, CD-ROMs have to be distributed beforehand. For web-based aids, an Internet connection is required.

CASE STUDY 6: Computer-Based Trades and Technology (CBTT) Courses at Okanagan University College

The learning centre for CBTT at Okanagan University College in Kelowna, Canada has developed "upgrading" courses for automotive technicians, recreation vehicle technicians, and carpentry technicians While allowing craftspeople and technicians to upgrade and refine their skills, these courses are designed to prepare people with previous work experiences in the trades for the apprenticeship inter-provincial examination. Students can learn "at home, at work, at schools or institutions" ("Carpentry…", no date, para. 3). The courses use audiographics technology where the graphics are delivered "via a computer and modem link to the instructional sites" ("Carpentry…", no date, para. 3). Typically, groups of students share a computer and speakerphone. The visual materials are prepared beforehand and the students at all sites can view the material simultaneously. The instructor and students have the ability of revising and annotating the visual materials in real-time. The real-time interaction between the instructor and students was the main reason why the course was designed using audiographics as opposed to being web-based. (Stevens, 2001). The courses offered for CBTT can be viewed at http://www.ouc.bc.ca/cbtt/CBTTCourses.htm.

2.2.9 Interactive Television

In this context, interactive television refers to instruction occurring over broadcast television. It allows learners to receive live television instruction remotely, away from the actual instructor. The

instructor(s) are located at a broadcast studio and the learners view the instructor(s) on a television monitor. Interaction is provided by one or more additional components. “They can ask questions and/or provide feedback to the instructor through a number of mechanisms that can be used either independently or in combination” (Stevens, 2001, p. 23). Typically, an audioconferencing mechanism is used for real-time interaction. Additionally, a response pad can be used to link learners to a computerized instructor console in the broadcast studio (Stevens, 2001). There are other asynchronous aids that can also be used such as e-mail and fax.

The actual broadcast can be achieved using geo-stationary satellite, microwave, cable, or fibre optics. There are also commercial suppliers that provide the infrastructure and programme development services for interactive television. Learners usually congregate at an interactive television site that has all the required equipment (such as satellite receivers, teleconferencing tools, and television monitors or projection systems) to receive instruction (Stevens, 2001).

Advantages and disadvantages

The main advantage of interactive television is that instruction can be transmitted to several different sites, and thus potentially reach a large number of learners using existing broadcasting infrastructure. It can provide a high level of interaction if an audioconferencing mechanism is utilized. The effectiveness of the instruction depends on the quality of the audiovisual equipment. Low-quality equipment and unreliable infrastructure that causes outages can seriously hamper instruction (Jurich, 2003).

The main drawback of an interactive television system is its high cost, both at the main broadcasting site and the learner sites. There is also a high telecommunications cost for the transmission of the video, and there may be an additional audioconferencing cost.

These costs, however, can be offset if the instruction can reach a large enough number of people in multiple sites. Thus, travel costs, number of staff and staff hours can be reduced significantly (Stevens, 2001).

2.2.10 Videoconferencing

Videoconferencing allows participating individuals in different locations to see and hear each other in real-time through videoconferencing equipment (Stevens, 2001). Dixon (2000) states that it “is much more like using the telephone, with the added feature of being able to see the person you are talking to” (p. 22).

Older videoconferencing technology uses ISDN or leased telephone lines at high hourly rates and the installation cost of this type of system is expensive. It is also a more rigid environment that requires special room set-up, advanced scheduling, and a professional operator (Dixon, 2000).

The more recent videoconferencing technology, however, uses the Internet as the transmission infrastructure, thus decreasing the installation and usage costs. It also has the same advantages as the Internet: flexibility, convenience, and ubiquitousness.

A videoconferencing terminal consists of several components (Videoconferencing…, 2002):

- a camera – captures live movement of the participating parties;
- a video display – displays the images of the other remote parties;
- a microphone and speakers – enables the transmission and reception of voice and audio;

- a CODEC (CODer/DECoder or COmpressor/DECompressor) – digitizes the audio and video information appropriately to allow for efficient, rapid transmission over the network. CODEC can be either a software or hardware component that enables real-time communication;
- user interface – provides the mechanism to install and uninstall the system, place calls, control audio/video features (for example, volume, echo, color, brightness), etc;
- computer system – can be either the typical desktop PC or a standalone system;
- network connection – the new video conferencing standards (H 323) were developed for sending videoconferencing data over the Internet. These data rates require a high speed Internet connection either through ISDN, T1, cable modem, DSL, satellite, or a LAN.

Videoconferencing equipment can be configured in two ways: PC-based and standalone. PC systems use the standard desktop PC with either a software or a hardware CODEC configuration. The cameras and microphones that are typically included in a PC configuration cater to use on a desk for up to three people, not to a classroom or conference room setting (Dixon, 2000). Software-based systems do not supply the same quality as a hardware-based system and they are not recommended for teaching or high-performance applications (Dixon, 2000).

A standalone system is an autonomous system that operates without a PC. The system includes a high-quality microphone and camera. The video must be displayed on a TV monitor or projector. The camera can be controlled with a remote control; some cameras have a tracking mechanism that automatically focuses the camera on whoever is talking. Standalone systems are easy to operate and are ideal for a classroom or conference room setting. The common commercial standalone systems range from $4,000 to $10,000 (Dixon, 2000). It is also possible to establish multipoint Internet videoconferencing involving more than two sites.

Advantages and disadvantages

The main advantage of videoconferencing is that it allows real-time, two-way interaction between individuals in different places. Participating parties may be in remote areas and may be separated by large distances. All individuals involved in the educational system from the teachers, students, curriculum developers, and specialists, to the policy makers can participate in a videoconference. It can be used for presentations, teaching sessions, discussion, course delivery (in combination with other media), and student support (Perraton et al., 2002, p. 43). During course delivery and lectures, instructors can gauge a student's progress and responsiveness immediately. Instructors can answer questions and provide feedback immediately.

The main drawback for videoconferencing is the cost. For traditional systems, there is a high start-up cost for equipment and technical support must be available for the equipment at each site. Even Internet videoconferencing systems have a relatively high cost. PC-based systems require a PC and a compression card while the standalone systems cost in the thousands. Due to the high set-up cost, videoconferencing sites may not be readily available, especially in remote sites and developing countries. Thus, students may have to travel far to those sites that do use the technology. As well, the proper bandwidth and high-speed Internet access required for video conferencing may not be available and thus add to the overall cost.

2.3 How and Where ICTs Fit in the Learning Environment

Haddad and Drexler (2002) state that there are five different hierarchical levels of education where ICTs can be used: presentation, demonstration, drill and practice, interaction, and collaboration. These levels and example technologies are outlined in the following table (Haddad and Draxler, 2002, p. 9):

Table 3: Appropriate Technology for Different Teaching Levels

	TECHNOLOGY				
USE	**TEXT**	**AUDIO**	**VIDEO**	**COMPUTER**	**INTERNET**
Presentation	X	X	X	X	X
Demonstration	X	X	X	X	X
Drill and Practice	X	(e.g. language lab)		X	X
Interactive	hyperlink			X	X
Collaborative				networked	X

Each of the different technologies provides instruments that communicate their "content in one or more modes" (Nunes and Gaible, 2002, p. 97). For example, a book readily accommodates text, images, and graphics (Nunes and Gaible, 2002, p. 97). Each of the different modes and instruments offer their own benefits and limitations.

Nunes and Gaible (2002, p. 99-100) present the following table to outline the different modes and instruments, along with their benefits and limitations.

Table 4: Affordances and Limitations of Modalities

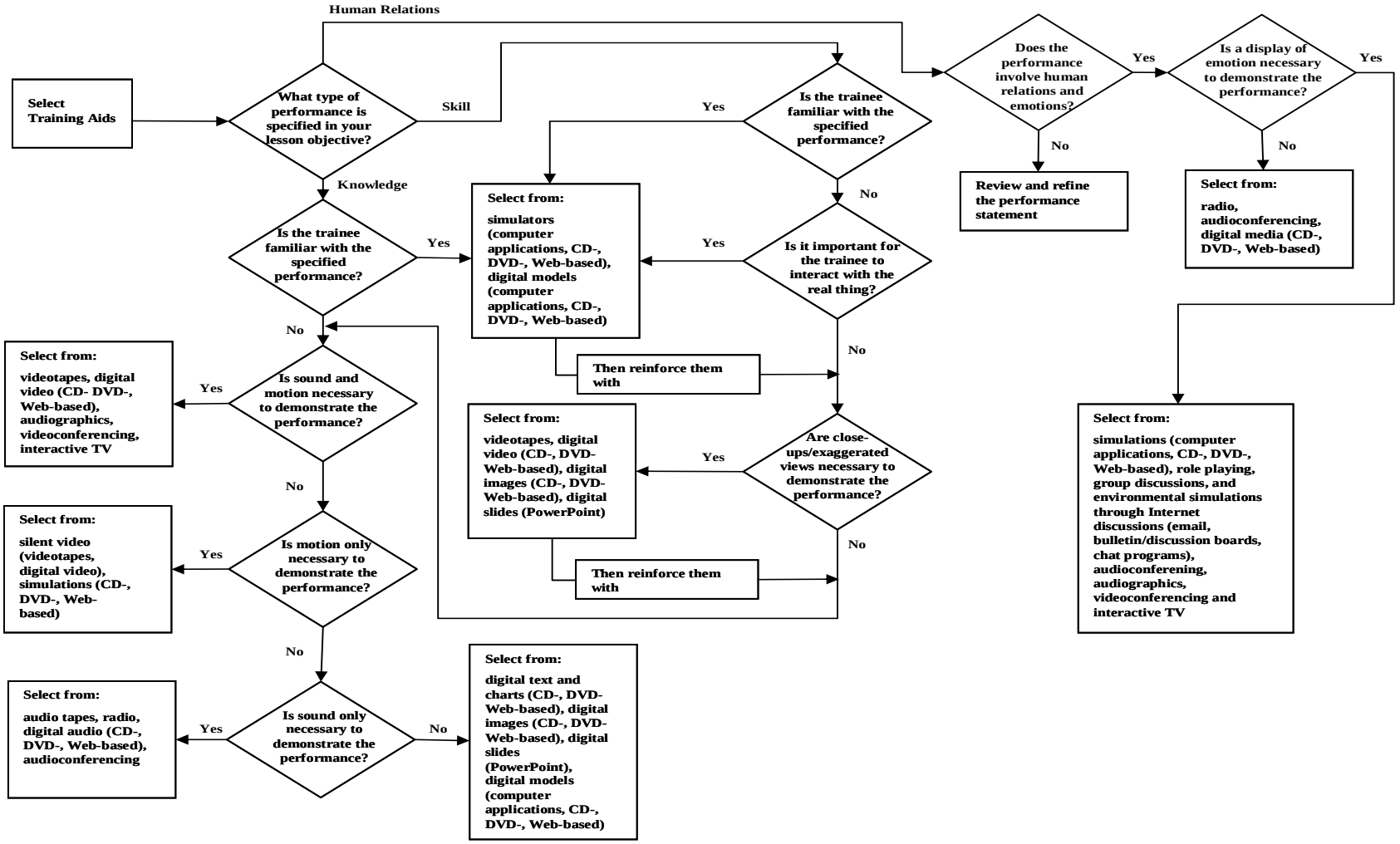
MODE	INSTRUMENT	AFFORDANCES	LIMITATIONS
Text	Books/magazines	➢ Portable ➢ Durable ➢ Can present complex information ➢ Sequential structure guides learner ➢ Little eyestrain ➢ Moderate cost of development	➢ Difficult to modify (as in localization, updating, etc.) ➢ Requires literacy plus higher-order thinking skills ➢ Content is difficult to extract for use in other resources ➢ High per-unit cost of publication
	Web page	➢ Dynamic and easily modified ➢ Hyperlinks enable nonsequential navigation ➢ Low development cost and very low publishing cost ➢ Supports interactivity (e.g., navigation, user-centred information, etc.) ➢ Can support assessment	➢ Nonsequential structure may obscure critical information or cause confusion ➢ Reading may cause fatigue ➢ Requires PC, electricity, connection ➢ Potential additional system requirements (e.g., Java, plug-ins)

MODE	INSTRUMENT	AFFORDANCES	LIMITATIONS
Images	Printed photos, maps, and schematic drawing	➢ Concrete, specific, detailed information ➢ Appropriate for learners with "visual intelligence" ➢ Engaging and motivating for many learners	➢ Low information value relative to text ➢ Resistant to reuse by learners ➢ "Visual literacy" skills required for best use ➢ High reproduction cost
	Digital photos, maps, and schematic drawings	➢ Benefits similar to printed photos ➢ Easily copied, shared, and used ➢ Low reproduction and publishing costs ➢ Can be data-based or Web-served for delivery to handheld computers and other "anytime, anywhere" devices	➢ Limitations similar to printed photos ➢ Require PC and electricity, and possibly an Internet connection
Audio	Radio	➢ Can present contemporary and topical information easily ➢ Highly accessible and potentially engaging format (no literacy skills required) ➢ Widely adopted in developing countries ➢ Moderate production costs ➢ Highly scalable ➢ Low-cost hardware	➢ Information is not durable; learners can't "review" a broadcast ➢ Poor presentation of complex concepts ➢ No visual component (e.g., schematics, maps, photos) Synchronous form requires system-wide coordination (e.g., announcements, class schedules, etc.)
	Audiotape	➢ Widely adopted ➢ Low hardware cost ➢ Information persists (tape may be reviewed many times) ➢ Moderate production and reproduction costs ➢ Highly accessible ➢ Supports asynchronous presentation ➢ Sequential structure guides learner	➢ Poor presentation of complex concepts ➢ Medium is not durable, especially in extreme circumstances ➢ Studio recordings not easily modified or well-suited for current events
	Digital audio (Web- and CD-based)	➢ Can present contemporary and topical information easily (Web) ➢ Information is durable (that is, it can be reviewed many times) ➢ Medium is durable ➢ Moderate production costs ➢ Low reproduction costs; easily scaled ➢ Easily catalogued and reused (by developers and users) ➢ Can be indexed or catalogued to enable nonsequential access	➢ Requires robust PC and/or high-speed Internet connection ➢ High storage "overhead" (in terms of hard drive capacity) ➢ May not support presentation of complex concepts
Video	Analog	➢ Highly accessible and potentially engaging format (no literacy skills required) ➢ Sequential structure guides learner ➢ Concrete, specific, detailed	➢ High production costs ➢ Moderate reproduction costs ➢ Complex information may be difficult to present

MODE	INSTRUMENT	AFFORDANCES	LIMITATIONS
		information ➢ Appropriate for learners with "visual intelligence" ➢ Engaging and motivating for many learners ➢ Moderate hardware costs	effectively ➢ Information may prove difficult for some learners to analyse/synthesize
	Broadcast	➢ Same as analog video ➢ Can present contemporary or topical information easily	➢ Same as analog video; however, costs may be higher
	Digital (Web- and CD-based)	➢ Same as analog video (NOTE: "moderate hardware costs" is not applicable) ➢ Can present contemporary or topical information easily ➢ Easily catalogued and reused (by developers and users) ➢ Can be indexed or catalogued to enable nonsequential access	➢ Same as analog video ➢ Requires robust PC and/or high-speed Internet connection ➢ High storage "overhead" (in terms of hard drive capacity)
Simulations	Interactive (Web- and CD-based)	➢ Same as noninteractive simulations ➢ Active-learning characteristics engage learners via several paths to reinforce concepts ➢ Quantitative elements are supported and reinforce conceptual learning ➢ Engaging and motivating for many learners ➢ Can support assessment	➢ Requires robust PC and/or high-speed Internet connection ➢ Potential for additional system requirements (e.g., Java, plug-ins)

Selecting a technology or a combination of technologies for teaching and learning depends on many factors, such as available infrastructure, pedagogical constraints, learners' characteristics, subject matter, content, and time available to teach and learn. Nunes and Gaible (2002) claim that it is not possible "to give recipes for what technology tools to use or when to use them. Each case is distinct." (p. 98) However, the guidelines presented in the following flowchart (Figure 2) can give a systematic approach to the decision-making process in the selecting ICTs for TVET programmes. It is not an absolute "recipe", but it can be used as a starting point when deciding which technologies are better suited for specific needs and certain situations. The flowchart has been adopted from the "Training Aids Selection Scale" for designing technical and skills training programmes developed by Sage and Rose (1985, p. 15).

Figure 2: Selection Flowchart for Technology Use in TVET



Source: Adapted from Sage and Rose (1985, p. 15)

2.4 Open and Distance Learning in TVET

UNESCO (2002a) defines Open and Distance Learning (ODL) as an "educational process in which all or most of the teaching is conducted by someone removed in space and/or time from the learner, with the effect that all or most of the communication between teachers and learners is through an artificial medium, either electronic or print" (p. 22). IITE (2000a) identified three types of ODL: (1) learner-content; (2) learner-learner; and (3) learner-tutor. The infrastructure and level of technology available in the region determine the choice of the medium. This may include printed study guides, educational television, radio systems, multimedia systems, and Internet-based systems. The open nature of ODL helps learners take responsibility for "what they learn, where they learn, (and) how quickly they learn" (UNESCO, 2002a, p. 22).

Mishra (2002) noted that "advances in education technology have led us to accept that the benefits from TVET through ODL are far greater than from other types of courses" (p.xi). Hampton and Bartram (2002) argued:

> If access to technical and vocational education and training (TVET) is to increase, new ways of developing and delivering courses must be explored. TVET must be taken outside of the classroom and into the communities, the workplaces, and the homes of the students. Traditional ways of thinking about TVET must be put aside and different ways of packaging and delivering knowledge and skills must be developed. This is particularly critical in meeting the demands of countries with depressed economies and countries where people are separated by water (as in island states) by terrain or by distance… (p. 63)

ODL can be used in TVET to empower those people most disadvantaged such as the disabled, women, and the unemployed and ethnic minorities. ODL can also allow greater participation in technical and vocational education and training after work hours for those who can't afford to take time off from their jobs and who are interested in improving their vertical mobility professionally (Mishra, 2002). ODL in the field of vocational training may have to be supplemented by hands-on work though, which could be done through residential schools, home experiment kits or collaboration with the workplace (UNESCO, 2002a).

John (2002) noted that in developing countries ODL has been successfully used to change the social lives of people, raising them from economic vulnerability to economic empowerment. ODL has been used to successfully impart carpentry skills, building construction, etc. Dhanarajan (2002) also noted that ODL has been successfully used for training workers in many fields ranging from farming to electronics, health to engineering, and animal husbandry to automobile engineering.

There are many obstacles that hinder the full implementation of distance learning. Some of these barriers include: lack of infrastructure, underfunded programmes, high costs of installation and maintenance, lack of organizational support, and lack of training of those involved.

Some factors affecting costs of ODL include: number of course materials that need to be developed, the frequency with which course material must be revised and changed, and the choice of technology. Advocates of ODL often cite economies of scale in their support of this mode of delivery. However, this concept does not necessarily apply to distance learning. There are many cases where it would be more cost efficient to attend classes on campus instead of studying through distance education. Many North American universities that invested heavily in distance education are now phasing out their programmes due to low enrolment and a high dropout rate. It appears that the role of distance education is not to minimize the costs of teaching and learning, but to find various media able to reach as many people as possible (UNESCO, 2002a).

Based on a comprehensive review of literature Brennan, McFadden and Law (2001, p. 8) identified the following pre-conditions necessary to meet student/user needs through online learning:

- Acknowledge and take into account differences in student/user backgrounds in every phase of the design and delivery of online learning materials and support.
- Strenuously apply the lessons we have already learnt about good teaching and learning.
- Cater to the differences in learning styles and preferences of student/user.
- Accept that student technological skill and comfort is located along a continuum of proficiency and plan to accept these and design materials and environments accordingly.
- Recognize that there is a huge difference in access to new technologies and work towards reducing these.
- Evaluate the effectiveness of online programmes using a variety of methodologies and time frames.
- Prepare teachers/trainers to use new technologies flexibly and beyond minimum levels of competence.
- Seek to explicitly enhance information literacy skills.
- Focus on the communicative and interactive dimensions of the new environments.
- Don't expect technology to solve all the hard problems.

The following case study describes a project conducted by the IITE on distance education.

CASE STUDY 7: Distance Education for the Information Society

IITE (2001b) prepared an analytical survey on distance education *Distance Education for the Information Society: Policies, Pedagogy, and Professional Development.*
The aims of this research initiative were:

- To report on worldwide experience regarding infrastructures and media that have been developed to provide distance education;
- To review the main theories behind the development of distance education as a basis for understanding current practice and planning for the future;
- To identify the professional development needs and implementation strategies for distance education in general and exploitation of technologies in particular; and
- To review policy and legislative frameworks affecting distance education initiatives and those factors which determines success (p. 6).

This analytical survey is available from the IITE web site: www.iite-unesco.org

2.5 ICT-Mediated Learning Environments

ICT-mediated learning provides two educationally rich learning environments to the learners: (1) explorative environments; and (2) interaction environment (Dillemans et al. 1998). In the explorative learning environment learners can practice their skills in safe settings, but they can also investigate (simulated) aspects of the world. Modelling tools go even further, enabling students to shape (simulated) the world themselves (Van Baalen and Moratis, 2001). In the interaction environment ICTs facilitate human interactions. Dillemans (et al., ibid) proposed six critical dimensions that must be examined in order to bring out the best of educational technology in the explorative and interaction environments. Following is a brief description of each:

1. Information modality: ability of the technology to transmit verbal, para-verbal and non-verbal information.

2. Linearity: the technology can transmit the information in a linear or non-linear way.

3. Type of interaction: distinction between human-human and human-machine interaction.

4. Number of participants: the interaction with ICT-mediated learning can be one-alone, one-to-many, and many-to-many.

5. Time/place (in) dependency: ability of the technology to transmit information of time and place.

6. Immediacy: amount of time for sending a message and getting a response to this message.

The juxtaposition of these six dimensions with the two learning environments gives a powerful decision-making tool for ICT-mediated designers and developers (see Table 5).

Table 5: Classification of tools.

		Information modality	Linearity	Number of Participants	Time (in)dependency	Immediacy
Explorative Environment	Interactive video	Dynamic visual	Linear or alinear	Not Applicable	Not Applicable	Immediate or non-immediate
	CD-ROM	Text, dynamic visual display	Linear	Not Applicable	Not Applicable	Immediate or non-immediate
	Hypermedia	Text, dynamic visual display	Alinear	Not Applicable	Not Applicable	Immediate or non-immediate
Interactive Environment	Audio-conferencing	Audio	Linear or alinear	One-one one-many many-many	Synchronous	Immediate
	Audiographic conferencing	Audio, still graphics	Linear or alinear	One-one one-few few-one	Synchronous	Immediate
	Computer conferencing	Dynamic visual display, mainly written words	Linear or alinear	Many-many	Asynchronous	Non-Immediate
	Video conferencing	Audio, still graphics, nonverbal information	Linear or alinear	One-one one-many many-many	Synchronous	Immediate
	Internet	Dynamic visual display, mainly written words	Alinear	Many-many	Asynchronous	Non-immediate

Taken from Van Baalen and Moratis, 2001, p. 106.

SECTION 3 SPECIALIZED USE OF ICT-MEDIATED LEARNING IN TVET

This section provide an in depth discussion on the specialized use of ICTs for teaching and learning. The discussion is focused on current practices as well as the issues and concerns regarding the use of ICT teaching, attitudes, practical skills, workplace training, study at home, informal training, virtual internship, and assistive technology for accommodating people with special needs. Whenever appropriate, a case study is provided to support the discussion.

3.1 Teaching Attitudinal and Practical Skills in TVET using ICTs

Effective human performance in TVET consists of the successful interactive effects of skills, knowledge, and attitude. All TVET programmes aim to develop all three of these domains of learning. While there is a considerable amount of literature dealing with the development of cognitive skills using ICTs, there is a paucity of publications dealing with the development of psychomotor skills and this review failed to identify any publications dealing with the affective domain in TVET. There is a perception that distance education is not an appropriate method for teaching and learning in TVET. However, in high performance work environments, the cognitive and affective learning domains constitute greater segments of skill sets than do psychomotor skills. Providing distance education in these two domains is much less challenging than teaching manual skills at a distance (Stevens, 2001).

3.1.1 Teaching Attitudes Using ICTs

As mentioned previously, research offers little guidance for teaching attitudinal skills in TVET. According to the limited studies available, five approaches show some potential for attitude development in TVET. These are a democratic approach, indoctrination approach, group discussion, dramatic involvement, and role modelling. The key issue here is, can ICTs be used for developing attitudes in TVET? This question will remain unanswered for lack of empirical evidence. However, one could speculate about the appropriateness of using ICTs to help students develop desired attitudes.

The indoctrination approach is often used for teaching safety attitudes in TVET. It is possible to indoctrinate learners in an ICT learning environment by creating a very rigid environment, one which does not encourage thinking and where the only choice to students is to learn a set of strict rules. The ICT learning environment can lend itself well to group discussions using bulletin boards and Internet telephony. These group discussions must be carefully moderated to prevent a negative and undesirable attitude from developing. Dramatic involvement can be achieved using games and simulations within an ICT environment. Finally, electronic mentoring could be used to provide role models to learners.

Using a strictly technology-based learning environment eliminates face-to-face contact, hampering the development of people skills that are just as valuable in the workforce as technical skills. Audio or video conferences, online discussion groups, e-mail, etc. do allow interaction with other people; however, these tools are not considered as effective in improving people skills as dealing with someone face-to-face. According to management consultant David Anderson of Anderson and Associates, nothing can replace direct people interaction. “When you're interacting with a Web page you can be as uninterested, sarcastic, or rude as you like. The Web page won't call you on it. People skills need to be taught by people” (Delio, 2000, p. 2).

The teaching of attitudes remains a challenge for even face-to-face instruction. Attempting to teach attitudes using ICTs is a significantly more challenging task, one plagued with uncertainty. The decision to use or not to use ICTs to teach attitudes in TVET must be guided by a risk assessment focused on the consequences of inadequate performance. Is the risk negligible, serious, or life threatening?

3.1.2 Teaching Practical Skills Using ICTs

The literature and research dealing with developing practical skills in a face-to-face environment is limited. Romiszowski (1981) argued that: “training of physical skills …seems to have had a history quite divorced from the main stream of educational research and development. This is probably because for a long time educators tended to look down on the physical skills domain as unworthy of their attention” (p. 227).

In commenting on the use of ODL for teaching practical skills Hampton (2002) noted: “the learning of practical skills is most often associated with workshops and laboratories, specialist materials and equipment, smaller class sizes and, frequently, longer blocks of time for practice and rehearsal. For the open and distance learning (ODL) environment, the teaching of practical skills poses more difficulties that the teaching of knowledge and theory” (p. 83). She added that the teaching of practical skills would always require the

support of skilled people and a range of tools or equipment. Haddad and Draxler (2002) noted however that the inability to meet the challenge is self-inflicted because of a tendency to use Industrial Age models to solve Information Age problems.

Oliveira and Rumble (1992) noted that for many years educators believed that ODL was only suitable for teaching cognitive skills. Sparkes (1982) argued that it might be more effective to teach a practical skill using a video rather than face-to-face instructions. He does concede, however, that practical skill will continue to need face-to-face supervision at least until two-way television is available. The author identified three organizations using ODL for teaching performance skills: National Extension College, UK; University of Victoria, Canada; and Indonesia Banking Development.

It could be useful to look at the taxonomy of the psychomotor domain before examining the appropriateness of ICTs for teaching and learning practical skills. The psychomotor domain can be divided into 5 main categories:

1. Imitation: The learner goes through a period of trial and error to imitate an act that has been explained and demonstrated.
2. Manipulation: The learner continues to practice the skill until some level of proficiency is attained.
3. Precision: The learner continues to practice until he/she attains the competency requirement.
4. Articulation: The learner attains a higher level of competency that allows him/her to solve problems.
5. Naturalization: The learner reaches a stage where responses can be automatic, without thinking.

Analysing these categories sheds light on how practical skills develop and provides some insights regarding the implications of using ODL for teaching such skills. It is interesting to note that only during the imitation stage does the learner need explanation and demonstration. During the manipulation, precision, articulation, and naturalization stages the learner can practice independently to perfect his/her skill. Consequently, the imitation stage is the most critical stage of practical skills development and it is this phase that requires most guidance and support in an ODL environment.

Hampton suggested that it is critical to take into consideration the learner's learning style in choosing or developing materials for teaching practical skills by distance. She noted that print-based illustration and step-by-step procedures are most often used for learning a practical skill at a distance and that video, interactive multimedia on CD-ROM and online learning are increasingly being used. She also assesses these three approaches. Advantages and problems with these three approaches were discussed previously in section two.

Other approaches in current use for developing practical skills using ICTs are online learning, simulators and virtual reality. Pilots, truck drivers, and crane operators may

spend more training time in a virtual reality environment and in simulators than with the actual equipment to reduce hazards and equipment rental costs.

Majumdar & Ray (no date) states that the military has always been using state-of-the-art technology through simulation packages for teaching dangerous tasks like flight training, astronaut training, surgical operations, and handing nuclear energy. The author noted that the use of ICTs allows these skills to develop without using expensive equipment or subjecting trainees to extreme danger.

In addition to technological support, appropriate learning environments must be provided to enable learners to practice and perfect their skills. The types of support that have been proved to be effective include: mobile workshops, learning centres or learning commons, workplace training, on-the-job training, work-based learning, and work experience (Hampton, 2002).

Assessing skills acquired by distance learning is as challenging as developing them. The assessment of practical skills involves two elements: process – formative evaluation, and product – summative evaluation. Process assessment involves evaluating the procedures used for executing a practical task. Product assessment, as the name suggests, consists of evaluating the quality, accuracy, and finish of a final product. Hampton (2002) suggests that process evaluation can be accomplished through self-assessment and that product evaluation can be achieved using demonstration of skills, video recording of performance, validators, and workplace trainers and assessors.

3.2 Using ICTs for Workplace Training

The Conference Board of Canada (2001a) notes: “more than ever, employers depend on knowledgeable and skilful employees to create value-added products and services, efficiently and effectively, so that they can compete successfully” (p. 3). Economic prosperity in the global economy is becoming highly dependent on an ability to develop, attract, and maintain a well-educated workforce. As a result of these changes, the demand for skilled workers often exceeds the supply in many sectors of the economy. Seventy per cent of Fortune 1000 companies perceive the lack of a pool of talented workers as the biggest barriers to sustaining growth. In order to ease this skill gap, employers are significantly investing in workplace education and training. Table 6 shows the participation rate of adult workers in training in OECD countries.

Table 6: Workers aged 25 to 54 years taking employment-related training, 1994–1995

Country	Participation rate (%)	Average number of hours per worker
Australia	44.6	61.3
Canada	37.7	41.1
Germany	20.0	40.5

New Zealand	49.1	69.0
Sweden	55.5	ND
Switzerland	33.0	11.3
United Kingdom	58.0	52.1
United States	48.8	46.6
Unweighted mean*	37.1	41.5

Source: OECD (1999), Training of Adult Workers in OECD Countries

Trends indicate that workers acquire 70% of the skills they need for the workplace through informal training. Employers are increasingly embracing e-learning solutions to meet this growing requirement for workplace training. It appears that information on employers' involvement in e-learning may not be readily available. Wolley and Booker (no date) expressed difficulties in researching the use of ICTs for corporate training in Australia.

In its recent survey of 29 countries with advanced economies, OECD found the two most important incentives for integrating e-learning in the corporate world were reduced costs and increased flexibility (OECD, 1999). Bates (2001) noted that the most dramatic impact of ICTs has been on campus learning and corporate training. Canadian employers intend to increase their use of e-learning from 17% to 24%. This is consistent with American counterparts who also foresee a growth in the use of ICTs for workplace learning – from 19.8% to 24%. It is estimated that 50% – 70% of American firms use the web for instructional delivery and that corporate spending for online learning in that country will reach $11.4 billion (Zirkle, 2002). The estimated growth of e-learning for 2003 in the corporate sector and higher education, combined, is in the area of $18 billion (Bates, 2001). A significant proportion of employers are using both the Internet and Intranet to meet their learning needs. Research conducted by the Conference Board of Canada (2001a) indicates that the top reasons given by employers for using ICTs in training and development are: improved just-in-time workplace learning (60%), cost-effectiveness (45%), greater control of employees over learning (35%), and best fit with organization's workplace learning needs (33%).

In recent years there has been a proliferation of "corporate universities" in the private sector. These training facilities make extensive use of ICTs such as videoconferencing and the Internet for teaching and learning. The unprecedented demand for workplace training has also encouraged the development of an online learning industry led by contractors interested in servicing the training needs of small- and medium-sized companies (Bates, 2001). Fifty-one per cent of Canadian employers' e-learning solutions are developed in-house, while 49% are acquired off-the-shelf (Conference Board of Canada, 2001).

Although corporate e-learning is growing at an exponential rate and is perceived by many employers as an essential tool for keeping their employees workplace-ready, there are

serious barriers that hinder e-learning implementation. The top three starting barriers are: cost of learning technologies, time required for programme development, and lack of content in learning technology format. The top three implementing barriers include: cost of learning technologies, lack of dedicated learning time, and time necessary for developing e-learning programmes (Conference Board of Canada, 2001).

3.3 Using ICTs for Study-at-Home TVET Programmes

The high demand for skilled workers, coupled with the growing requirement for some form of technical training as a condition for initial employment, are challenging TVET institutions. Even in well-developed countries it is not uncommon for cash-strapped institutions to list a two- to three-year waiting list on some high-demand training programmes. A two-tiered TVET home-study system is flourishing as a result. Many of the TVET home-study programmes are run by private and for-profit organizations, although some public institutions are also involved. While a two-tiered system for health care meets with considerable resistance in many countries, it appears to be more acceptable for training, thus giving the "haves" easier access to skills training than the "have-nots".

Home-study programmes are available in a wide range of trades and professions, from auto mechanic to accounting. Delivering these programmes has traditionally relied heavily on print-based materials; however, in recent years more ICTs have been used to deliver programmes.

CASE STUDY 8: Education Direct

Education Direct is a "Train at Home" Canadian correspondence school offering TVET programmes in over 55 occupations to Canadians. Education Direct is fully accredited by the Canadian Education and Training Accreditation Commission (CETAC).

In 2002, more than 35,000 Canadians were enrolled in an Education Direct career diploma course (www.edudirect-canada.com).

3.4 Using ICTs for Assessing Teaching and Learning

Three broad strategies are used in assessing performance in TVET. Cognitive skills are assessed using written tests, practical skills are assessed for process and product, and attitude is assessed through ongoing observation. ICTs can provide considerable support to TVET instructors in the assessment process. A computer with the associated software can be used to design, develop, administer, score, and evaluate objective tests and examination. A hand-held computer can be used for the progressive assessment of practical work or to record observation data in the assessment of attitudes. Electronic records of performance allow instructors to monitor students' progress regularly and identify patterns and trends that would lead to improved teaching. ICTs can also be used to assist students in generating an electronic portfolio.

Following is a case study that illustrates how the apprenticeship system in Canada uses ICTs for assessing the knowledge of apprentices.

CASE STUDY 9: Interprovincial Computerized Examination and Management System (ICEMS), Canada.

The implementation of the ICEMS is a collaborative effort of the Canadian government through Human Resources Development Canada and all provinces and territorial governments. The purpose of the ICEMS is to automate examination development, administration, and assessment for 46 designated apprenticeable trades in Canada (listed below). A purpose-made software was developed for operating the ICEMS. The system contains item banks of questions and answers for each designated trades. It can also generate examinations according to a specific set of criteria, mark answer sheets, and output examination results.

Designated Apprenticed Trades

Appliance Service Technician
Automotive Painter
Automotive Service Technician
Baker
Boilermaker
Bricklayer
Cabinetmaker
Carpenter
Cement Finisher
Construction Electrician
Cook
Electrical Rewind Mechanic
Electronics Technician - Consumer Products
Farm Equipment Mechanic
Floorcovering Installer
Glazier
Hairstylist
Heavy Duty Equipment Mechanic
Industrial Electrician
Industrial Instrument Mechanic
Industrial Mechanic
Insulator
Ironworker
Lather
Machinist
Mobile Crane Operator
Motorcycle Mechanic
Motor Vehicle Body Repairer
Oil Burner Mechanic
Painter and Decorator
Partsperson
Plumber
Powerline Technician
Recreation Vehicle Mechanic
Refrigeration and Air Conditioning Mechanic
Roofer
Sheet Metal Worker
Sprinkler System Installer
Tile Setter

3.5 Using ICTs for Informal Skills Development

According to the ILO World Employment Report (1998) the great majority of new jobs in developing countries are being created in an informal economy. This economy can be defined as: “small and micro scale economic operations that are not institutionalised through business registration or registration with other regulatory authorities and undertaken with little investment” (National Institute for Policy Research, 2002, p. 22). ILO estimates that this informal economy involves approximately 500 million jobs. This job growth in the informal economy operates primarily in agricultural, industrial, and service sector activities both in rural and urban areas and comprises mostly the poor. The rise of the informal economy can be attributed to inadequate job growth in the formal economy.

In addition to the technical skills, workers involved in the informal economy must also possess a set of generic competencies in the following domains: cognitive, social, and entrepreneurial skills (Singh, 2000). The National Institute for Policy Research indicated that skill training could play an important role in improving the management capability and productivity in the informal economy. The Institute also provided a list of critical training needs:

- Management/entrepreneurship
- Enterprise development
- Multi-technical skills
- Use of appropriate technology
- Access to and analysis of information on product design and development.

The Institute further noted that institutional training systems are not responding to the training needs of informal sector workers. It therefore recommended introducing open learning, mobile training, and distance learning to meet the training needs of these workers.

The increased demand for informal learning is not unique to developing countries. A study conducted by Livingstone (2000) suggested a trend toward the vocationalization of informal adult education. Two-thirds of adult Canadians surveyed were involved in informal learning related to their current or future employment for an average of six hours a week. The Canadian Commission for UNESCO (2002) identified four main barriers preventing Canadians from participating in adult education. These are: lack of time (60%), family obligations (women: 26% and men: 15%), education and training costs (40%), and timing and location at which education is offered (40%).

Based on the above analysis it is clear that ICTs can play a major role in providing informal learning to adult learners in developed and developing countries. The following case study provides an example of the use of ICTs in informal learning.

CASE STUDY 10: Using ICTs for Informal Learning

Women in Uganda and India used new technologies to develop skills in computer awareness and use the Internet. These informal learning experiences have enabled them

to sell their craft over the Internet. Using ICTs to access informal learning opportunities also helped these women to overcome gender barriers and improve their social and economic status.

Source: ILO (2001). World Employment report 2001. Life at work in the information society. Press releases, http://ilo.org/public/english/bureau/inf/pkits/wer2001.

3.6 Using ICTs for Prior Learning Assessment and Recognition

The Conference Board of Canada (2001b) notes: "more than ever, employers depend on knowledgeable and skilful employees to create value-added products and services, efficiently and effectively, so that they can compete successfully" (p. 3). Economic prosperity in the global economy is becoming highly dependent on its ability to develop, attract, and maintain a well-educated workforce. As a result of these changes, the demand for skilled workers often exceeds the supply in many sectors of the economy. In order to ease this skill gap, there has been an increased interest in developing and implementing policies and practices for assessing and recognizing prior learning. The process is known as Prior Learning Assessment and Recognition (PLAR). Although adults spend a considerable amount of time on employment-related training (Figure 5), educational institutions fail to recognize knowledge and skills acquired outside of formal education environments. A recent report issued by the Council of Ministers of Education of Canada (1998) suggests that the full range of knowledge and skills of Canadians should be recognized and used efficiently and comprehensively in Canada's education systems and workplaces.

The concept of Prior Learning Assessment and Recognition (PLAR) grew out of the need for lifelong learning. PLAR bridges learning and education by allowing individuals to get recognition for the skills and knowledge they have acquired, and by giving equal value to comparable learning and skills, whether these skills come from school, post-secondary education, workplace experience, community work, on-the-job training, or other life experiences (Conference Board of Canada, 2001b). In an effort to counteract exclusion and promote inclusion, many nations including the United States, United Kingdom, Australia, New Zealand, France, and Canada have adopted PLAR.

> The Canadian Labour Force Development Board (1997) outlines four applications of PLAR, (1) recognize learning from workplace experience or other forms of lifelong learning; (2) receive credit for a certain level of education or vocational training; (3) receive proper recognition for education and training from another country; and (4) recognize that a person has acquired a skill set, but not the required education. A Canadian study also shows five main benefits related to the implementation of PLAR (Aarts et al., 1999). These are:
>
> 1. Assess and recognize prior learning of adult learners;
> 2. Boost confidence in adults' ability to learn and motivates them to engage in further education;
> 3. Reduce learning investment in time and costs;
> 4. Attract adult learners to educational programmes.

The Conference Board of Canada (2001b) further highlights the benefits of PLAR for educational institutions and adult learners (Table 7).

Table 7: Benefits of PLAR for Educational Institutions and Adult Learners

Benefits of PLAR to Educational Institutions and Adult Learners.	
Institutions	**Learners**
• Greater number of learners in learning programmes • Meet societal needs for holistic learning and personal development • Provide more lifelong learning opportunities • Enhanced recognition of learning environment • Make better use of resources • Provide access to a wider range of potential learners • Enable institutional growth • Increased access to employment opportunities and promotion	• Higher income • Enhanced personal development • Greater lifelong learning opportunities • Reduced duplication of education and training • Enhanced quality of life • Increased job mobility, access to employment, and enhancement of career development • Learners who are members of disadvantaged groups gain more equal access to learning

The Conference Board of Canada (2001b)

Chinien, Boutin, Moratis and Van Baalan (2002) suggested that TVET should work in collaboration with its social partners to develop standardized assessment strategies that would facilitate mobility and portability of competencies for work and for retraining across institutions. New strategies should also be developed to measure soft skills, such as essential employability skills, individually and collectively, as well as their interactions with specific occupational skills on work performance. TVET should adopt the PLAR concept in order to increase access to education, eliminate duplication of training, reduce programme costs and facilitate articulation between learning environments (Ontario Ministry of Education, 1998),

ICTs can be used in TVET to provide new and innovative strategies to facilitate the assessment and recognition of prior learning. Alboim (2002) presented a very comprehensive model of PLAR involving the use of ICTs at the Canadian National Summit on Innovation and Learning. Her model is primarily designed to facilitate the labour market entry of skilled immigrants in Canada. The main role of ICTs in this model is through an Internet portal. Some key components of this proposed portal include: (1)

information; (2) assessment services for academic achievement; technical skills; language and Canadian work practices; (3) labour market counselling and learning plans; and mentorship by Canadian practitioners.

The Canadian Council for Human Resources in the Environment (2002) also presented an electronic immigration-screening tool at the above-named summit. The emphasis of this system is on the assessment and recognition of foreign trained workers. The case study which follows describes a Canadian initiative for using ICTs for the assessment and recognition of Canadian and international educational and occupational qualifications.

CASE STUDY 11: The Canadian Information Centre for International Credentials

The Canadian Information Centre for International Credentials (CICIC) collects, organizes, and distributes information, and acts as a national clearing house and referral service to support the recognition and portability of Canadian and international educational and occupational qualifications. CICIC was established in 1990, after Canada ratified the UNESCO Convention on the Recognition of Studies, Diplomas and Degrees concerning Higher Education in the States belonging to the Europe Region to assist Canada in carrying out its obligations under the terms of this convention. The convention promotes international mobility by advocating wider recognition of higher education and professional qualifications.

CICIC collects data about procedures for recognizing academic and occupational credentials in different Canadian jurisdictions. This information is stored in a regularly updated database covering more than 800 professional organizations. In partnership with the provinces and territories, CICIC also provide current information about postsecondary education systems in Canada for a variety of users, including Canadian missions and evaluation agencies abroad.

CICIC submits detailed information about Canadian postsecondary education for the World Higher Education Database (WHED) CD-ROM, a powerful research tool that facilitates comparison of credentials from every part of the world.

Source: http://www.cicic.ca/indexe.stm

3.7 Using ICTs for Virtual Internship

The uncertainty regarding the efficient and effective transfer of knowledge and skills acquired in formal TVET to the workplace is a major concern to educators. To overcome this difficulty TVET educators have established cooperative education or internship programmes that give students the opportunity to practice their skills in the real work environment under the supervision of experienced workers. While these programmes have proved to be very successful, they are resource-rich. Therefore, they are reaching only a limited number of students. Additionally, students from rural areas may experience difficulties in locating a suitable internship site. It is also very costly to sponsor international internships that give students international work experience.

In order to address these shortcomings, a group of European educators and business leaders have used ICTs to support a system of Virtual Internships. The colleges taking part in this innovation were: Tietgen Business College, Denmark; Arcada Polytechnic, Finland; Buserud University College, Norway, and Institut de Formation International, France. Four companies also participated: Tronrud Engineering; Kremlin, Inc; ICL Invia; and DFDS Transportation Group.

The project team defined a virtual internship as an activity that involves the use of the information and communication technology supported environment where students interact with each other and with companies, independent of time and space and across traditional geographical boundaries. In this environment, effective communications are created between students, faculty and company representatives, in order to carry out a specific and meaningful work-based activity that fits within the student's compulsory education environment.

The following case study illustrates an example of a virtual internship project.

CASE STUDY 12: Virtual Internship

Company involved: Tronrud Engineering – Norway. The company specializes in industrial automation and purpose-built machinery.

Colleges Involved: 30 students from the Tietgen Business College in Denmark; nine students form Buskerud College in Norway; and seven students from Arcada Polytechnic in Finland**.**

Project Objectives:

Tronrud Engineering manufactures the Thread Controller TC-1 loom, which reproduces distinguished motifs using a technique that controls every thread with a PC. The virtual internship focused on researching markets, exhibitions, and fairs in other countries with a view to expanding the TC-1's market share. Students were given the opportunity to work as analyst/research consultants.

Specific Tasks Completed by Students:

- Preparation of a company profile
- Analysis of potential customers for Tronrud Engineering's digital weaver
- Location of possible trade fairs in Denmark where Tronrud Engineering could market its products
- Preparation of a list of competitors in Denmark
- Description of how these competitors market their products at trade fairs in Denmark
- Preparation of suggestions on how Tronrud Engineering could best be represented on the Danish market
- Report of main findings to partner companies and students in other countries

Technology Infrastructure

A collaborative workspace was developed to facilitate communication and collaboration

among students, teachers, and company representatives. Audio, videoconferencing, and asynchronous, one-to-one or one-to-many, electronic messaging were used to replace face-to-face meetings. PowerPoint™ presentations were also used.

Source: Virtual Internship: Real Experience in a Virtual World. A best Practice Handbook for those interested in the concept of virtual internship in Business Education.

3.8 Using Assistive Technologies in TVET

Traditionally, people with special needs have been excluded from TVET. However, for their own well-being and inclusion in society, action must be taken to ensure that they have every opportunity to participate in vocational education. An *Analytical Survey of information and communication technology in special education* prepared for UNESCO states: "By definition, people with disabilities are often restricted in the extent to which they can take a full part in the society in which they live, but many of those restrictions can be reduced by their receiving good education." (Edwards et al., 2001, p. 5) When the number of suitably trained teachers is limited, "it is often easier to procure and provide technological solutions, and it is most fortunate that in special education, technology can play a highly beneficial role." (Edwards et al., 2001, p. 5). The case study, which follows, describes an initiative of the IITE (2002a) to the use of ICTs for people with special needs.

CASE STUDY 13: Reach the Unreached and Include the Excluded

Ensuring access to education for millions of children and adults living in poverty and disadvantaged by economic status, geography, cultural or linguistic barriers or special needs, constitute a major challenge for UNESCO. In order to ensure that the needs of the poor, the excluded and the marginalized are addressed, UNESCO is committed to assist in capacity building, gather and disseminate best practices, and stimulate dialogue about inclusive approaches to educational strategies. Consistent with this goal, IITE (April 2002) conducted an expert meeting dealing with *ICTs in Education for People with Special Needs*. Thirteen experts from eight countries (Armenia, Australia, Belarus, Cyprus, Denmark, Italy, Russian Federation, and United Kingdom). The final report of that meeting is available at: http://www.iite.ru/iite/publications/publications?id=54

Most existing technology was not initially designed to provide accessibility to people with special needs. Assistive technology attempts to bridge this gap. Assistive technology aids people with disabilities, impairments, and/or handicaps to overcome their limitations. Assistive technology can range from a simple aid such as a crutch to a computer-based Braille system. In order not to deprive people with special needs of any life opportunities, it is essential that assistive technology be incorporated into TVET. This section will outline some of the assistive technologies and strategies for aiding people with special needs in TVET.

In its *Report on Assistive Technologies for Online Training Delivery* (which is part of an initiative within the Australian Flexible Learning Framework for the National Vocational Education and Training System 2000–2004), the Australian National Training Authority (ANTA, 2002a) outlines the following assistive technologies that facilitate online learning in TVET (and in general) for people with disabilities. Most of these technologies are not simply exclusive to TVET but common to SNE in general.

Braille systems for the blind

There are three main Braille systems: note takers/writers, printers (embossers), translation software, and hardware. Braille note takers/writers support speech synthesisers "enabling the user a choice to review documents" (ANTA, 2002a p. 7). Braille printers emboss Braille dots on special paper and most printers connect to a PC through a serial port. Translation software and hardware converts printed documents into Braille, where software programmes convert ASCII text files into Grade 2 Braille.

Screen readers and voice synthesisers

A screen reader is a software programme that "reads the contents of the screen aloud to a user" (W3C, 1999, *Screen reader*). The components of a computer-based voice synthesiser also include computer software and a sound card. These systems are geared toward the blind and they read and dictate to the user what is being typed or what is on the screen. There is also specific software geared for accessing information on Internet sites, where the text on the sites is spoken to the user.

Optical character recognition (OCR) systems

OCR involves converting printed material to speech or digitised format, thus giving the blind access to printed materials. These systems include a scanner, the recognition component, and OCR software. They can accompany other assistive technologies or act as a stand-alone reading device.

Closed circuit TV (CCTV) systems

CCTV enables visually-impaired users to view enlarged text from printed material on a computer or TV screen. One configuration uses either a fixed camera situated over a movable table where the document lays, or a mobile camera that moves over a document. These systems can be connected to a computer where the CCTV image can be seen on the same screen as a computer programme such as a word processor. An alternate configuration features a mobile, stand-alone unit that can be used in libraries, labs, shops, or the workplace.

Text enlargement software

This computer software supports visually impaired individuals by enlarging text and images on a computer screen.

Voice recognition software

Voice recognition systems allow the user to "type" and control programmes using speech. Some programmes have the ability to interpret words spoken at normal speed and have them appear in the document. Users can also edit and format text using voice commands.

Computer software

There is other software that "assists students who experience difficulties either accessing, processing, or delivering information" (ANTA, 2002a, p. 9). This type of software offers various features:

- speech feedback letter-by-letter, word-by-word, sentence-by-sentence, marked block and proof-reading;
- word-by-word spell checking to catch errors as they occur;
- Word completion and suggestion (predictive typing), which saves very slow typists from having to type the whole word;
- Page modification to suit individual needs and also to select, space, highlight, and mask specific text (ANTA, 2002a, p. 10).

Keyboard alternatives

There are software programmes that assist users who have difficulty in using a normal keyboard. In the Microsoft Windows™ environment, there are various features to aid users. StickyKeys allows for commands that typically involve the simultaneous pushing of more than one key (i.e. commands that use the SHIFT or ALT keys) to be executed by pushing one key at a time. Users instruct the operating system to interpret the keys pressed as if they were pressed simultaneously. This is ideal for learners that type with one finger or a mouth stick. FilterKeys allows Windows to ignore keys that are not held down for a minimum amount of time, which aid users who unintentionally press certain keys. MouseKeys allow the mouse pointer and mouse commands (clicking, double-clicking, dragging and dropping) to be controlled using the keyboard.

Mouse alternatives

There are several alternatives for learners who cannot use a standard mouse: trackball, mouse pen, foot mouse, mouse pad, head mouse, joystick, mouth joystick, and membrane keyboard.

On-screen keyboards

On-screen keyboards allow users to point to keys displayed on the screen using switches, a mouse, or mouse emulators, instead of pushing them on a keyboard.

Teletypewriter (TTY)

A TTY (also known as a text-telephone) enables people who are deaf or speech-impaired to communicate over the telephone network. Individuals type into the TTY where the text is transmitted to the other person and printed out the receiving TTY. For people who are both deaf and blind, TTY must also interface with a Braille system.

Given that web-based training is gaining widespread acceptance, it is essential to make this type of training accessible to all, including people with disabilities and/or impairments. “Authors creating Web pages for online courses and information need to make them accessible to students with cognitive, motor, and sensory disabilities” (Robertson and Harris, 2003). The World Wide Web Consortium (W3C) has created the Web Accessibility Initiative (WAI) that “pursues accessibility of the Web through five primary areas of work: technology, guidelines, tools, education, outreach, and research and development” (W3C, 2000, *6. Techniques for Web Content Accessibility*). As part of the initiative, it has developed a set of guidelines, namely the Web Content Accessibility Guidelines 1.0, to make web sites accessible for people with disabilities. These guidelines should be applied to TVET programmes, delivered via the Internet. A brief overview of these guidelines is presented in Table 8.

Table 8: Web Content Accessibility Guidelines 1.0 as developed by the WAI through the W3C

Guideline	Overview
Provide equivalent alternatives to auditory and visual content	Provide content that, when presented to the user, conveys essentially the same function or purpose as auditory or visual content.
Don’t rely on colour alone	Ensure that text and graphics are understandable when viewed without colour.
Use markup and style sheets and do so properly	Mark up documents with the proper structural elements. Control presentation with style sheets rather than with presentation elements and attributes.
Clarify natural language usage	Use markup that facilitates pronunciation or interpretation of abbreviated or foreign text.
Create tables that transform gracefully	Ensure that tables have necessary markup to be transformed by accessible browsers and other user agents.
Ensure that pages featuring new technologies transform gracefully	Ensure that pages are accessible even when newer technologies are not supported or are turned off.
Ensure user control of time-sensitive content changes	Ensure that moving, blinking, scrolling, or auto-updating objects or pages may be paused or stopped.
Ensure direct accessibility of embedded user interfaces	Ensure that the user interface follows principles of accessible design: device-independent access to functionality, keyboard operability, self-voicing, etc.
Design for device-independence	Use features that enable activation of page elements via a variety of input devices.
Use interim solutions	Use interim accessibility solutions so that assistive technologies and older browsers will operate correctly.
Use W3C technologies and guidelines	Use W3C technologies (according to specification) and follow accessibility guidelines. Where it is not possible to use a W3C technology, or where doing so results in material that does not

	transform gracefully, provide an alternative version of the content that is accessible.
Provide context and orientation information	Provide context and orientation information to help users understand complex pages or elements.
Provide clear navigation mechanisms	Provide clear and consistent navigation mechanisms -- orientation information, navigation bars, a site map, etc. -- to increase the likelihood that a person will find what they are looking for at a site.
Ensure that documents are clear and simple	Ensure that documents are clear and simple so they may be more easily understood.

SECTION 4 USING ICTs FOR PROGRAMME SUPPORT IN TVET

TVET makes considerable use of ICTs for supporting its programmes. This section provides a description of this usage. More specifically, the discussion will focus on the use of ICTs for administrative purposes, career education and guidance, labour market information, placement of graduates, control of technical systems, information search and retrieval, communication purposes and programme design and development. Whenever appropriate, a case study is provided to support the discussion.

4.1 Using ICTs for Administrative Purposes

The use of ICTs in education for administrative purposes has perhaps met with less resistance and has been more readily accepted and adopted. This is perhaps because educational administration embraces more the management rather than the educational paradigm; and ICTs are perceived as empowering rather than threatening, as is sometimes the case in the teaching profession. ICTs are currently being used for administrative purposes even in institutions where it is not being used formally for teaching and learning.

ICTs have been very effectively and effectively used in TVET for the following administrative purposes:

1. Accounting
2. Advertising
3. Staff administrative services
4. Student administrative services
5. Support services
6. Research and evaluation
7. Physical plants
8. Fund raising.

Table 9 shows how ICTs can be used for administrative purposes.

Table 9: Administrative Uses of ICTs

Uses of ICTs	Specific Functions
Accounting	Budgeting, purchasing, grants administration, cash flow, account receivable, account payable, audits.

Advertising	Promoting programmes and courses offered.
Staff, administrative services	Human resources management - assessing staffing needs, recruiting staff, monitoring staff performance keeping records, communicating with staff Human resources development - conducting needs assessments, needs analyses and training needs analyses, delivering and assessing employee training
Students, administrative services	Recruiting and selecting students, advising students, supporting prior learning assessment and recognition, registration, recording attendance, record, and fee payment.
Support services	Providing programme information – calendar featuring programme and course description; pre-requisites and other requirements; keeping records to comply with freedom of access to information; maintaining web site giving access to administrative units, faculties and departments; managing computer and e-mail accounts for faculties and students.
Research and evaluation	Conducting institutional research, programme evaluations, and student assessments of faculties; statistical analyses.
Physical plants	Keeping records and inventory of facilities and equipment; storing information on occupational health and safety, including workplace hazardous information system.
Fund raising	Establishing databases for fundraising; keeping records of donations.

The Management Information System (MIS) is a type of software geared specifically for administrative purposes. An MIS is essentially a computer programme that can store important pieces of information. Since all the data are stored electronically, an MIS facilitates the collection and analysis of these data. The data can be easily accessible to instructors and administrators, which will save time for routine tasks. There are several types of student data that can be stored: attendance, assessment, report writing, timetable, finance, communication, allocation of classroom and laboratory facilities, budgeting, cash flow, etc.

4.2 Using ICTs for Career Education and Guidance in TVET

There are currently too many school leavers that "spend several years floundering in the labour market before they find steady, long-time jobs" (Stern, 1997, p. 4). The average age of beginning apprentices in Canada is 28 years old. TVET practitioners and career guidance counsellors should work in close collaboration to monitor labour market conditions and requirements in order to provide optimal services to students. Since a large proportion of secondary school leavers will not attend universities, all stakeholders need to work together to improve the image of TVET so that parents and students can appreciate the relevance and importance of vocational training.

The European Community (*Livre blanc sur l'éducation et la formation*, 1995) recognized that the individual is the most important agent responsible for constructing her/his qualifications by upgrading, combining and using acquired knowledge, skills, and training to make herself/himself employable and adaptable in the changing world. However, in the present environment where choosing and preparing for a career is like attempting to shoot at a moving target, proper career guidance and counselling are of critical importance to ensure seamless learning throughout life. The purpose of vocational guidance and counselling is to assist students to: "understand and appreciate their talents; relate effectively to others; explore career alternatives; develop appropriate educational and vocational training plans; implement and complete their plans; and integrate successfully in society and the labour market" (Conger, 1998, p. 1).

The US has developed the National Career Development Guidelines to assist educators in implementing career development programmes in elementary, secondary, and post-secondary education and training. The model includes three main components: self-knowledge, educational and occupational exploration, and career planning.

Career Education and Guidance (CED) consists of a set of approaches and strategies specifically designed to enable people to make informed choices related to their education and their work (BECTA, 2001a). According to the UK Department of Education and Skills, CEG has three goals:

Self-development:	helping students to understand themselves and develop their capabilities.
Career exploration:	helping students to investigate career opportunities, find out about post-16 choice, and investigate the knowledge and skills people need at work.
Career management:	using the results of self-assessment to implement their career, and developing effective strategies for making and implementing career decisions (BECTA, 2001a).

ICTs are revolutionizing CEG by providing new ways of exploring career options through video, graphics, and sound. Many CD-ROM titles and specific web sites dedicated to the following aspects of CEG are now available: information databases, self-evaluation aids, decision-making aids, work simulations and games, psychometric tests and checklists, self-presentation aids, and career resources (BECTA, 2001).

ICT support to career education and guidance includes:

- Storing large amounts of information in a range of formats
- Searching for and retrieving information quickly and accurately
- Matching information to individual preferences
- Printing out information in a personalized form
- Simulating work environment
- Updating information quickly
- Providing a mechanism for sharing and communicating information (BECTA, 2001a, p. 1).

The following case study features Bridges, a career exploration package commonly used in Canada.

CASE STUDY 14: Career Education and Guidance

Bridges is a career explorer software designed by career counsellors to enable students from Grade 6 to 12 to explore various career options. The programme is available both online and on CD-ROM. The online version is more accurate as it is updated everyday. The online version also supplies more resources on the Internet to further students' research and to assist them in planning their career path.

The programme offers features such as awareness tools, exploration, planning, transition, and instructional support. The awareness tool is used to expand students' knowledge regarding various career opportunities. The exploration tool is used to assess students' interests, abilities, and traits and match them to possible careers or job opportunities. On the online version, the exploration tool can be accessed through the library and be searched by using key words or career clusters. The planning tool emphasizes goal development by assisting students create a career path. The transition tool uses the career path and creates a career portfolio that keeps them informed of career news and scholarships available for their career choice. Youth also have the opportunity to create an online portfolio, which gives them the ability to store information such as references, course information, and résumés. It also offers a connecting tool that allows youth to connect to post-secondary institutions, financial aid, and employment opportunities. Instructional support provides lesson plans, new developments in their field of choice, and links to other resources. (http://cxinfo.bridges.com/)

The Daily News features of this tool allow career counsellors to gain access to all new content and to have access to online experts.

The online version offers two routes to choose from. One can subscribe as a student and have access to career exploration, or as a professional and have access to career news, alerts to conferences both nationally and internationally, and possible subscriptions to other newsletters. There is a free trial available online that, once a person is registered, is valid for 30 days. After the 30-day period, a fee is charged to access the service.

The programme and web site are easily navigated, making it possible for anyone to take advantage of all the available features. Help and assistance is available online and by voice.

4.3 Using ICTs to provide Labour Market information in TVET

In an economy where human capital has become a critical element in the production of goods and services, easily accessible and up-to-date labour market information (LMI) must be available to students as part of the CEG services. ICTs are increasingly being used for disseminating LMI. Following is an example of how the Canadian Government (Human Resources Development Canada) is using the Internet to provide detailed LMI to Canadians. This information can help people to search for work, and to make general

employment, training, and career decisions. The following Labour Market Information is accessible from the Human Resources Development Canada web site. This information is broken down by specific regions of the country and by occupational titles.

CASE STUDY 15: Labour Market Information

Summary of Labour Market

Glossary
Occupation Title and Code

The occupation classification title and code from the National Occupational Classification (NOC).

Example Titles

Sample of typical occupations contained in the occupational group. The information comes from the National Occupational Classification (NOC).

Nature of Work

General description of the main activities of the occupational group.

Main Duties

Description of the main duties of the occupational group.

Employment Requirements

Education and/or training, experience or certification required to obtain employment in an occupational group. In addition, tools or equipment needed are indicated where applicable. If available, provincial licensing, certification, registration, apprenticeship or regulated trade requirements as well as specific local requirements will also be displayed under this heading.

Employment Trends/Outlook

Any significant observations about the occupational group such as special education, skill sets needed, and current developments that have an impact on the occupational group and long-term growth projection.

Wage Ranges

Current prevailing wage ranges in the area determined from a variety of local data sources. Where available, union wage ranges are given separately.

Terms and Conditions

Most common conditions of work for the occupational group. It could include the normal hours of work (i.e. days, evenings, mostly weekends, or shift work), whether the job is normally full-time, part-time, or seasonal and types of remuneration (piece work, commission, gratuities).

Employment by Industry

List of the main industry sectors in which workers are usually employed for the occupational group.

Employment by Age and Gender

Count of the employed labour force by age category and gender. Average employment income is also given. This is based on persons working full-time all year and does not include seasonal or part-time workers.

Training Availability

Where applicable, the name of institutions providing the education and/or training necessary for an occupational group.

Professional Associations

List of associations where it may be possible to obtain more information on the occupational group.

Labour Force

Employed labour force includes the working age population 15+ who were employed in the occupational group. Experienced labour force includes those who were employed or unemployed in the occupational group. This reflects the size of the labour force in the local labour market for the occupational group.

Related Occupations

List of occupations that have similar titles or functions. Profiles may not be available for all of the related occupations listed.

Employment Potential

Indicates the short term (3-6 months) outlook for employment opportunities within a given occupational group in the local labour market, based on the analysis of events captured for the occupational group. Available indicators include:

Good: in the short term, there will be employment opportunities in the local labour market for

skilled clients in this occupational group and the short term outlook for employment is good.

Limited: in the short term, there will be few, if any, employment opportunities in the local labour market for skilled clients in this occupational group and the short term outlook for employment is limited.

Potential Employer

Employers where the occupational group is or may be represented.

Significant Occupation

An occupation is deemed significant depending on the number of employees, the labour pool, or the skills required for this occupational group.

Indicators

Special indicators for the occupational group such as seasonality, in demand, or surplus occupation in the local labour market.

Licensing or Certification

Requirements for a formal recognition that a person has attained a standard of proficiency in a set of knowledge, skills and abilities required to practice a trade or occupation in the province.

Identification of Red Seal trades for which common interprovincial standards have been established, enabling portability of credentials as related to the designated trades.
OR
Requirements for a specified term of
Seasonal

Occupation for which employment levels depend on regular fluctuations in the demand for certain goods and services.

Occupation Without Recruiting Difficulty

Occupation for which vacant positions are filled without difficulty, either because the pool of labour is sufficient to fill the available positions, or because of a high turnover of workers.

Shortage of Skilled or Qualified Labour

Occupation for which there are recruiting difficulties due to an insufficient labour force or a lack of qualifications in the available labour force.

Temporary Demand

Short term demand resulting from new projects or activities, or demand for temporary jobs as a result of a special event of short duration but to the exclusion of seasonal demand.

Labour Surplus
Occupation for which there is a substantial pool of qualified, unemployed individuals who are experiencing difficulty in finding jobs.

Regulated Trades or Apprenticeship
Substantial on-the-job supervised training combined with classroom training and during which the apprentice works under supervision of a qualified individual and learns the knowledge, skills, tools and material of the trade.

Source: Human Resources Development Canada Web Site: http://lmi-imt.hrdc-drhc.gc.ca/scripts/profile.asp?lang=eandprov=MAandgeo=B3andplat=1andtitle=sandocc=7242andopt=8

4.4 Using ICTs for Placement of TVET Graduates

To a large extent, the effectiveness of TVET programmes is measured by the success TVET graduates to obtain jobs in jobs related to their occupational preparation. Service providers and funding agencies usually conduct follow-up of TVET graduates to assess placement rate after graduation.

ICTs are revolutionizing employee recruitment and job search. Many countries, including Australia, Canada, and United States, have created online national job bank where employers can post vacancies and job seekers can search for jobs by occupational categories, average earnings, and geographical location. These free services have considerably reduced the time needed for matching employers and employees.

4.5 Using ICTs for the Control of Technical Systems

The globalization of the economic systems has had major impacts on the use of ICTs in the production of good and services. In summarizing the impact of new technologies on production, Sapountzoglou (1998) noted:

> The internalization of the economic activity favours the development of new technologies, and simultaneously, new technologies favour the internationalization of economic activity. This two-way phenomenon is relative to the continuous evolution and change of production and consumption patterns in contemporary societies (p. 85).

Following are some of the trends in the production of goods and services:

- Increased variability of goods and services to adapt them to demand, and constant innovation;
- Growing importance of quality in the selection criteria of clients;

- Reduced delivery time and strict observance of deadlines;
- Decentralized information technology in services;
- Large networks operating in real time;
- Automation of simple and repetitive tasks and the suppression of unskilled jobs;
- Spread of programmemable automation allowing production to adapt to demand (Jalllade, 1998);
- Development and timely introduction of new technologies in both production and products, "innovation and time to market";
- Reorganized production process, and restructuring of production chain;
- Just-in-time production and services;
- Provision of modern technological equipment.

Businesses and industries have experienced dramatic transformations as a result of the exponential growth of ICTs. For example, the transportation industry has seen massive computer integration into their operating systems. Some vehicles use three or more computers to control different onboard systems. Separate computers are being used to control the engine, transmissions/transaxle, instrumentation, and climate control, suspension system, and antilock brakes. Today's automotive technicians must not only update themselves with changes in automotive technology but must also keep up with new equipment and procedures. In modern automotive repair shops, workers must use computerized diagnostic tools to diagnose problems and make repairs. Other information technology systems provide access to technical service bulletins, manufacturers' service information, and inventory databases (Erjavec and Scharff, 1996).

The design, the manufacturing, and the printing sectors have also been transformed in major ways. Many machines that were traditionally manually or mechanically operated and controlled are now controlled by information technology. In the machining trades, Computerized Numerical Control (CNC) has replaced traditional setups and processes. Computer-Assisted Drafting (CAD) has replaced much of traditional hand drawing. In the printing trades, computers are replacing light tables and artists' knives (Lewis, 1996 p. 47).

The manufacturing sector has also been dramatically altered by ICTs. Many technology-based processes have been implemented in manufacturing such as Computer Numerical Control (CNC), Computer-Aided Manufacturing (CAM), Computer-Aided Design (CAD) and Computer-Integrated Manufacturing (CIM). Today, computer numerical control (CNC) machines are found almost everywhere, from smaller shops in rural communities to Fortune 500 companies in large urban areas. Truly, there is hardly a facet of manufacturing that is not in some way driven by these innovative machine tools (Lynch, 1998).

There has been further integration of information technology on the shop floor through the Ethernet and more recently, the Internet. These technologies are used to store and retrieve data and provide communication among programmemable devices. (Haynes, 2001). An ethernet on the shop floor has also meant immediate, easier, and paperless communication between workplace personnel (Zelinski, 2002).

In the building construction and fabrication industries ICTs have helped to improve product designs. Computer-Aided Design (CAD) is used for many tasks, including drafting and designing, analysing buildings for heat loss, and generating 3D interior mock-ups. The adoption of Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) techniques has provided speed, dimensional control, and accuracy to the work process (Finn, 1998).

Information and communications technologies have also made some inroads into the trucking industry. Satellite telecommunications are used by many fleet operators to track vehicle location and to communicate with on-board electronic systems (Bennett, 1999). The industry also uses Global Positioning Sensor (GPS) receivers and data recorders that can be used with or without a computer in the vehicle. This equipment provides information on real-time tracking and navigation data, mapping, direction, speed, duration of stops and addresses along a route (*Trucker's Helper*, 2002).
There has been some progress in the use of ICTs for developing occupational skills in TVET. For example, some equipment has been developed to train students to use CNC and CAM equipment. This equipment can emulate the controls found on the larger industrial machines. Some manufacturers offer 3D software that allows the student to make a programmemed part, virtually. That is, a virtual tool, cutting a virtual piece of material, from start to finish (Desktop CNC, Educational Machines, 2003).

TVET draws its foundation from technological innovations. One of the major challenges facing TVET is to stay abreast of technological developments occurring in business and industry in order to ensure that all graduates are workplace-ready in a context of declining resources. TVET educators have developed various initiatives to equip their laboratories with the latest technological innovations to compensate for the lack of resources. Some of the most common initiatives include cooperative education, work-based learning, high school apprenticeship, internships, work-study, and job shadowing. The use of ICTs in TVET provides opportunities for developing more innovative ways to bridge the gap between laboratories and workplaces. The following case study describes a creative approach for implementing a virtual internship in TVET.

4.6 Using ICTs for Information Search and Retrieval

In workplaces where employees' performances depend heavily on information, computerized manuals are replacing printed information. Manuals are conveniently stored on various CD-ROMs so that they are readily accessible (Kirk, 2002). In this information age the ability to retrieve and use information in form of electronic text, sound, graphics and video is fast becoming an essential skill. BECTA (no date, b) identified these critical skills related to information retrieval:

- ability to conduct Internet search skills;
- ability to restructure information;
- ability to assess the quality of information;
- ability to assess the validity and authenticity of material;
- ability to assess the quality of information;

- ability to select the most appropriate source of information;
- ability to download and save information.

All education institutions in developed countries host digital library catalogue systems where teachers and learners can perform a computer-based search. Searches can be done on a number of variables such as authors, subject, titles, and keywords and can use searching limits such as the date or year published, language, and material type (IITE, 2002b). Educational institutions can also purchase licenses to electronic databases that contain bibliographic information for books, articles, and journals. These databases span several different disciplines such as engineering, science, social sciences, and humanities. The case study, which follows describes an expert meeting and workshop hosted by The IITE (2002b) to address issues dealing with digital libraries.

CASE STUDY 16: Digital Libraries

In June 2001, the UNESCO Institute for Information Technologies in Education hosted an expert meeting and workshop in Moscow, dealing with Digital Libraries. Ten experts form eight countries attended the meeting and nineteen experts attended the workshop. The three major discussion topics were:

- Experience of the most effective digital libraries (DL) usage for education;
- Merits and demerits of digital libraries in education; and
- Role and policy of IITE in the development of digital libraries for education.

The final report of that meeting can be obtained from the IITE web site: www.iite-unesco.org

The Internet revolution has spawned a whole new approach to information retrieval, allowing teachers and learners to access information from all over the world in fractions of a second. Some educational institutions are placing their digital library catalogue on the web. Some public library systems are also placing their catalogue online. The British Library Public Catalogues one such example (http://blpc.bl.uk/). Online catalogues can sometimes be restricted by password to students, teaching staff, or subscribers.

Some magazines and/or journals (also known as e-journals) provide their articles online where users can search and browse through the current issue or archived issues. Examples of such journals/magazines include Techknowlogia (http://www.techknowlogia.org), Syllabus magazine (http://www.syllabus.com/) and the International Review of Research in Open and Distance Learning (IRRODL) (http://www.irrodl.org/).

Individuals can use search engines to find information on the web. Examples of search engines include AllTheWeb, AltaVista, AOL, Excite, Google, Hotbot, Lycos, and Yahoo.

There are also meta-search engines that submit the keywords to multiple search engines and the results from the different search engines are returned. Examples of meta-search engines include Surfwax, Copernic, and Ixquick. IITE (2000b) better search results on education can be obtained by using a specialized information system.

The case study that follows provides three examples of online research databases in vocational and technical education and training.

CASE STUDY 17: Research Databases in TVET

The UNESCO Institute for Information Technologies in Education (IITE) is an autonomous Institute, forming an integral part of UNESCO. The mission of the UNESCO Institute for Information Technologies in Education is to strengthen the national capacities of UNESCO Member States for applying ICTs in education. This mission is accomplished using a three-prong approach: (1) conducting research related to ICT-mediated learning; (2) developing and delivering training programmes in ICT-mediated learning; and maintaining a clearing house dedicated to ICT-mediated learning. : http://www.iite.ru/iite

UNESCO International Centre for Technical and Vocational Education and Training (UNESCO-UNEVOC International Centre), Bonn, Germany hosts an online research database featuring full text documents dealing with TVET. (http://www.unevoc.de/publications/index.htm)

The ETV (European Training Village) is an interactive platform; a meeting point for policy-makers, social-partners, practitioners, researchers, and all those with an interest in vocational education and training. Experts in the field can share and exchange knowledge and experience with associates within and outside the European Union. Established in 1998, it has become an expertise community, which counts up to 25,000 members and is rapidly growing. The ETV is administered by Cedefop, the European Centre for the Development of Vocational Training, www.cedefop.eu.int

The National Research Centre for Career and Technical Education conducts research and development in Career and Technical Education in the US. (http://www.nccte.org) National Dissemination Centre for Career and Technical Education: (www.nccte.org)

VOCED is an international database of research abstracts for technical and vocational education and training. It is hosted by Australia's National Centre for Vocational Education Research (NCVER) as part of its role in a UNESCO regional centre of excellence in technical and vocational education and training, and the Adelaide Institute of TAFE. (http://www.voced.edu.au/) UNESCO-UNEVOC Centre of excellence in TVET in partnership with Adelaide TAFE.

Other databases of interest to TVET practitioners and learners include online job banks, labour market information, and directories of TVET institutions and programmes.

4.7 Using ICTs for Communication Purposes

The advent of the Internet has dramatically opened new avenues for communicating. Although older technology such as the telegraph, telephone, radio, and postal service are still useful, the Internet is becoming a dominant form of communication. It is convenient, cheap (typically there is no cost for communicating via the Internet once the actual Internet connection is paid for), and allows for learners around the world to share and exchange ideas instantly. Communication techniques can be divided into two categories: asynchronous and synchronous.

Asynchronous Communication

Asynchronous communication refers to communication between individuals is independent of time and location. The individuals do not receive messages instantaneously; they receive messages only when they have the initiative to retrieve or view them (Illinois, 2001). Examples of asynchronous communication are e-mail, listserv, bulletin boards, discussion boards, and newsgroups (Karahalios, 2000).

E-Mail

As implied by the name, e-mail (electronic mail) is essentially an electronic letter. It is a text-based form of communication where a message can be sent to one person or a group of people in different locations (Karahalios, 2000). E-mail can be managed by programmes such as Emacs™, Microsoft Outlook™, Netscape Mail™, and Pine™. Web-based e-mail (such as Hotmail and Yahoo) can be accessed through an Internet browser, without any special e-mail programmes. Objects such as documents, images, etc. can be attached to an e-mail. Assignments can be handed in and documents can be exchanged through e-mail.

Listserv

A list server (listserv) is a programme that automatically sends e-mail to the members on a mailing list. Users can subscribe to a particular mailing list by sending an e-mail to a special mailing list address and the listserv automatically adds the e-mail address to the mailing list. Users unsubscribe in a similar fashion and they can be removed from the mailing list. Listservs conveniently manage mailing lists by allowing announcements and information to be easily distributed to the required individuals (listserv, 2001).

CASE STUDY 18: TVET Listserv: forum@unevoc.de

The UNESCO International Centre for Vocational and Technical Education and Training, Bonn, Germany hosts the listserv "Forum" (forum@unevoc.de). Its purpose is to facilitate networking, communication, and information exchange among individuals

involved in technical and vocational education worldwide. Forum is a moderated list. Contributors wishing to post a message must do so to forum@unevoc.de.

Discussion Boards and Newsgroups

Tools such as discussion boards and newsgroups allow individuals to post questions, answers, comments, and relevant information to people subscribed to that group. The posted information is available for all the authorized individuals to view and to respond to. Discussion boards and newsgroups can be private, such as the ones provided in web-based courses. There are also public forums called usenets that anyone can join. There are over 17,000 usenet groups spread across the nine high-level categories: biz (business-related topics), comp (computer-related topics (including software), misc (discussions that don't fit into any one category), news (discussions on Usenet itself), rec (hobbies, games, and recreational related topics), sci (sciences other than research biology), soc (social groups, often ethnically related), talk (Politics and related topics), alt (Alternative or controversial related topics) (Karahalios, 2000).

Synchronous Communication

Synchronous communication refers to communication that occurs in real time, that is, instantly. Responses to messages can be received right away where the interaction mimics a telephone conversation. Synchronous communication tools can be text-, audio-, or video-based, or a combination of any of the three. Examples of synchronous communication methods include chat and instant messaging programmes (such as IRC, NetMeeting, MSN Messenger, AOL Instant Messenger), Internet telephony, audioconferencing, videoconferencing, and audiographics.

Chat and Instant Messaging Programmes

Chat and messaging programmes allow individuals to have a real-time, that is, undelayed conversation through text messages. Individuals can type and send messages to each other and they can respond immediately. There is an area where users can type their messages and another area where users can view the messages that have been sent from remote users.

Internet Relay Chat (IRC) is a "multi-user chat system, where people convene on 'channels' (a virtual place, usually with a topic of conversation) to talk in groups, or privately" (Internet Relay Chat…, 1996, para. 1).

NetMeeting (*http://www.microsoft.com/windows/NetMeeting/default.ASP*), MSN Messenger (*http://messenger.msn.ca/*), AOL Instant Messenger (AIM) (*http://www.aol.ca/aim/index_eng.adp*), and ICQ (*http://web.icq.com/*) are other examples of instant messaging tools. A person sends a message to another person by using a nickname, e-mail address, or ID number. The aforementioned chat programmes also allow users to exchange files between each other.

Internet Telephony

Internet telephony (also known as voice-over IP) is a technology that transmits digitised voice packets over the Internet. Essentially, it allows individuals to have voice conversations over the Internet with the proper equipment (microphone and speakers). NetMeeting, MSN Messenger, AIM, and ICQ are examples of Internet telephony.

Audioconferencing, Videoconferencing, and Audiographics

Audioconferencing and audiographics allow real-time voice exchange. Audiographics can also have real-time transfer of graphics and images if interactive whiteboards are used. Videoconferencing allows individuals to see and hear other individuals in remote areas. These technologies are discussed in detail in section 2.1. NetMeeting, MSN Messenger, AIM, and ICQ have audioconferencing capability. NetMeeting and MSN Messenger also have videoconferencing capabilities.

4.8 The Use of ICTs for TVET Programme Design and Development

Good vocational education programmes are designed using a system approach. This approach includes various systematic processes, such as job analysis, task analysis, curriculum design and development, and instructional system design and development. These are very complex, time-consuming, and laborious processes. This section provides a discussion on the use ICTs automate some of these processes and to facilitate the decision-making process during TVET programme design and development.

4.8.1 Online Occupational Analysis and Essential Skills Profile

There is a strong demand on TVET for imparting, retooling and enhancing job related skills. If the purpose of a TVET programme is to improve the job performance, it is then important to use the job requirements as a basis for programme design and development. Job analysis is a strategy developed to breakdown a job into parts and components. Any job can be divided into duties, tasks, and subtasks. Duties are the major work activities performed by workers. Tasks are specific work activities, while subtasks are the steps that must be completed in the accomplishment of a task. Lack of front-end analysis is the single most common error in programme planning. Analysis is a very important phase of the programme planning process. It influences all the underpinning assumptions used in the decision-making process and provides the basic foundation for programme design and development. The process and product of the analyses also provide an audit trail for validating the programme planning activities as well as programme outcomes after its implementation. Additionally, job or occupational analysis is the only valid source of information for making programme-planning decisions.

Occupational Analysis

Occupational analysis is the strategy used for identifying the duties, tasks, and sub-task performed by job incumbents. The product is used for designing job description, task

inventory, performance systems, performance assessment system, compenzation systems and training design and development. Job analysis is expensive and time consuming. Consequently, it is warranted only after the needs assessment activity has demonstrated a performance gap and training analysis has established that an instructional solution will close that gap (Rothwell & Kazanas, 1992). Canada has made significant contributions to the job analysis techniques by the introduction of DACUM, which is an innovative method that has revolutionized programme planning. DACUM is an objective and cost effective technique for conducting job or occupational analysis using a brainstorming process involving 8 to 12 expert workers. Chinien (Case Study included) has developed a software for capturing the brainstorming process and projecting it on a wide screen using a multimedia projector.

CASE STUDY 19: Using ICTs for Occupational or Job Analysis

DACUM is a strategy that is universally used in TVET for conducting an occupational or job analysis during programme design and development. The process involves essentially expert workers brainstorming to identify the duty, task, sub-tasks as well as the supporting knowledge and abilities of an occupation or a job. The software ANALYZE IT was developed to conducting paperless DACUM workshops. ANALYZE IT captures all job analysis data during the process and, using a multimedia projector, projects the information on screento.
Source:
Dr Chris Chinien, Director, National Centre for Workforce Development.
Chinien@ms.umanitoba.ca

Canada has established the Red Seal Programme to provide greater mobility across Canada for skilled workers. Through this programme, apprentices who have completed their training and certified journeypersons, are able to obtain a "Red Seal" endorsement on their Certificates of Qualification and Apprenticeship by successfully completing an Interprovincial Standards Examination. The programme encourages standardization of provincial and territorial apprenticeship training and certification programmes. The "Red Seal" allows qualified trades persons to practice the trade in any province or territory in Canada where the trade is designated without having to write further examinations. An important segment of this collaborative effort consists in developing and updating National Occupational Analyses (NOAs) for the trades.

Human Resources Development Canada (Government of Canada) in collaboration with all the provinces and territories maintains a series of National Occupational Analysis (NOA) for 45 trades. These NOAs include the following elements: (1) duties, (2) tasks; (3) sub-tasks; (4) supporting knowledge and abilities, (5) tools, equipment and supplies; and (6) and occupational trends. All these NOAs are updated every five years and are made available electronically to programme planners and TVET instructors. The NOAs can be accessed at the following URL: http://www.hrdc-drhc.gc.ca/hrib/hrp-prh/redseal/english/analist_e.shtml

Human Resources Development Canada is also developing a series of Essential Skills Profile for all the NOAs. Each Profile provides information on all the essential skills and how they are used within that occupational group. Essential skills are defined, such as reading, writing, numeracy, oral communication, and problem solving. They are also used throughout the activities of daily life: from shopping to food preparation, from recreational activities to community involvement. These profiles are available electronically to programme planners and TVET instructors and can be accessed at the following URL:
http://www.hrdc-drhc.gc.ca/hrib/hrp-prh/redseal/english/analist_e.shtml

The following skill sets are included in the Essential Skills Profile:

Reading
Document use
Writing
Numeracy
Oral communication
Thinking skills
Problem solving
Decision making
Job task planning and organizing
Finding information
Working with others
Computer use
Continuous learning
Other information

The Wisconsin Technical College System Foundation has developed a software to facilitate programme design and development. Called the Worldwide Instructional Design System (WIDS), its main features are described in the case study that follows.

CASE STUDY 20: Worldwide Instructional Design System

WIDS was developed by an advisory team composed of representatives from 16 community colleges and a K-12 school system. They incorporated proven teaching, learning theories, and best practices in the development of the software.

WIDS offers educators a set of tools to facilitate learner-centred, competency-based curriculum design and development. It provides a consistent framework for the design of course and programme outlines, learning plans, syllabi, and assessment tasks. The work is stored in a database and can be easily exported to HTML or Microsoft Word™ applications. This software will store learning outcomes, related assessments, occupational analyses, and programme design information such as competencies, performance standards, learning objectives, and learning activities. WIDS is currently being used to design and develop TVET programmes in the US and many other countries. Twenty six out the 28 community colleges in the state of Michigan have adopted WIDS.A free trial version of WIDS is available form the following URL:
http://www.wids.org

4.8.2 Automated Instructional System Design and Development

Past surveys have determined that over 200 development hours are required to produce one hour of online learning (Kemske, 1997 as cited in Chapman, no date). For highly interactive lessons, the number of hours can jump to 800, even 1000 hours (Chapman, no date). This significant time commitment to programme design and development warrants the use of instructional design tools to increase efficiency and productivity. The whole instructional development process can be separated into two major phases: design and development (authoring).

Automated instructional design (AID) tools assist professionals, especially people with limited instructional design expertise, to create instructional products. Abby (1998, p. 2) classified these tools into four categories:

1. Expert systems:	Expert systems facilitate decision-making and instructional analysis process using a built-in knowledge base.
2. Advisory Systems:	These tools assist or coach the designers in the instructional design process.
3. Instructional Design Environment:	This tool supports an instructional design methodology for teaching the use of software in real-life problem solving context.
4. Electronic Performance Systems:	These are self-instructional electronic environments that provide just-in-time information, guidance, data, tools and assessment to support instructional design tasks.

There are several authoring tools on the market such as Authorware, Quest, and ToolboxII. The tool Designer's Edge focuses on the design phase of the process. The following case study provides a description of Designer's Edge.

CASE STUDY 21: Automated Instructional Design: Designer's Edge

Designer's Edge was developed by Allen Communication (*http://www.allencomm.com*) and is an instructional design tool that provides pre-authoring tools and wizards that guide instructors through the instructional design process, from the analysis stage to the evaluation stage (Designer's Edge 3.5, 2000). It is not an authoring system. It guides the designer through the design process and it allows the design to be integrated into an authoring system for final production. It uses a Windows™-based graphical user interface (GUI). The designer can use either a "task analysis" or "needs analysis" design model. The design steps are based on the standard instructional system design model (ISD) of Analyse, Design, Develop, Implement, and Evaluate (Chapman, 1995). As the designer proceeds through each step of the design process, a course "map" and course "blueprint" develop. Storyboards can be used to lay out exactly how the course will be presented to

the user. Designer's Edge provides 12 sequential design steps:

1. Analyse Needs – Conduct a thorough needs analysis based on the needs and goals of the target audience.
2. Draft Mission Statement – Develop a mission statement, definition of the course, and due dates for milestones (design strategy document, script storyboard, alpha, and beta tests, final due date).
3. Create Audience Profile – Gather specific information about the audience such as its likes and dislikes, the kind of music it prefers, level of education, hobbies, etc.
4. Write Objectives – Identify clear objectives based on the needs and goals stated earlier.
5. Analyse and Outline Content – Develop an outline of the course and determine how the course should flow.
6. Layout Course Map – Specify the course structure in a visual format and integrate any available data to produce a blueprint of the course.
7. Define Treatment – Determine what the course should look and feel like.
8. Select Learner Activities – Determine the instructional strategies that should be used to match the target audience.
9. Create Detailed Plan – Using the course map, "create a structured storyboard that links objectives, strategies, content, and treatment to specific frames in the course", develop the screen design concepts, and assemble a media log of the required media (Designer's Edge. 12 Steps, 2003, para. 10).
10. Produce Media – Develop a checklist of the required media, who created it, where it is located on the network, etc.
11. Author Course – Export the design into a supported authoring system, RTF compatible word processor, or a database through ODBC. With Net Synergy (another Allen Communication product), the design can also be exported to HTML/Java templates.
12. Evaluate Course – Evaluate the course through the provided tools. Pre-built data collection forms are provided for "alpha and beta test checklists, content gathering, audience surveys, media production and evaluation of course performance in the field" (Designer's Edge. 12 Steps, 2003, para. 13).

Through research and surveys performed in conjunction with Allen Communication, Kagel Research Associates found that on average productivity increased in several areas: objective writing (16%), outlining content (14%), defining learning strategies (14.8%), creating a course map (18.9%), storyboarding (17.3%), and evaluation (12.8%). These numbers combine to provide an overall average gain in productivity of 36% (Designer's Edge Return, no date, para. 4).

Authoring tools are designed to simplify programmeming during the instructional development of ICT-mediated learning. The most commonly used authoring tools include Macromedia Authorware; Aim Tech IconAuthor; WBT Ssytems TopClass and Asymetrix Toolbook (Abby, 1998).

4.8.3 Learning Objects

Learning objects is a new concept that will greatly facilitate programme development in TVET. Ausburn (2002) argues that the demand for mass customization of technology-based learning (TBL) will require a shift from a traditional model of instructional design and development. The concept of the learning object is central to this new paradigm. The author defines learning objects as "learning components that can be used, reused, revised and reshuffled as needed to become part of any number of larger learning materials or course" (Ausburn, 2002, p. 35). Downes (2001) as cited in Ausburn (2002, p. 36) also provides an operational definition of learning objects as "a learning objective and all instructional components (text, graphics, test items, activities, etc.) associated with the objective". Learning objects are placed in a learning object repository, which is essentially a computer database and an information management system. These objects can be retrieved for modification, reuse, and reassembly into specific instructional products.

The key feature of learning objects is that they are reusable. Ideally, a basic concept can be made into a learning object that can be used in a variety of contexts. It can be as simple as a single image or as elaborate as an interactive presentation. Learning objects can include applets, animations, video and audio clips, etc. They must have one clear, define purpose, and not encompass a wide range of information and their use is restricted to only one particular context (Online Learning Resources…, no date). Learning objects help avoid the "monolith" problem, where courses are treated as a single entity. Learning objects alleviate the problems with the "monolith" methodology. They provide several benefits: flexibility and versatility, cost savings, ease of updates, searches, content management, and interoperability. They also facilitate competency-based learning.

Flexibility and Versatility: It is easier to reuse material that is designed for multiple contexts from the outset than it is to reuse material that has to be re-designed for each new context (Longmire, 2000). For example, material used for medical students could be suitable for other healthcare workers or medical technologists (Online Learning Resources…, no date). The learners also have flexibility since they can determine their own learning path based on their learning style.

Cost savings: Money is saved every time an object is reused since time and resources are not spent on re-design. Companies or educational institutions may also decide to sell these objects resulting in increased income (Longmire, 2000). Additionally, companies and institutions may collaborate and develop objects together, resulting in decreased costs. Downes (2001) presents a simple example to emphasize this point:

> Suppose that just one description of the sine wave function is produced. A high quality and fully interactive piece of learning material could be produced for, perhaps, $1,000. If 1,000 institutions share this one item, the cost is $1 per institution. But if each of a thousand institutions produces a similar item, then each institution must pay $1,000, with a resulting total expenditure of $1,000,000. For one lesson. In one course (para. 4).

Ease of updates, searches, and content management: Metadata that is associated with each learning object "facilitate rapid updating, searching, and content management by filtering and selecting only the relevant content for a given purpose" (Longmire, 2000, para. 4). Rapid and easy updating mechanisms ensure that information is current and up-to-date.

Interoperability: With standards currently being developed by groups such as the IEEE Learning Technology Standards Committee (LTSC), and the Advanced Distributed Learning Initiative, learning objects will be able to be used in other learning systems and contexts around the world (Longmire, 2000).

Facilitation of competency-based learning: The competency-based model of teaching and learning, as used in TVET programmes, is based on the idea of a "competency" being a function of three components: attitudes (behaviour), knowledge, and skills (Williams and Hua, 2001). Thus, a competency in "Planning and Design" involves the knowledge of the principles of design, the skills required for planning and design (for example, computer-aided design and communication skills), and the required attitudes (for example, accuracy and quality) (Williams and Hua, 2001). Truly modular learning objects can be used to fill the gaps in competencies (Longmire, 2000).

4.8.4 Metadata

Metadata can be simply defined as information about an object or "data about data" (Nunes and Gaible, 2002, p. 111). Learning object metadata provides a general outline and description of the learning object itself. The draft standard for Learning Object Metadata put forward by the IEEE LTSC states that "a metadata instance for a learning object describes relevant characteristics of the learning object to which it applies. Such characteristics may be grouped in general, life cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories" (Draft Standard…, 2002, p. 5). Downes (2000, p. 17) describes metadata metaphorically: "We might think of authoring learning objects as akin to authoring pieces of a puzzle, in which case the content is the image or picture on the surface of the piece, while the metadata is the shape of the piece itself which allows it to fit snugly with the other pieces". Metadata is important since it is potentially this information that will be stored in a system of learning objects repositories around the world, according to Downes (2000, p. 26). In his scenario, there will be central database(s) containing the "tens or hundreds of thousands of individual objects". These databases will be multi-functional with information for online courses, online journals, magazines, knowledge management applications, etc. Each object in the database will contain metadata and the learning object repositories will access the relevant metadata for online courses (Downes, 2000). In the case of TVET, the learning object repositories can potentially filter for only TVET-related metadata.

TVET educators have had a head start with regard to the adoption of learning objects. Many TVET programmes are competency-based and in many countries specific standards have been developed for these specific competencies. These competencies and standards can be used as a basis for developing learning objects for TVET programmes.

Research conducted by the International Labour Organization (ILO) in connection with the Modules of Employable Skills (MES) has also promising potential in the context of learning objects.

Developed back in 1992, the MES model for vocational training programmes "are based on the competencies required to perform the tasks of given jobs and/or national training standards where such standards exist" (Chrosciel and Plumbridge, 1992, p. 4). The ILO defines a modular unit as "a logical acceptable division of the work of a particular job or occupation, having a clear start and finish and which would not be further subdivided" (Ibid, 1992, p. 5). For example, the job of car servicing in automotive engineering may consist of the seven modular units: Servicing ignition system, Servicing battery, Servicing cooling system, Changing engine oil, Cleaning car body, Servicing tires, and Servicing brake system (Chrosciel and Plumbridge, 1992). These modular units combine together to form the MES for the job of car servicing. Learning Elements (or instructional units) are "self-contained instructional booklets, each covering a specific item of skills or knowledge" that are used in MES training programmes (ibid., 1992, p. 7). They contain a specific objective, a list of required equipment, materials and aids, a list of other related learning elements, instructions with text and illustrations, and a progress check that precisely matches the learning objective (Chrosciel and Plumbridge, 1992).

A modular unit is made up of different learning elements that train a person to perform the required steps of the modular unit. The common and basic learning elements can be linked to several different modular units. For example, the learning element "Measuring – Using Rules and Tapes and Straight Edges" can be used in the modular units of the area of Building Construction, and reused in the Electrical/Electronic Engineering and Plumbing and Pipe Fitting areas. The idea of modular units and learning elements cater perfectly to the learning object concept as defined by the IEEE LTSC. Massaging a learning element (as referred to in the context of MES and TVET) into a learning object structure and storing it in a widely available repository has enormous potential in revolutionizing the way TVET programmes are developed.

The Generic Skills study conducted by the Government of Canada (Smith, 1979) is also of significant importance in considering the implementation of learning objects in TVET. This study was based on the use of 588 trade tools (such as portable hand tools, shop machinery and equipment, wheeled vehicles, etc.) by 1,600 workers (such as tradesmen/women, trades supervisors, technicians, technologists, etc.) in 131 different occupations (Smith, 1979). The workers identified the skills that they used in their work duties. The data were organized by occupation and by skill "to determine which skills 'belonged' to which occupations and which skills were required in all or most of the occupations" (Smith, 1979, p. 2). A threshold of 30% whereby "if 30% or more of the job holders responded to a particular skill, it was recorded as an occupational requirement" (Smith, 1979, p. 2). The "reusability" of these skills was determined as each pair of occupations was "compared to determine the percentages of skills held in common (COMMUNALITY FACTOR) and the percentage of skills which each occupation used of the total skills held by the other occupation (TRANSFERABILITY FACTOR)" (Smith, 1979, p. 2). For example, Aircraft Mechanics use 93% of the tool skills of a Body

Repairer and Body Repairers use 72% of the tool skills of an Aircraft Mechanic (transferability factors). The communality factor between the two is 68% (Smith, 1979). This type of research is useful in determining what learning elements (or learning objects) should be included in a TVET programme and how they can be shared between different programmes; this will considerably cut down the time required for programme planning. This quick and inexpensive approach for designing TVET programmes also means that a programme could be designed for only one student to meet a labour market need instead of using the traditional model where the break-even point for a programme requires an instructor-trainees ratio of 1:20.

Figure 3 presents a specific example of how the duties of a specific occupation can be broken down into smaller, modular sections. Each occupation has explicit duties that must be performed. Each duty can be broken down into a number of tasks. These tasks can be structured into specific steps. To perform each step satisfactorily, the worker must possess specific knowledge and abilities. The required knowledge and abilities can be formalized into a general instructional objective that must be taught to the worker. Each general instruction objective can be subdivided into specific instructional objective(s). Further, there are "enabling objectives" that the worker must learn to achieve a specific instructional objective.

The full impact of learning objects will manifest itself when educators begin to share and exchange these objects. Downes (2001, p. 1) as cited in Ausburn (2002, p. 36) noted: "he economics are relentless. It makes no financial sense to spend millions of dollars providing multiple versions of similar learning objects when single versions of the same objects could be shared at a much lower cost per institution. There will be sharing, because no institution producing its own materials on its own could compete with institutions sharing learning materials".

However, before the wide scale implementation of learning objects, there are some issues that must be resolved, including: What standards are used for metadata? Will the learning object information be available in languages other than English? (Shata, 2001) and, What will it cost?

4.8.5 Learning Object Standards

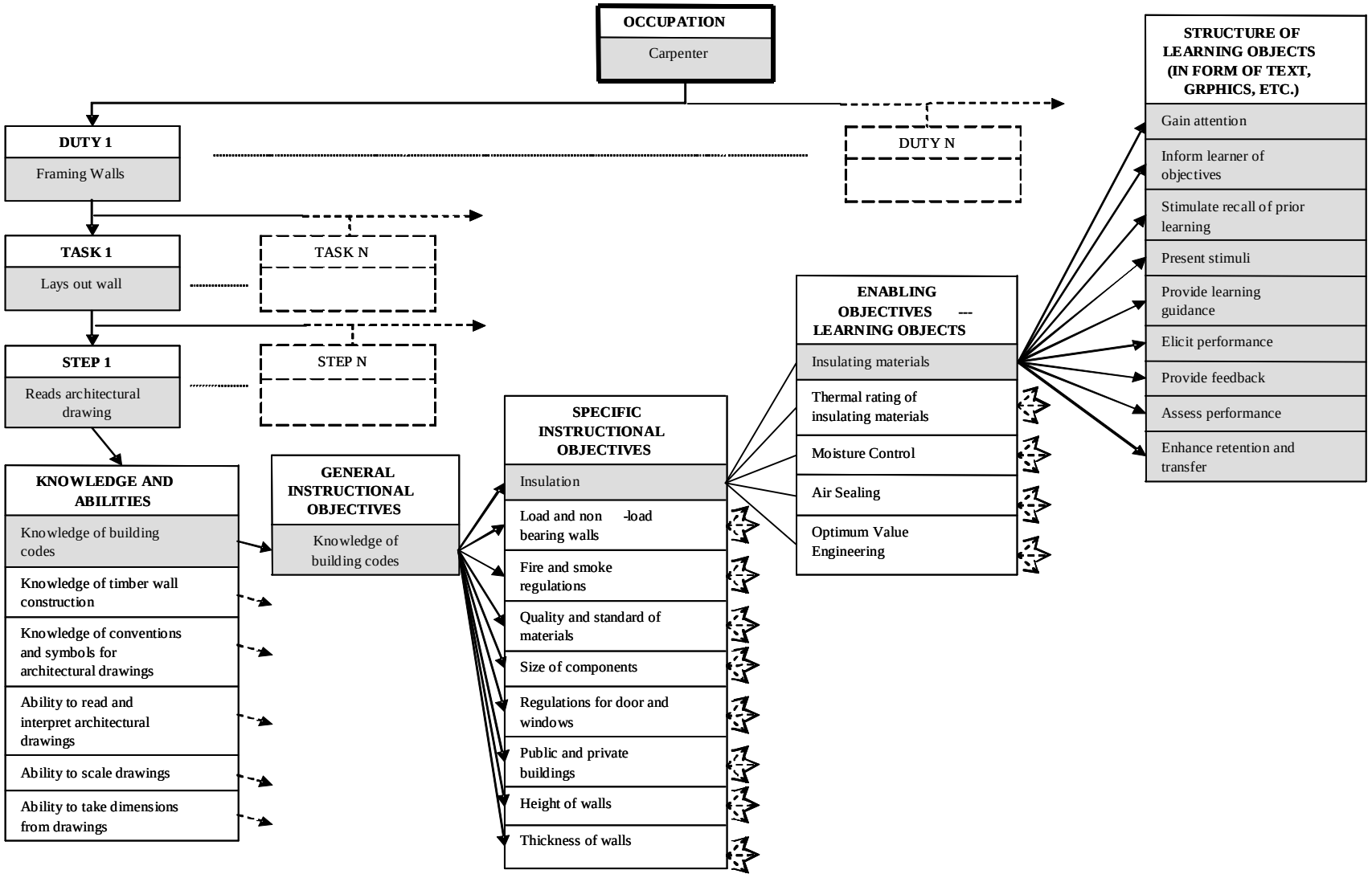
Standards and specifications attempt to universally define the best way to describe and handle learning objects. The development of standards for metadata allows objects to be "searched, evaluated, acquired, and combined" (Nunes and Gaible, 2002, p. 111). The Australian National Training Authority presents the benefits of "open and internationally consistent technical standards" (ANTA, 2002b, p. 6). They can:

- Help make training available online and thus avoid problems of place, time, working arrangements, or equity group,
- Reduce the risk and cost in making purchasing decisions at all levels,
- Ensure the maximum interoperability (compatibility) and scalability of technical infrastructure,

- Increase the ease with which quality teaching and learning resources can be found, obtained, transferred, adapted and used by teachers and students,
- Ensure that teachers and students can participate in teaching, learning and professional development activities across organization, sector and state/territory boundaries,
- Allow competition and cooperation as appropriate (ANTA, 2002b, p. 6).

The major players in devising learning object standards include the IEEE LTSC P1484 (*http://ltsc.ieee.org/wg12/s_p.html*), the IMS Global Learning Consortium, Inc. (*http://www.imsproject.org/specifications.cfm*), the Advanced Distributed Learning Initiative which created the Sharable Content Object Reference Model (SCORM) (*http://www.adlnet.org/index.cfm?fuseaction=scormabtandcfid=367799andcftoken=97864349*), the European Union-based group ARIADNE (*http://www.ariadne-eu.org*), the Aviation Industry CBT Committee (AICC) (*http://www.aicc.org/*), the World Wide Web Consortium (*http://www.w3.org*), and the Dublin Core Metadata Initiative (DCMI) (*http://dublincore.org/*).

Figure 3: Component Tasks of an Occupation



CASE STUDY 22: Multimedia Educational Resource for Learning and Online Teaching (MERLOT)

Developed in 1997, MERLOT (http://www.merlot.org) is "an international cooperative for high quality online resources to improve learning and teaching within higher education". It creates an online educational community of systems, consortia, and institutions of higher education, professional organizations of academic disciplines, and individual members. It is "a tool for enabling faculty to effectively, easily, and enjoyably integrate instructional technology into their courses" (MERLOT 2001-2002 Annual…, 2002, p. 1). Hosted by the California State University Centre for Distributed Learning MERLOT is a free resource, open for anyone to join and use. It serves "over 1400 campuses that serve over 350,000 faculty and about 8 million students" (about…, para. 1). MERLOT provides a variety of resources: links to online teaching and learning materials, evaluations of the online resources, sample assignments illustrating classroom use of materials, links to people with common interests in a discipline and in teaching and learning, electronic portfolios for its members containing their contributions to MERLOT, and professional development programmes for faculty, faculty development personnel, academic technology staff and administrators from participating institutions (MERLOT 2001-2002 Annual…, 2002). As of June 2002, there were 7037 learning materials, 9154 registered members, 516 peer reviews, and 2875 member comments within the MERLOT collection. Most of the learning materials are considered to be modular so they can be incorporated into a larger course and most are designed to be viewed online through a web browser with JavaScript and cookies enabled (MERLOT, 2001-2002). There are currently 13 discipline communities: Biology, Business, Chemistry, Engineering, Health Sciences, History, Information Technology, Mathematics, Music, Physics, Psychology, Teacher Education, and World Languages.

CASE STUDY 23: EduSource Canada

EduSource Canada is a recent Canadian project that involves the creation of a "national grid of learning object repositories", with one central metadata repository (McGreal, no date, p. 1). It will be based on a peer-to-peer architecture and use the CanCore protocol, which "is based on and fully compatible with the IEEE Learning Object Metadata standard and the IMS Learning Resource Meta-data specification" (Cancore, para. 1). The interoperable learning objects will be accessible to educational institutions, teachers and students throughout the world via the Internet (eduSource…) (McGreal, no date). This initiative recently received $4.25 million CDN in funding from the federal government (Industry Minister…, 2002).

CASE STUDY 24: Australian Flexible Learning Toolboxes

Similar to learning objects, "toolboxes" have been developed in Australia under the Australian Flexible Learning Framework for the National Vocational Education and Training System 2000-2004 agreement (Anta, 2001b). A toolbox is defined as "a collection of online training materials comprising learning activities, resources and user guides to support programme delivery". These toolboxes are used to form a training package, which can be made up of multiple toolboxes. Furthermore, toolboxes are separated into units where specific units of a toolbox can be used in different training packages. For example, the "Tourism" toolbox has a "Plan and manage meetings" unit that is also used in the "Hospitality" training package, and a "Coordinate marketing activities" unit also used in the "Seafood Industry" training package.

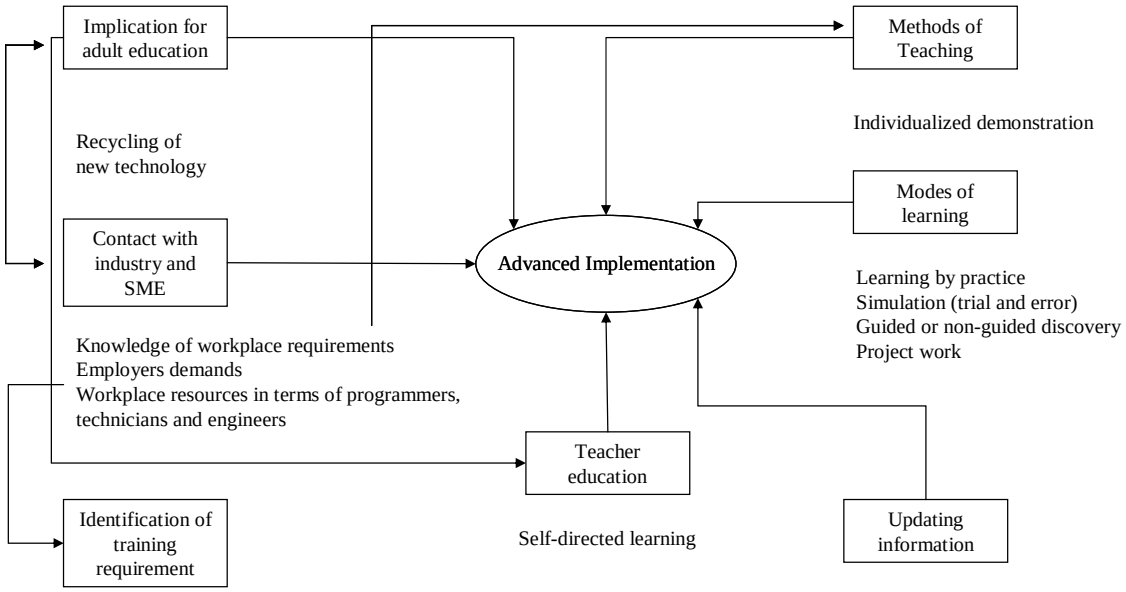
SECTION 5 THE USE OF ICTs AND TVET: A GLOBAL PERSPECTIVE

5.1 Emergent Model for Integrating ICTs in TVET

Chomienne (1990) conducted a study to investigate the factors that facilitate the integration of ICTs in TVET. Results of her study pointed toward four pedagogical applications of computers technology: computer as a technical tool for teaching, computer as a teaching tool (teaching aid), computer as a working tool for the students (professional tool), and computer as a control system tool or laboratory and workshop tool.

To find out more, Chomienne collected additional data from teachers who have reached an advanced implementation level of ICTs in their teaching. Her objective was to better understand the ICT implementation process followed by these "exemplary" teachers. The result is summarized in an Emergent Model of ICT Implementation shown in Figure 4. ICT implementation in TVET emerged from an intricate process. Contacts with industry kept teachers current with workplace requirements, and employers' human resource needs. This information helped teachers to identify the training requirements and directly influenced the teaching methods used. The preparation received by teachers regarding methods of teaching and learning modes, along with their self-directedness in learning that kept them up to date are all factors that affect the level of ICT implementation in TVET.

Figure 4: Emergent Model for Implementing ICTs in TVET



After reviewing the literature on the usage of ICT-mediated learning Farell (2001) concluded:

> …there are still very few examples, globally, of what one might call "pure" virtual learning. In other words, there are a few examples in which facets of teaching/learning process are carried out through some type of ICT interface. Furthermore, most of the activity is still occurring around the edges of institutions, particularly the public sector institutions (p. 152).

Most of the literature on the use of ICT-mediated learning is focused on the sectors of K-12, university education, and adult basis literacy. The literature dealing with the usage of ICT-mediated learning in TVET is scarce, fragmented, and difficult to access.

Although ICTs are by far the most significant element undergirding the foundation of TVET, there is a paucity of literature and research regarding its implementation and use in this field of education and training. Attwell (1999) noted: "whilst there is a wealth of studies and debate on the use of information and communication technologies in university and higher education, there has been only limited work on the potential impact for vocational education and training". This lack of research-based information on the use of ICTs in TVET is also echoed by Zircle (2002 b). Brennan, McFadden and Law (2001) noted: "The degree to which diligent and high-quality research percolate beyond their place of origin is questionable. It is almost as though we have groups of people working in this area who do not have the structures in place to exchange information and insights in a productive way. Dissemination of these results seems to be a serendipitous process" (p. 64). However, based on the limited amount of information available, this section attempts to provide a global perspective of the usage of ICTs in TVET in both developed and developing countries.

5.2 Usage of ICTs in TVET in UNESCO Member States and Other Selected Countries

Andre Lewis, Director of the National Training Framework of the Australian National Training Authority recently noted that traditional training approaches of TVET "are under threat and new ways of thinking about, organizing and ensuring adequate skills formation that is useable in enterprises are required" (2001, p. 1). All UNESCO Member States are attempting to reform their TVET systems to make them more responsive to this new reality. Many countries are trying to harness the power of ICT-mediated learning as part of a comprehensive strategy to reform the TVET systems. However, there is a lack of a systematic approach for evaluating ICT usage in education. IITE (2001c) held an expert meeting to discuss indicators of ICT usage in education. The case study, which follows, describes this expert meeting.

CASE STUDY 25: Indicators of ICT Usage in Education

In March (2001b), the UNESCO Institute for Information Technologies in Education hosted an expert meeting in Moscow *ICTs in Education: State-of-the-art, Needs and Perspectives – Indicators and Information system.*
Twelve experts form twelve countries attended the meeting, which dealt four main themes:

- International experience in evaluating the educational usage of ICTs.
- Structure of indicator data set and its application in ICT usage evaluation.
- Organization of data and information system requirements.
- Development of training module for policy makers and decision makers.

The final report of that meeting is available from the IITE web site: www.iite-unesco.org

This section provides a brief overview of the usage of ICTs in TVET in some UNESCO Member States and other selected countries.

5.2.1 Afghanistan

"Two decades of war has destroyed infrastructure of the society, economy, political and education of Afghanistan…about 70% of educational institutions were destroyed and many teachers were killed during the war" (p. 37). The population has been deprived of TVET. Problems confronting TVET in Afghanistan include: shortage of training facilities, lack of teachers, shortage of equipment and materials, shortage of teaching and learning materials, non-provision of courses in ICTs, shortage of financial resources. (National Institute for Educational Policy Research – NIER, 2002).

5.2.2 Africa

The African Virtual University (AVU) uses satellite technology, the Internet, phone lines and e-mail to link AVU centres across Africa to a studio classroom to provide learners with real-

time interaction with the instructor. Tutors at the AVU centres provide support to students and facilitate two-way communication with the studio classroom instructor. AVU centres have successfully trained thousands of students as technicians, engineers, managers, and scientists … in more than 15 African countries (African Virtual University 2001 Web site. http://www.worldbank.org/knowledgebank/facts/avu.html) (Stevens, 2001, p. 70–74).

Distance education programmes developed by the Commonwealth of Learning have been used to train untrained/unqualified TVET teachers in Botswana, Kenya, Swaziland, Tanzania, Uganda, Zimbabwe, Nigeria, Sierra Leone, Guyana, Bangladesh, St. Lucia and Papua New Guinea (John, 2002).

In Botswana, distance and open learning is the responsibility of Distance Education Programme, an arm of the Botswana Department of Non-Formal Education. The Government of Botswana is planning to introduce several new TVET programmes as well as construct several new TVET institutions. Bostwana has more than 20,000 Internet subscribers. This relatively high level of access to ICTs facilitates the government's plan to implement high quality TVET programmes for various groups, using flexible learning methodologies (ANTA, 2001a).

The Educational Media Agency (EMA) in Ethiopia has partnered with WorldSpace. WorldSpace is providing one broadcast channel and 50 digital receivers to broadcast over 400 programmes from AfriSat. This satellite can broadcast audio programmes and transmit multimedia information, and it can download text, video, audio, and graphics to a radio. Files can then be sent to an attached computer. EMA intend to use the system to transmit data via the satellite to resource centres throughout the country (Stevens, 2001, p. 58).

Open and Distance Learning (ODL) in Namibia is offered through a number of providers, some of the most important ones being the Namibia College of Open Learning (NAMCOL), the National Institute for Educational Development, the Polytechnic of Namibia and the University of Namibia. Providers have established a fair number of learning centres across the country to reach population in rural areas. Schools become learning centres after regular hours. Enrolment in ODL has tripled in three years and accounts for 52% of all tertiary enrolments. The scarce programme offerings and the availability of learning resources limit greater increase in enrolment. The Namibia Open Learning Network is a joint venture between the public providers and the government in an effort to provide better learning resources at centres across the country. ODL programmes depend on local tutorial support by teachers and experts in the field (Polytechnic Taskforce v2030, 2003).

The Owerri Digital Village in Nigeria offers four main programmes: TechKids, TechTeens, TechEnhancement, and TechCommunities. TechKids caters to children between the ages of 8 and 12 whereas TechTeens focuses on students between 13 and 18. TechEnhancement is geared toward civil servants who want to acquire skills that will help them in their daily activities (Ugwuegbu & Gipe, 2002, para. 12). TechCommunities trains poor, rural, semi-literate women to gain critical skills that will help improve their small businesses and communities. The Owerri Digital Village offers academic learning and vocational and technology training, and provides adult education in business management skills. It exposes

women to the new ICTs and how these can benefit them in their everyday life. For example, "trader women will use the e-post facilities at the digital village to deliver messages to their customers in the villages when a new shipment or stock has been received" (Ugwuegbu & Gipe, 2002, para. 18).

5.2.3 Arab States

UNESCO Regional Office for Education in the Arab States (1995) identified the types of ICTs commonly used in TVET in the Arab States in workshops and laboratories and for learning:

Workshops and laboratories:

- Operating Systems
- Networking Systems
- Communication Protocols
- Computers and associated software
- Computer Aided Design (CAD) systems
- Computer Aided Engineering (CAE) systems
- Computer Aided Manufacturing (CAM) systems
- Material Requirement Planning (MRP) systems
- Computer Integrated Manufacturing (CIM) systems
- Group Engineering
- Management Information Systems (MIF)
- Document Management Systems (DMS)

ICT-mediated learning:

- Multimedia Authoring Systems
- Computer-Based Learning
- Computer-Based Training
- Open Learning/Teaching Courseware
- Application courseware
- Training Courseware
- Electronic Mail
- Electronic Bulletin Board
- Videotext
- Automated Libraries
- Databases and Databanks
- Multimedia
- Word processing
- Spreadsheet
- Desktop Publishing

5.2.4 Argentina

Among Latin American countries, Argentina has a greater push for distance education. Young people and adults who were not trained by the formal educational system, inhabitants of rural areas, government employees, and convicts are the beneficiaries of the Argentinean distance education system. The distance education programme in TVET is mostly housed by the secondary education sector. The types of technologies used include: printed materials, audiocassette, and video (Ortiz, 1999).

5.2.5 Australia

Australia is recognized as a trendsetter in the area of TVET. The country has also established itself as a world leader for its initiatives in research, innovation and reform in TVET. In keeping with this tradition: "Australia's pre-eminence in the area of distance education has been widely acknowledged" (Tapsall and Ryan, 1999, 147). At the national level, all states and

territories have agreed to an Australian Flexible Framework for Vocational Education and Training 2000-2004. The propose of the agreement is to:

- Build a critical mass of VET staff who are able to use flexible learning approaches;
- Achieve a national VET system, which facilitates affordable access by all communities, learners and employers to online services;
- Develop world class online content, applications and services; and
- Remove unnecessary regulatory barriers to online learning (Keating & Thompson, 2001).

Australia has already made some significant accomplishments in flexible learning. Following are a few examples (EdNA VET Advisory Group, 2001, p. 5):

- Most states have TAFE on line or are in the process of implementation.
- Adoption of the National Technology Standards Policy (1997).
- Adoption of Preferred Standards to Support National Cooperation in Applying Technology to VET.
- Development of Multimedia Toolboxes for Training Packages.
- Hosting Conferences on flexible delivery in TVET.
- Providing professional development for flexible delivery.
- Communicating and marketing flexible delivery initiatives.
- Conducting research on online network in VET.
- Conducting research designed to provide practical guidelines to practitioners.

EdNA VET Advisory Group (2001). Australian Flexible Learning Framework for the National Vocational Education and Training System 2000–20045. Australian National Training Authority, Brisbane.

Australia has developed a strategic plan for achieving its flexible learning vision in VET. This plan is outlined in the Australian Flexible Learning Framework for the National Vocational Education and Training System 2000-2005. This plan addresses five areas of strategic importance:

1. Creative, capable people: To build a critical mass of VET staff that can apply flexible learning.
2. Supportive technological infrastructure: To ensure the availability of ICTs and necessary connectivity to achieve a national VET, which is accessible to all.
3. World-class online content development, application, and services: To assist the Australian VET system to maintain and expand its share of the training market within Australia and internationally.
4. Enabling policies: To ensure that policies and protocols facilitate uptake and usage of flexible learning in VET.
5. Problem-solving regulations: To advocate for a regulatory framework to protect learners, remove legal and regulatory barriers, and foster the export of Australian VET products and services (EdNA VET Advisory Group, 2001, p. 14).

Under the leadership of the ANTA, many training packages with strong emphasis on ICT-mediated (computer-based training, online learning, videoconferencing) learning have been developed for the TVET sector. The college network in Adelaide makes extensive use of videoconferencing to eliminate unnecessary travel across campuses. Videoconferencing is also used in Queensland to train personnel for the hospitality industry. Australia is experimenting with the use of AsiaSpace, a point-to-point satellite service for online learning. This system has the capacity to deliver data to fixed and mobile locations without phone (Tapsall and Ryan, 1999). The State of Victoria is planning to launch TAFE Online, which will be a web-based campus representing 30 TAFE colleges. All states are implementing coordinated and centralized networked online system for information and student administration. Several states have also implemented learning centres to encourage the use of multimedia and video-conferencing. The types of formal delivery include:

- a mixture of online and face-to-face;
- a mixture of online and print-based distance education materials; and
- total online delivery (Brennan, McFadden and Law, Ibid).

The Onkaparinga Institute of TAFE (Technical and Further Education) in South Australia uses CD-ROMs in many of their courses, in fields ranging from community services and health, to horticulture and agriculture, to transport engineering. One of their transport engineering courses offers training in Heavy Vehicle Mechanics. In 1997, the institute began to use interactive CD-ROMs as a learning tool for their students in this course. Both the practical and theoretical components of the course material were provided on the CD-ROMs. The materials are presented using text, audio, graphics, and video and are geared to students who prefer less text, and more user-friendly and interactive presentations including diagrams, photographs, and video. Some of the modules developed on the CD-ROMs are being used in the actual workplace where the computers are located at the end of the workbench and provide step-by-step instruction for specific tasks.

Australia has also some exemplary online training initiatives in the private sector. For example, Quantas College Online was established to service 30,000 employees who are unable to attend face-to-face training because of their shift work and travel. The rapid growth of ICT-mediated learning in Australia has been fuelled by the reluctance of employers to release trainees during working hours.

A recent study conducted by Misko (2000) showed that: “online delivery of instruction is still in its formative stages in Australia TAFE colleges” (p. 12). Another research conducted by Mckavanagh et al. (1999a, 1999b) cited by Brennan, McFadden and Law (Ibid) found that:

- A lot of the delivery was not yet online, although there were a lot of plans.
- Most online module had a nominal duration of 40 hours.
- The number of enrolments reported for the 73 valid cases from 12 different providers varied from six to 144, with a median value of 31, again indicating the small present scale implementation of online learning in VET.

Lewis (2001) indicated that Australia is also working on the next generation of online learning based on the concept of toolboxes.

5.2.6 Bangladesh

Investment must allow TVET to acquire machines and equipment that are used in the workplace. Compulsory computer literacy must be implemented in TVET (NIER, 2002).

5.2.7 Cambodia

Cambodia has been focusing on the development and improvement of TVET for more than a decade. Problem faced by TVET in this country include: obsolete training equipment, inadequate training materials, TVET programme are non-responsive to labour market needs, and TVET programmes are inflexible and inaccessible to many people (NIER, 2002).

5.2.8 Canada

Canada has four national programmes that affect virtual education and training. First is the Office of Learning Technologies (http://olt-bta.hrdc-drhc.gc.ca/indexx.html), which works with governments, institutions, and private sector organizations to promote research, assessment, and use of technologies in education; raise awareness of the opportunities, challenges and benefits of technology-based learning; and act as a catalyst for innovation in the area of technology-enabled learning and skills development. The second is School/Net, an initiative of governments, the business sector, and the educational community. It provides a wealth of information and promotes the use of the Internet in the school systems. Third is the Telelearning Network of Centres of Excellence, located at Simon Fraser University, which researches, develops, and demonstrates effective tele-learning pedagogies to support the development of knowledge economy. Finally, the Canadian Association for Distance Education promotes research and organizes conferences and workshops for professionals working in distance education. Several examples of virtual education can be found in the school system, from kindergarten to university level. Exemplary programmes implementing ICTs in TVET are: Mount Royal College in Calgary, which offers a programme in critical care nursing for Web delivery; and George Brown College in Ontario, which has developed a complete Electrician Technician Certificate for delivery via CD-ROM (Farrell, 1999).

5.2.9 Chile

Chile's Instituto Nacional de Capacitacion Profesional (INACAP) provides technical and vocational education through its distance education branch, Sistema Nacional de Capacitacion a Distancia (SINCAD). Twenty-five offices throughout the country offer three types of vocational courses: basic occupational training; technological training programmes; and specific training courses. Following an introductory session, students learn independently using self-study materials, audio and video cassettes, slides, or meetings with the teacher. A certificate is awarded to the candidate following the successful completion of the final exam. Some of the courses offered are: introduction to electronics, material technology, basics of electricity, health and safety at work, reading technical drawings (Stevens, 2001, p. 51).

5.2.10 China

Government policy in China aims to train 22 million secondary vocational graduates and 8 million higher vocational education graduates within five years. There is also a need to train 50 million city workers annually. Additionally, 2 million displaced workers need to be retrained and 150 million rural people need to be trained prior to transfer for city work. Given this magnitude of the country's training needs, the government is taking major initiatives for promoting the use of ICT-mediated learning. The ChinaOnline (2001) (cited by ANTA, 2001a) reports that "the Ministry of Education (MOE) hopes that by 2010, distance-learning networks will be available for everything from basic to graduate education, vocational programmes, teachers' training and specialized instruction for rural and rural labourers". MOE has established the China Education and Research Computer Network (Cernet) to link all potential online service providers. An enormous rate of growth in Internet users is expected in China over the next few years.

5.2.11 Europe

The Lisbon European Council (2000) (cited by ANTA, 2001a) stated that although Europe has one of the world's highest level of education and the necessary investment capacity, it still lags far behind in the use of ICT technologies (p. 36). The European e-learning Action Plan was adopted in March 2001. The objective is to "make lifelong learning the driving force behind a cohesive and inclusive society within a competitive economy" (p. 40).

Massy and Ward (2002) conducted a survey through The European Training Village to determine the extent of use of new technology in training and learning in Europe within organizations using e-learning in TVET. Although this is not a robust study using random sampling, it does help to fill an information gap. Results showed that about a quarter of respondents' training time in Europe was spent either in e-learning (11.6%) or (15.4%) in blended learning (Table 10).

Another survey conducted by the European Training Village (2002) indicated that 61% of all respondents rated the overall quality of e-learning negatively – as "fair" or "poor". It is noteworthy that 82% of the 433 respondents were from EU countries.

Table 10: User of Training by time spent on e-learning, blended learning and classroom tuition in selected EU Member States.

	Classroom Instruction	E-Learning	Blended Instruction
Finland	67.4	8.5	21.4
France	41.7	8.8	13.9
Germany	36.3	13.2	16.9
Greece	62.5	3.3	8.8
Ireland	23.9	7.8	17.4
Italy	50.4	14	11
Netherlands	42.6	15.9	24.4
Spain	32.3	13.7	20.3

Sweden	76.8	4.1	8.7
United Kingdom	43.5	12	10.9
European Union	43.4	11.6	15.4

Massy, J.H. and Ward, T. The European e-learning Market 2002. Published by Bizmedia Ltd 2002. www.elearningage.co.uk

The European Centre for the Development of Vocational Training (CEDEFOP) is an initiative of the European Community. The Centre keeps vocational education and training stakeholders in Europe informed of the present and future trends in VET using an interactive web site, newsletter, journal, seminars and workshops. CEDEFOP sustains links between policy makers, organizations, and practitioners across Europe and provides information and advice to help them make informed choices about vocational training policy (ANTA, 2001a).

The European Training Village (ETV), a project of the European Union, is part of the CEDEFOP. The objective is to provide state-of-the-art information about innovative training methods to key stakeholders.

In 1995, European Union established a task force to allow the six European programmes (Socrates, Leonardo da Vinci, TSER, Esprit, Telematics Applications and TEN-Telecom) to collaborate for boosting the development and implementation of ICTs in education.

5.2.12 Iraq

UNESCO (2003b) has established a special link dealing with the war in Iraq on it Internet portal. This link provides the country's report for the EFA – 2000 Assessment. Following is a report of the status of educational recourses in Iraq following the 1991 Gulf war:

1. The number of the damaged school buildings in the countries provinces, aside of the self-governing area, was (4,157).
2. The number of impaired school trips: (323,850).
3. The number of spoiled books in school libraries: (1,343,438).
4. The number of computers and its operating apparatus damaged: (488) sets.
5. Damaged equipments of (107) vocational training centre.
6. The number of damaged educational media devices (898,181).

Source: THE REPUBLIC OF IRAQ MINISTER OF EDUCATION. EDUCATION FOR ALL ASSESSEMENT FOR YEAR 2000
http://www2.unesco.org/wef/countryreports/iraq/contents.html

5.2.13 Korea

Founded in 1997, Korea Polytechnic University's mission is to provide continuing education to technicians. The Polytechnic must also train technologists through distance education and provide tradespersons with field experience as well as face-to-face education. The university has established the Centre for Distance Technology Education and Training to develop virtual

courses and to design different models of ICT programme delivery (Robertshaw, 1999). The Human Resources Development Centre (HRDC) in Samsung Group has established a Web server and developed virtual courses and Web video lectures for their members. Samsung Cyber Campus (http://cyber.samsung.net) now offers a more integrated form of virtual training.

South Korea hosts a UNESCO Centre of Excellence in TVET. Although the country has successfully reengineered its TVET system to meet changing industrial demand and to sustain the competitiveness of the nation. Lee (2001) (cited by ANTA, 2001a) states that TVET programmes in South Korea must enhance that country's competitive power in the area of technology. He also advocated the use of ICTs in TVET. Porter, Doszpot and Maxwell (2001) also suggested that putting appropriate TVET course online should be a priority for South Korea.

5.2.14 Lao P.D.R.

The Lao P.D.R. (Laos) implemented a new policy in 1997 to improve the quality, relevance, and management of its Technical and Vocational Education system. To make TVE more responsive to emerging needs, several strategies were set up, such as: introducing a broader range of programmes sanctioned with diplomas or certificates, creating skill training courses of varying duration and apprenticeship training, developing new curricula and teacher training, and using computers more for teaching and non-teaching purposes such as secretarial and administrative tasks (Asia and Pacific Regional Bureau for Education, no date).

This country is experiencing difficulties in implementing TVET programmes due to lack of equipment, training materials, and vocational teachers. Through bilateral agreements and donations many TVET institutions have been equipped with computers. Some institutions have also access to Internet and e-mail. Computers are used for both teaching and administrative purposes. Approximately 50% of the TVET teachers are computer literate. It is noteworthy that institutions located in the urban area have better access to ICTs than those in rural areas (NIER, 2002).

5.2.15 Malaysia

The TVET sector in Malaysia is wrestling with the challenges of applying new technologies in TVET, to combat the digital divide and to integrate flexible learning systems in TVET (bin Sipon, 2001). Malaysia is planning to implement an ambitious e-learning programme in its TVET systems. The plan calls for the online delivery of polytechnic programmes via distance. Special provisions will be made for the delivery of special education courses at the polytechnics in line with the principles of access and equity (ANTA, 2001a).

5.2.16 Mongolia

Problems faced by TVET in Mongolia include: outdated facilities, lack of textbooks and teaching staff. The average age of training equipment in TVET institutions is 17 years and professional literature in the libraries has not been renewed for the past 12 years. There is an

average of two computers per public school in Mongolia. The country's thirty-five TVET schools are not fully computerized.

The government is committed to provide free access to the Internet to all Mongolians and to create the necessary environment for the development of ICT knowledge and skills. The Ministry of Education has adopted a facilitating order for the integration of ICTs in Education by year 2010. The following enabling initiatives have already been implemented:

- The National Park was established in 2002, to provide ICT skill development for young people.
- The establishment of a computer Network connecting all TVET schools.
- ICT training for teachers and trainers.
- Investment in the ICTs in education.

Mongolia has acquired the technology and the expertise for implementing distance education. In 1994, UNESCO implemented a distance education programme in Gobi to assist women to prepare dairy products and run small business. A Non-Formal Education Centre has been established with the assistance of the Korean Government (NIER, 2002). The increased investment in ICTs is strengthening Mongolia's capability for open and distance education and training.

5.2.17 Myanmar

Problem faced by secondary school TVET in Myanmar include: lack of facilities, lack of textbooks and teaching staff. Internet is not widely used in this country and there are no open and distance learning programmes being offered in TVET (NIER, 2002).

5.2.18 Namibia

Vocational education and training in Namibia is provided by seven government and government supported centres and seven community skills development centres. Open and Distance Learning (ODL) account for 52% of all tertiary enrolments and is offered through learning centres located in all regions of the country. ODL programmes extend face-to-face offerings and are mainly focused on easily accessible target groups. Course delivery is done using mainly printed material supported by inconsistent tutorial guidance. Only one centre has so far introduced videoconferencing and online delivery. The drop out rate among OLD students is extremely high (46.8%).

Support form the European Union has enabled the country to establish the Namibia Open Learning Network (NOLNET). This network will provide the learning centres with better learning resources.

The Presidential Commission on Education, Training and Culture has recently made a series of recommendations to address issues of access, relevance, efficiency, equity, quality, integration and flexibility of programmes and programme delivery (Polytechnic Task Force v2030, 2003).

5.2.19 Nepal

The integration of ICT-mediated learning in TVET is relatively new in Nepal. The equipment is underutilized for two main reasons: (1) inadequate teacher preparation; and (2) unreliability of equipment due to lack of maintenance staff. ICTs are used more for administrative purposes than for teaching (NIER, 2002).

5.2.20 New Zealand and the Pacific Islands

New Zealand has no coherent policy for the integration of ICTs in education. While the country has one of the highest per capita telecommunications access among developed countries as well as the highest rate of penetration of the Internet, educational institutions are not being adequately funded to purchase ICTs. Additionally, they lack a coherent vision and champion for courses as well as trained staff and support systems (Rajasingham, 1999).

The Open Polytechnic is New Zealand's leading provider of open and distance learning and the largest tertiary-level institution with an enrolment of over 30,000 students annually. It uses mostly print-based learning material supplemented with audio and/or videotapes, audio graphics and teleconferencing. The Polytechnic operates from a central base in Waiwhetu in Lower Hutt, with business centres in Wellington, Auckland, and Christchurch. Over three-quarters of current students are studying part-time to enhance their career opportunities. Seventy-three per cent are over the age of 25. The institution offers over 130 programmes and 1300 courses and grants formal qualifications at the certificate, diploma, and degree levels. Most courses are approved by the New Zealand Qualifications Authority and registered on the National Qualifications Framework. Major programmes offered are: business and management, computing, information systems and technology, engineering and technology, financial services and planning and construction. The Open Polytechnic has recently established the Open Mind Online, and is now offering business programmes and qualifications through this medium (Stevens, 2001, p. 17).

The research showed that the University of South Pacific was using a satellite network that links five centres, namely: Lautoka, Fiji, Cook Island, Tonga, Vanuatu and Samoa to provide distance education. ICTs were also being used in these centres for career counselling (Rajasingham, 1999).

5.2.21 Pakistan

Problem faced by TVET in Pakistan include: lack of facilities, poorly equipped and maintained workshops, lack of textbooks and teaching staff, irrelevant curriculum to labour market requirements. There is an interest for implementing distance education to increase access to TVET (NIER, 2002).

5.2.22 Singapore

Singapore Polytechnic has spearheaded several development projects such as the CD-ROM-based Electronic Lab Book (ELB), Virtual Lab (Vlab), Electronic Performance Support Systems (EPSS) for the marine industry and Web-based EPSS. Current EPSS projects include

EPSS for marine operations and EPSS for marine regulations. (Banerji, 1997 as cited in Banerji, 2000). The web-based EPSS initiative has led to the development of the Virtual College, which operates and administers a large collection of interactive, online learning modules: Diploma in Accountancy, Diploma in Media and Communication, Diploma in Chemical Process Technology, Diploma in Plastics Technology, and Diploma in Architectural Technology, to name only a few. The two major goals of this college are "to provide continuing education and lifelong learning for graduates and professionals in industry" and "to supplement conventional lectures and improve teaching and learning through Information Technology for full-time students" (Cheong et al., 2000, para. 4).

5.2.23 Sri Lanka

Little is being done to integrate ICT-mediated learning in TVET in Sri Lanka. This lack of penetration of ICTs in TVET is due to the inadequate preparation of teachers, and limited access to Internet and ICT-based materials. ICTs are however taught as discrete component by specialized teachers (NIER, 2002).

5.2.24 Thailand

High costs of investment make it difficult for TVET to keep abreast of technological change. Ongoing efforts to improve TVET include: (1) the replacement of outdated machinery and equipment with those using new technologies; (2) the training of teachers to integrate ICTs in TVET. ICTs have become part of the teaching and learning process in TVET. Consequently, national policies call for the expansion of existing infrastructure and for staff development. Approximately 413 TVET colleges have access to the Internet (NIER, 2002).

5.2.25 United Kingdom

The British Educational Communication and Technology Agency (BECTA) was established by the United Kingdom government in 1998. The role of BECTA to promote the use of ICTs to improve and transform learning, teaching, and leadership in schools, colleges and Lifelong Learning. BECTA provides advice and support educational users in the effective integration of ICTs into their work.

The UK has set up the University for Industry (UfI) to provide workers from small- and medium-size enterprises with job-related education and training. The UfI will be instrumental in developing a national network of learning centres. It will take a leadership role in drawing all stakeholders together, provide guidance so that workers can achieve their potential, promote lifelong learning; and co-ordinate the infrastructure of information (Mason, 1999).

5.2.26 United States

Dirr (1999) observed that "there has been an explosion of interest in distance and virtual education in recent years in the US. He noted that out of the 3,000 colleges and universities 1,400 were offering distance education courses and programmes and that 79% of all the institutions were offering one or more distance education courses. In the US, the community

colleges are the largest providers of TVET. Because of their open-door mission and tradition to community service, the community colleges have been quick to embrace ICT-mediated learning. Recent statistics indicated that 87% of the colleges have the necessary infrastructure for satellite videoconferencing, 60% were equipped for two-way video conferencing, and one-third were using T1 lines. Fifty per cent of the colleges were actually using two-way video conferencing for teaching and another 4% expressed an interest in adopting distance education. In 1997, 80% of the public two-year colleges offered distance education courses and 62% of their students were enrolled in these courses in 1997–98. Distance education is reducing the degree completion time for college learners (Olson, Coyner and McCann, 2000).

5.2.27 Venezuela

Venezuela offers a programme that trains teachers to become multiplying or innovative agents in distance education. This programme is offered by the Universidad Nacional Abierta and includes courses in basic principles of distance education, new technologies for distance education, and design of curriculum for distance education (Ortiz, 1999).

5.2.28 Viet Nam

Approximately 1,000,000 young people graduate from high school every year. Only 15–20% of these high school graduates will continue their education. Thai Thanh Tung (2002) argued that ICTs could assist Viet Nam to meet the vocational education and training need of its people. He further argued that ICTs "may provide opportunity for people in the whole country regardless of their geographical location, their financial situation and their social position (NIER, 2002).

SECTION 6 ISSUES REGARDING THE USE OF ICTs IN TVET

This section deals with various issues and concerns to consider when integrating ICTs in TVET. More specifically, the discussion focuses on the digital divide, the cognitive divide, institutional barriers, teacher barriers, and student barriers. Finally the copyright issues and the resistance and tension surrounding the use of ICTs in education and training are briefly reviewed. Whenever appropriate, a case study is provided to support the discussion.

This section will focus on some key issues that need to be carefully considered in deciding whether or not to implement e-learning in TVET. These issues are: barriers to the integration of ICTs in TVET, the digital divide, the cognitive divide, difficulties in developing psychomotor and affective skills by distance, and the effectiveness of ICTs for teaching and learning.

Haughey (2002) identified the following five policy issues and concerns that need careful consideration in deciding weather or not to implement e-learning in TVET

1. Infrastructure: Appropriate infrastructure must be available to ensure equity of access and proper delivery of content.

2. Administration: The system must provide adequate resources and support for technology integration.
3. Learning: ICTs must be used to enhance teaching and learning.
4. Teaching: Teachers need to be adequately prepared for using ICTs to teach and facilitate student's learning.
5. Content Development: Content development can be costly and time consuming, and the content itself can have a short shelf life. Developing and keeping high quality instructional products up-to-date is a major challenge for TVET.

6.1 Barriers to the Integration of ICTs in TVET

While technology-enhanced education holds great promise, its widespread implementation also poses some immediate challenges with respect to: capital outlays in hardware and software, equal access to eliminate technological "haves and "have-nots", appropriate strategies for integrating technology across curricula, copyright issues, and availability of pedagogically sound materials. Teacher development is a major challenge for the implementation of technology-enhanced learning since for most teachers information technologies are both exhilarating in their possibilities and daunting in the uncertainty created by the speed of change (Council of Ministers of Education, 1997).

The Conference Board of Canada (2000) has identified nine of the most common challenges faced by employers who have attempted to use ICTs for workplace learning. These are: lack of time, money and support; technological and systemic limitations; difficulty of using ICTs; no evaluation of outcomes; resistance to change; lack of planning; lack of communication; lack of leadership; and learner resistance. The discussion that follows will focus on two critical barriers: the digital divide and the cognitive divide.

Stevens (2001) also identified five barriers related to the implementation of ICT-mediated learning in TVET, namely: content and curriculum, appropriateness and efficacy of technologies, quality and branding of programmes, stakeholders' resistance to innovations, and the digital divide. Details follow below.

6.1.1 Content and Curriculum

While much attention is being given to the development technologies that drive ICT-mediated learning, one of the most critical issues remains the curriculum content. As Stevens noted, "A current impediment to the further growth and diffusion of more advanced systems in all parts of the world is the unavailability of relevant, well-designed instructional content. This is particularly true in the technical/vocational training area" (2001, p. 52). Considerable up-front investment must be made in developing programme materials for electronic delivery. This is especially problematic in TVET because recovering investment costs could be difficult or even impossible to due to the relatively small markets, particularly in developing countries.

6.1.2 Appropriateness and Efficacy

There is a perception that distance education is not an appropriate method for delivering

vocational and technical skills. However, "… for many occupations within the emerging 'knowledge economies' the cognitive and affective learning domains are becoming more substantial relative to psychomotor skills" (Stevens, p. 52). Providing distance education in these two domains is much less challenging than teaching manual skills at a distance.

The efficacy for distance learning in vocational education will keep improving with the upgrading and improvement of: learning technology, instructional design, adaptive learning models, simulation of workplace environment, learners support systems, access to e-learning, and the development of intelligent tutoring. Greater emphasis on a self-directed style of learning and an increase in computer literacy among stakeholders will further enhanced the efficacy of distance learning in TVET (Stevens, p. 52).

6.1.3 Quality and Branding of Distance and E-learning

The proliferation of e-learning courses in North America raises suspicion among learners as to the quality of course content and the credibility of the institution. These courses must be accredited by educational authorities in order for e-learning to become a legitimate method of course delivery and to gain learners' confidence (Stevens, p. 54).

6.1.4 Stakeholder Resistance

The shift to technology-based learning may represent a threat to job lost for some stakeholders, thus resulting in resistance to embrace the innovation. Adopting ICTs for teaching and learning will not result in job lost, however there will be a change in the instructor's role, moving from teaching to facilitating and guiding the learning experience (Stevens, p. 54). Brennan, McFadden and Law (2001, p. 7) noted that "there is a potential lost of work if the scenario of teacherless classrooms comes anywhere near reality. Secondly, technology by its very existence and its degree of present and predicted permeation of education and training, throws all existing methods up to scrutiny. Practitioners are forced to examine and justify their existences". The case studies of online learning conducted by Curtin (2002) also confirmed this problem: "where the institutional constraints are not addressed, the case studies suggest that online delivery is likely to remain an island of innovation in a sea of resistance" (p. 7).

6.1.5 Institutional Barriers

Institutional barriers associated with ICT-mediated learning have been well documented in the literature. Following are some of the barriers:

- Lack of equipment and support
- Difficulties in scheduling
- Lack of adequate resources
- High cost of programme development
- Instructional difficulties
- Difficulties in recruiting qualified instructors
- Difficulties in maintaining reliable technical assistance and support (Zircle, 2001).

6.1.6 Student Barriers

There are many barriers experienced by distance education learners. These include:

- Cost of equipment and access to technology
- Motivation
- Lack of immediate feedback form instructors
- Lack of adequate support and services
- Alienation and isolation
- Lack of ICT literacy skills
- Lack of skills in managing data and time (Zircle, 2002).

The students also seemed to be uncomfortable with ICT-mediated learning. A recent survey conducted by the European Training Village (2002) indicated that 61% of all respondents rated the overall quality of e-learning negatively – as 'fair' or 'poor'. It is noteworthy that 82% of the 433 respondents were from EU countries. Research conducted in Europe also suggest that more mature and motivated learners are more likely to benefit for ICT-mediated learning than those involved in initial TVET programmes.

6.1.7 Lack of Appropriate of Software

The development of ICT-mediated learning materials for TVET has been slow as compared to rate for the general education sector. This trend can be explained by: (1) comparatively low enrolment in TVET; and (2) the need for a wide variety of occupational specific software in TVET. "Specifically, technology applications used in various occupational fields are not available to educators" (Allen, Walker, & Morehead 1999, p. 6).

Vocational educational does benefit from manufacturers developed software and hardware dealing with specific products or services. On the other hand, many of the products are not comprehensive enough to cover all aspects of a programme's curriculum. Herschbach (1984) notes:

> The market for vocational education is relatively small, compared to the potential market for general education subjects in the elementary and secondary levels. On the other hand, vocational education benefits from products of all kind developed for business and industrial applications in general, although there are few instructional areas where comprehensive coverage may be expected (p. 8).

6.1.8 The Digital Divide: Implications for TVET

ICTs can be seen as driving the new network economy. Access to ICTs is essential to innovation, economic growth, and social development. Research attributed GDP growth, economic activity, productivity growth, research and innovation, and higher paying jobs to the use of ICTs. Therefore, differences in access to ICTs create a "digital divide" between those who can benefit from the opportunities offered by ICTs and those who cannot (Montagnier,

Muller and Vickery, 2002). This digital divide is widening inequalities between the haves and the have-nots not only between countries but also within them. Speaking on this issue at the Plenary Session of the Millennium Summit of the United Nations, the Right Honourable Jean Chrétien, Prime Minister of Canada noted: "Alleviating world poverty is our common cause. We must share the benefits of globalization. We must give it a human purpose and a human face… And we must bridge the digital divide. We must ensure that the benefits of the information revolution are shared by all" (Prime Minister Jean Chrétien, Plenary Session of the Millennium Summit of the United Nations, New York, September 7, 2000).

The ILO identified three ways in which ICTs contribute to the widening of this digital gap. Firstly, higher-level skilled workers are moving freely in the global economy. Therefore, we are witnessing a global division of labour. Knowledge workers will cross borders freely, facilitating the circulation of technology, including the growth of technology-intense industries, and helping to create a truly global marketplace for skills (ILO, 2001). Secondly, although more than 200 countries are currently using the Internet, only 5% of the world's population are actually Internet users and 88% of those users are from industrialized countries. Furthermore, within each country, access to the Internet usually depends on income, education, age, racial or cultural background, urban or rural location, gender, geography, and firm size. Montagnier, Muller and Vickery (2002) noted that language is another dividing factor since the majority of web sites are still in English. Finally, speed separates companies and countries to the benefit of those in better position to adapt and change rapidly. ILO (2001) indicates that "A distinct minority of the world – the wealthiest, the best educated – is best placed to gain greatest advantage from these technologies" (p. 2). The digital divide has accentuated the existing social and economic inequalities among nations. The world today is not only divided by ideology, but also by technology.

To illustrate the magnitude of the divide, the ILO reports that the number of phone lines per capita in developed countries is approximately one line for every two citizens as compared to 1.4 phones per 100 people in low-income countries. This gap is further evidenced by the fact that of all the individuals in the world using the Internet today, only 1% live in Africa (Kadius, 2002). Africa is responsible for only 0.4% of Internet content. It is therefore not surprising that most of the world's technology innovations originate from only 15%of the earth's population, while a third of the world's population is technologically disconnected (ILO, 2001).

The ILO (2001) reported that: "The poorer developing countries face the formidable task of overcoming the handicaps that have so far prevented them from seizing the new opportunities. The first priority is to raise the basic education and skills levels of their populations, e.g. by establishing policies and systems for lifelong learning" (ILO, 2002). The involvement and active participation of developed countries is crucial to bridging the ever-widening ICT gap between developed and underdeveloped countries.

Farrell (1999) cautions: "even within developed economies, the disparity of access (to ICTs) is so great that many policy makers fear that adopting these technologies will result in widening the gap between the "haves" and "have nots" (p. 6). In commenting on this issue ANTA (2001a) noted: "Lack of access to learning can be experienced in technologically-advanced countries to as great an extent as in developing countries" (p. 42). Canada and Australia are

cited as countries with lack of access for groups of their citizens. The following case study illustrates an initiative to bridge the digital divide in Nigeria.

In a democratic society, addressing the current digital divide between developed and developing countries and within developed countries should be our top priority if we are to fulfil our commitment to education and training for all (Stevens, p. 54).

CASE STUDY 26: Bridging the Digital Divide: Owerri Digital Village

The Owerri Digital Village in Nigeria offers four main programmes: TechKids, TechTeens, TechEnhancement, and TechCommunities. TechKids caters to children between the ages of 8 and 12 whereas TechTeens focuses on students between 13 and 18. TechEnhancement is geared toward civil servants who want to acquire skills that will help them in their daily activities (Ugwuegbu & Gipe, 2002, para. 12). TechCommunities trains poor, rural, semi-literate women to gain critical skills that will help improve their small businesses and communities. The Owerri Digital Village offers academic learning and vocational and technology training, and provides adult education in business management skills. It exposes women to the new ICTs and how these can benefit them in their everyday life. For example, "trader women will use the e-post facilities at the digital village to deliver messages to their customers in the villages when a new shipment or stock has been received" (Ugwuegbu & Gipe, 2002, para. 18).

CASE STUDY 27: Using Telecentres to Bridge the Digital Divide

In an effort to close the digital divide that hampers ICT-mediated learning, service providers have developed and implemented the concept of telecentres. The telecentre concept was first developed in Scandinavia in the mid-1980s. It has now spread to Western Europe, Australia, North America, Africa, Asia, Latin America, and the former Eastern Bloc countries. ANTA (2001a) describes telecentres as kiosks that can provide access to telephone and fax services, as well as more sophisticated services such as tele-education, teletraining, telemedicine, teletrading and telecommerce. The use of telecentres in TVET could be a very successful approach for including the excluded and reaching the unreached.

6.1.9 Cognitive Divide: Implications for TVET

Technology is said to be driving this new economy and human capital is its fuel (Moe and Boldget, 2000). Increasingly, human capital investment is seen as an essential ingredient in the growth recipe of advanced economies (Baran, Bérubé, Roy and Salmon, 2000). In the new economy, human capital is defined as workers' knowledge that results in effective and efficient performance. Knowledge is not only beneficial to the well-being of the worker, but also

viewed as a major competitive advantage for the company and a key element to the country's national prosperity and social development.

In a recent report on human resources development the ILO noted: "People with low skill levels, outdated skills or no employable skills are more likely to be excluded from the labour market. Disadvantaged groups are also excluded from opportunities that are central to participation in the social, political, and cultural life of society, as a result of their limited access to education, skills training, health care and employment. Their exclusion incurs high costs on social security systems and society in general. Also, the opportunity cost to national economies of having so many inactive people is substantial" (ILO, 2002).

Access and equity in adult education and training is seen as an essential policy for combating exclusion and promoting inclusion, especially among disadvantaged groups. Considerable efforts and resources are being devoted to providing equal education and training opportunities to all. However, having equal educational opportunities now means more than having access to education and training. It also means that a person has the repertoire of cognitive skills needed to learn and succeed in the learning environment. Many adults lack the essential cognitive literacy skills to succeed even if they were given access to education.

Following is a framework for designing and developing learning how-to-learn training interventions for adult learners. This framework was derived from research on the human information processing system and individual differences among learners arising from their habitual mode of acquiring, processing, storing, retrieving, and using information.

When information is presented to an individual, it is received through the perceptual modalities. It is then held for a very brief time in the perceptual memory bank after which the information moves to a filtering system where a basic decision is made for memorizing, transforming, learning, or rejecting the information. If the information is to be memorized, transformed, or learned, it is immediately transferred to the short-term memory, which has a very short capacity and duration. The incoming information is then held in the working memory for comparison and analysis with previously stored information before being moved to long-term memory. That information then becomes part of the person's cognitive structure. Because of the rapidity with which information is processed and because of the limiting capacity of various parts of the information system, control must be exercised over the system or the information could be rejected, lost, or incorrectly transferred or stored.

In order to identify the appropriate controls to facilitate efficient and effective information processing, we examined individual differences among learners regarding their preference for various modes of gaining, storing, processing, and using information (Witkin, Moore, Goodenough, and Cox, 1977). Some students are unable to accomplish a cognitive task simply because they lack the necessary information processing skills (Regan et al., 1979).

Cognitive-based research over the past 15 years has demonstrated that one of the most important factors contributing to achievement differences is the cognitive skills that a student brings to academic tasks. In order to succeed a student, must possess a repertoire of thinking skills that meet the cognitive demands of learning and performance tasks (Letteri, 1985).

Several cognitive skill dimensions have been identified. Seven of these cognitive skills appear to contribute more significantly to effective learning (Chinien, Boutin, and Letteri, 1997). These skills are: analytical, focus, reflective, narrow, complex, sharpener, and tolerant. The following case study illustrates how these were used in the development of CD-ROMs designed to enhance the cognitive skill of adult learners.

6.1.10 Copyright ICT-mediated Learning Materials

The Australian National Training Authority (ANTA, 2002c) defines copyright as "a form of intellectual property that protects literary, dramatic, artistic and musical works, films, broadcasts, sounds recordings and published editions. Protection is also given to computer software" (p. 3).

The main goals of copyright systems are to ensure that the creators of a work are credited and compensated for their effort and to encourage creation and innovation (Dusollier et al., 2000). Copyright covers the expression of an idea, not the idea itself, which is public domain (Australian Copyright Council, 2002). Copyright protection comes into effect as soon as the creator's work is in a reproducible form. The creator should place a copyright notice and symbol on the work.

CASE STUDY 28: **LEARN – Learning Enhancement for Adult Retraining Needs**

A Project of the National Centre for Workforce Development Canada – UNEVOC Centre)

The Aptitude by Treatment Interaction (ATI) research indicates that instructional treatments place different information processing demands on learners. A learner may fail to master an instructional task simply because she/he lacks the necessary information processing demands imposed by that particular task. There are two fundamental ways to address this need. The first is to apply the deficit model, where the environment is adapted to meet the learners' needs. The ethics of using this approach to meet short-term objectives has been of concern. A more appropriate approach is to alter the cognitive style of the learners so that they can become more adaptable to the needs of the learning environment (Ausburn and Ausburn, 1978).

Seven cognitive skill dimensions have been found to determine and predict with high accuracy ($p < .05$ or better) young learners' level of success in academic learning. (Letteri, 1985; Chinien and Boutin, 2002). These cognitive styles are:

Analytical: Recognizing the various component parts of a given problem as distinct and unique pieces of the whole.

Focus: Maintaining attention to the specific and important part in the problem and disregarding all irrelevant data.

Reflective: Taking sufficient amount of time to make a complete and accurate comparison between the given problem and prior problems for correct identification.

Narrow: Selecting from alternative solution strategies the one which most accurately

satisfies the problem task as presented.

Complex: Defining the problem accurately by specific category for the purpose of selecting appropriate solutions.

Sharpener: Comparing a problem with all other problems in a similar category and applying solution procedures that have succeeded in the past.

Tolerant: Having the ability and willingness to (a) deal with information that may not be consistent with what they know; and (b) explore novel areas of learning.

Using these seven cognitive styles, Chinien, Paul and Bannatyne (2001) developed ICT self-directed instructional material (LEARN – Learning Enhancement for Adult Retraining Needs) for enhancing the learning skills of adult learners. The material is available on CD-ROM and an electronic version is also available for download at the following URL: http://www.umanitoba.ca/unevoc/conference/main.html

ICTs are fast becoming an essential tool in education. Consequently, educators have a growing interest in copyright issues. Many believe that copyright laws are too restrictive to allow students to benefit fully from ICTs, and from the Internet especially. Participants in the Virtual Conference organized by the Commonwealth of Learning (2003) made the following additional conclusions with regards to copyright laws:

- If the industrial world is serious in its support of developing nations, then it must consider how its copyright laws affect those nations.
- Educators should consider using open source software and materials.
- Amending copyright laws to let students and teachers use freely available materials on the Internet is a position that can coexist alongside strong protection of creators' works.

At the conclusion of the UNESCO-organized Forum on the Impact of Open Courseware for Higher Education in Developing Countries, the participants recommended developing Open Educational Resources that will be available to all (UNESCO, 2002d). In Canada, the education community is urging the federal government to amend the *Copyright Act* to allow students and educators to make more effective and legal use of publicly available Internet materials. The debate rages as to what constitutes acceptable use of information and just how far copyright law should extend. The case study that follows highlights an initiative of the IITE (2002c) regarding the ethical, psychological, societal, and legal problems of application of information and communication technologies in education.

CASE STUDY 29: ICTs in Education: Ethical, Psychological, Societal & Legal Problems

In July 2001, IITE conducted a research seminar dealing with ethical, psychological, societal, and legal problems of application of information and communication technologies in education. Twenty-three international experts participated in this research seminar.

The aims of this research seminar were:

- To analyse state-of-the-art and evolution of ethical, psychological, societal and legal problems of application of ICTs in education;
- To state ethical, psychological, societal and legal issues of ICT usage for various groups of students and educators;
- To develop framework of ICT application in education reflecting ethical, psychological, societal, pedagogical and legal aspects.

The final materials of this seminar is available from the IITE web site: www.iite-unesco.org

SECTION 7 EFFECTIVENESS OF ICT-MEDIATED LEARNING

The integration of ICTs in TVET requires considerable investment in time and resources. When planning to implement ICT-mediated learning, it is critical to consider the instructional and cost-effectiveness of the technologies. The discussion that follows will focus on specific indicators of instructional and cost-effectiveness of ICT-mediated learning. Whenever appropriate, a case study is provided to support the discussion.

7.1 A Framework to Examine the Effectiveness of ICTs in TVET

Two key elements must be taken into account when considering the effectiveness of learning technologies, namely instructional effectiveness; and instructional efficiency. Instructional effectiveness and efficiency are two elusive terms for which no accurate definitions can readily be found in the literature. The difficulty in defining these terms is probably due to the number of factors extraneous to the material itself, which confounds measurement related to the quality of instruction.

In previous studies the efficiency and effectiveness of an instructional product have been used as dependent variables. Nathenson and Henderson (1980) note that research has had a very narrow focus with regards to the effectiveness of instructional materials. In many studies effectiveness has been viewed only in terms of learning gains on post-tests. The authors argued that although improved student performance is an important element, it should not be the only indicator of instructional material effectiveness. Chinien (1990) suggests that instructional material effectiveness should be viewed within a framework, which encapsulates three major elements, achievement, study time, and the students' attitude toward the material. After reviewing the research on distance education, the Institute for Higher Education Policy (1999)

identified three broad measures of effectiveness that were most commonly used, namely student achievement, student attitude, and student satisfaction.

Achievement

Several studies (see Chinien and Boutin, 1994) have demonstrated that the quality of instructional material can help to significantly improve students' achievement on post-tests. Two indicators of instructional material effectiveness are used with respect to achievement. The first relates to the ability of the material to help a predetermined percentage of students reach a designated level of mastery on post-tests. The criterial level of effectiveness could specify that 90% of the test subjects should score at least 90% on post-tests (Romiszowski, 1986). Setting the criterial level for number of students and for level of mastery is arbitrary, and the decision can be made on the basis on the consequences of inadequate performance or mastery of content. The gain in learning is a second indicator of effectiveness related to achievement. Learning gain is usually expressed as the difference between post-test and pre-test scores (learning gain equals post-test score minus pre-test score, Romiszowski, 1986).

Study time

The amount of time that students spend interacting with an instructional product is another critical element of instructional material effectiveness. Nathenson and Henderson (1980) cite many research studies that have reported achievement at the expense of increased study time. These authors quote Faw and Waller (1976) to emphasize the critical relationship between study time and the achievement component of instructional material effectiveness:

> (Since) the single most important determinant of how much is learned is probably total study time...it is hardly surprising that the manipulation which tend to extend the period of time spent in study...are in general accompanied by superior levels of learning (p. 169).

There are also some studies demonstrating improved student performances on post-tests while keeping study time constant. Study time is also commonly referred to as a measure of efficiency (Davis, Alexander, and Yelon, 1974; Futrell and Geisert, 1984).

Attitude

A third dimension of instructional material effectiveness is the student's attitude toward the material (see Chinien and Boutin, 1994). Studies conducted by Aberdor (1972), Stolovitch (1975), and Wager (1980) indicate that effective instructional materials generate more positive student attitudes. On the other hand, Berthelot (1978) and Chinien (1990) found no significant differences in students' attitude related to the quality of instructional material. Romiszowski (1986) cautions that the novelty effects may confound measures of student attitudes. He argues that the novelty may not only inspire negative attitudes that diminish over time, but may also generate excessive praise and enthusiasm that may also disappear.

Although research on time-on-task indicates that a positive correlation between achievement and time engaged in learning tasks, time is not generally used as an independent variable in research on distance education. The effectiveness of an instructional material can be conceptualised within a framework of three major elements: student achievement, study time, and student attitudes. All three elements are important and need to be considered collectively when assessing instructional material. Any investment in ICTs is a waste if not accompanied with investment in high quality, relevant curriculum material, since ICTs will not compensate for poor content (Bates, 1995).

7.2 Research Assessing the Effectiveness of ICT-Mediated Learning

An analysis of the extensive amount of research conducted by Russell (1999) to assess the effectiveness of ICT-mediated learning leads to the conclusion that there is no significant difference to be observed in performance measures between learning with and without technology. A meta-analysis of over 500 studies conducted by Kulik (1994) (as cited by Baalen and Moratis, 2001) indicated that students receiving computer-based instruction tend to learn more in less time.

Baalen and Moratis (2001) identified some interesting trends from these studies:

1. The preference of students for face-to-face instruction reported in the 1950s and 1960s can perhaps be attributed to their unfamiliarity to the technology. Recent research tends to show a developing preference for distance learning among post-secondary learners.

2. Earlier studies were designed to demonstrate that technology would not have a negative impact on learners' performance. The goal was to prove the non-significant difference. In contrast, more recent studies have attempted to determine if technology-based learning was more effective that face-to-face instruction. Although most of these studies report no significant difference in outcome measures, many other studies reported equal or superior achievement over traditional classroom instruction.

3. Earlier attempts to use technology for learning were restricted to drill and practice and tutorial programmes. With today's enabling technology ICT-mediated learning engages learners in authentic learning tasks that allow them to use the technologies to "simulate events, communicate, collaborate, analyse data and access information sources" (p. 101). Although research on these innovative applications of ICTs in education is not extensive, some studies have demonstrated positive learning outcomes in support of ICTs.

After reviewing the literature and research on distance education, the Institute for Higher Education Policy (1999) concluded: "It may not be prudent to accept these findings at face value. Several problems with the conclusions reached through these studies are apparent. The most significant problem is that the overall quality of original research is questionable and

thereby renders many of the findings inconclusive" (p. 3). Following are some of the shortcomings identified: much of the research failed to control for extraneous variables, most studies failed to use randomly selected subjects, instrument of questionable validity and reliability were used, and many studies failed to control for reactive effects. Brennan, McFadden and Law (2001) also concluded that: "the gaps between the often rhetorical claims of 'effectiveness' and the reality of well-researched studies are not often bridged" (p. 64).

Many studies comparing ICT-meditated learning to traditional face-to-face instruction are also of limited relevance and values for two main reasons. First, it is impossible to establish a benchmark for making meaningful comparison. Second, several years of educational research spent comparing methods of instruction have failed to inform practice. The Aptitude by Treatment Interaction research indicates that an instructional treatment interacts with the learner's characteristics to produce differential learning gains. Snow (1976) argued: "No matter how you try to make an instructional treatment better for someone you will make (it) worse for someone else" (p. 292). Additionally, according to Messick (1976) "No matter how you try to make an instructional treatment better in regard to one outcome, you will make (it) worse to some other outcomes" (p. 266). Clearly, there is a need for developing a conceptual framework to guide research in ICT-mediated learning and there is also an urgent need to impose more rigor on research in this area.

After conducting a thorough review of research on online delivery of education and training Brennan, McFadden and Law (Ibid, p. 65) concluded that there are many tensions in the literature regarding the effectiveness of online teaching and learning in TVET, notably:

- Online delivery of VET creates learner isolation versus online delivery of VET creates a community of learners.
- Online delivery promotes a transformational view of learning versus the medium perpetuates a transmission view of learning.
- Online delivery is socially and politically liberating versus online delivery is an expression of cultural domination.
- The medium encourages choice of information and learner autonomy versus the medium strictly controls information and learning.
- Online delivery facilitates new and exciting modes of communication between learners and facilitators versus online delivery further isolates those already isolated by distance, ethnicity, or socio-economic circumstances.
- Online delivery facilitates the growth of the learner versus online delivery encourages learner dependence.
- Online delivery regards the learner as a static vessel to be filled versus online delivery demands and encourages the learner to become an evolving and multidimensional individual with new skills and aptitudes.
- The site of online delivery establishes and builds a valuable learning culture versus online delivery is objective and disembodied.
- Online delivery focuses on the quality of the learning versus online delivery achieves quantifiable and sometimes narrow outcomes.
- Online delivery requires completely new ways of teaching versus online delivery requires small modifications to previous pedagogies.

- Online delivery can solve most education and training problems versus online delivery is restricted in its capacity to solve the major problems confronting education and training.
- Online delivery of education and training is engaging, intrinsically motivating, and inclusive versus online delivery of education and training discriminates against certain kinds of learners and their backgrounds and leads to disaffection with learning.
- Online delivery of education and training is predominantly a mass distributive versus online delivery of education and training is focused on communication, collaboration, and interactivity.
- Online delivery of education and training is a liberating opportunity for learning versus online delivery of education and training is characterized by low take-up rates.

Moratis (2003) believed that assessing the effectiveness and efficiency of ICT-mediated learning using empirical research results provides only a very narrow perspective on the true value of learning technologies. He suggested that the effectiveness and efficiency of ICT-mediated learning is "emergent". By this he meant that is only through experimentation and experience that the true value of learning technologies can be realized. Moratis (Ibid) argues that the emergent concept should also be applied the resistance of stakeholders to ICT-mediated learning as the level of resistance may change with experimentation and experience.

7.3 The Cost-Effectiveness of ICTs

ICT-mediated learning appears to hold great promise for achieving the goal of education for all. However, it is unclear at this stage whether ICTs is the cost-effective strategy to meet this goal. Blurton (1999, p. 20) (cited by Baalen and Moratis, 2001) argues that it is difficult, if not impossible, to assess the cost-effectiveness of ICTs in education. They gave four reasons, namely lack of meaningful data, variability in the implementation of ICT solutions, difficulties in making generalizations across programmes, and difficulties in assessing outcomes. Curtin (2002) concluded that it is difficult to conduct research focused on comparative analysis of online delivery and face-to-face teaching. He gave four main reasons explaining these difficulties: (1) limited time allocated for study, (2) accounting systems does not allow costs tracking; (3) reluctance of institutions to provide data perceived to be confidential; (4) reliance on estimates rather that actual costs.

According to UNESCO (2002a) "Capital investments usually substitute for high recurrent costs, making economies of scale a decisive factor. Large distance–learning programmes may produce graduates at considerably lower costs than conventional institutions" (p. 12). UNESCO (Ibid) also identified some key factors affecting the cost-effectiveness of distance learning systems. These are: number of learners enrolled, the size of the curriculum, the number of years over which courses are offered without change, containment of course development costs, sharing course development costs, technology choice, the level of student support, and a range of working, labour market and structural practices.

Some studies have attempted to establish relative costs of ICTs in education (Potashnik and Capper, 1998) (cited by Baalen and Moratis, 2001, p. 103):

> Print, audiocassettes, and pre-recorded instructional television (lectures) are the lowest cost technologies for small numbers of students (fewer than 250). While radio requires 1000 students or more to achieve comparable per student costs. Computer conferencing is a low-cost approach to providing interactivity between teachers and students, but live interactive broadcasts and video conferencing are still very high-cost technologies, regardless of the number of students enrolled.

Research on cost-effectiveness of ICT-mediated learning is inconclusive. While some studies demonstrate that ICT-mediated learning can be cost effective, others suggest that technology is not a cost-effective solution, and that the implementation and maintenance costs will continue to climb.

Any discussions relative to the cost of ICTs naturally raise the fear that "information poverty will reinforce 'real poverty' in poorer countries" (Buckley, 2000, p. 1). In an analysis designed to assess if ICTs can promote education in developing countries, the author noted that telephone, television and computers are in very short supply in developing countries, and "as the north-south digital divide expands, radio appears to be the only electronic medium that minimises the constraints on access to information" (p. 1). Bates (1995) (cited by Stevens, 2001) analysis in the context of the British Open University demonstrated that instructional radio could be cost-effective:

> Radio costs per student for courses with over just 100 students a year are ten times higher than courses with 1,250 students or so per year…Courses needed to have over 1,250 students a year before unit costs dropped below $1.50 per student study hour; on the foundation courses, though, each with more than 6000 students a year, radio costs came down to 30 cents per hour.

The issue of economy of scale is a major challenge regarding the integration of ICTs in TVET, since the training demand in most developing countries is for small numbers of graduates in a wide range of occupational profiles. Learning consortia must be developed among developing nations to minimize developmental and maintenance costs.

Daniel (Ibid) views the effectiveness of education within a framework encapsulating three elements: (1) access; (2) quality; and (3) costs. He defined quality as: "fitness for purpose at minimum cost to society" (p. 2). This framework is extremely useful in any consideration of accessibility:

> When you express the basic challenge of education in terms of this triangle of forces, one uncomfortable fact is clear. Traditional methods of teaching and learning cannot produce the changes required. Try putting more students in each class. Access may go up, cost may go down, but everyone will accuse you of lowering quality. Traditional ways of improving quality tend to reduce access and raise costs. There is clearly a problem. Throughout history education has made an insidious link between quality and exclusivity. You can only have high quality if you exclude many people from access to it (p. 2).

Daniel (Ibid) pointed out that evidence shows that technology can increase access, improve quality and lower cost all at the same time. Research conducted by Curtin (2002) identified

three models in current use by the VET system in Australia to achieve cost-effectiveness outcomes in online delivery:

- Reduce costs while maintaining current levels of effectiveness and volume.
- Improve learning effectiveness while maintaining current cost and volume.
- Increase volumes while maintaining current levels of cost and effectiveness (p. 6).

These models validate Daniel's framework establishing the relationship between access, quality, and cost.

International copyright and intellectual property rights increased costs on high quality ICT training materials, making them less accessible to developing countries. Varoglu and Wachholz (2001) (cited by Stevens, 2001) "express concerns with the effort by more advanced countries to 'commoditize' knowledge and rigidly enforce international copyright and intellectual property rights".

SECTION 8 ICT LITERACY SKILLS FOR VOCATIONAL DEVELOPMENT

The first part of this section focuses on the training of TVET teachers and the types of occupational and pedagogical literacy that they need to be effective in an ICT-based learning environment. The second part addresses the generic and specific occupational literacy requirements for TVET students. Whenever appropriate, a case study is provided to support the discussion.

8.1 Using ICTs for Teacher Education and Development in TVET

The first part of this section is focused on general issues related to the use of ICTs for teacher education and development and the content is drawn essentially from a recent UNESCO document entitled *Teacher Education Guidelines: Technology – Curriculum – Cost – Evaluation* (2002b). The second part is specifically focused on the education of TVET teachers.

8.1.1 Use of ICTs for Teacher Education: General Issues

UNESCO (2002b) has made a strong commitment to make quality education available to everyone by the year 2015. However, problems related to worldwide teacher shortages impede advancement towards this goal. Open and Distance Learning (ODL) can play a crucial role in teacher education and teacher development to overcome problems related to geographical dispersion and inability to travel. Teacher education through ODL is defined as educational approaches that use various media to "reach teachers in their schools, provide learning opportunities for them, or enable them to qualify without attending college in person, or open up new opportunities for keeping up to date no matter where they want to study" (p. 11).

Initial teacher education delivered by distance education has been extremely successful in China, Nigeria, and the UK. These programmes were designed to reflect country-specific norms and regulations. In terms of curriculum reform, distance education can help teacher

trainees adapt to changes in education content or process (UNESCO, 2002b). In South Africa, for instance, radio was used to help teachers improve their English and teach it more efficiently. Finally, distance education can play an important role in supporting teachers' career development.

Distance education has several advantages over conventional education. For one, distance education is quicker and is more comprehensive than the cascade approach. Since teachers can remain in their schools, distance education also relieves schools of the costs associated with finding a replacement and travel. Furthermore, distance education integrates theory and practice by "putting information about curricula and teaching approaches directly into the hands of individual teachers" (Robinson, 1997, p. 125 cited in UNESCO 2002b).

8.1.2 Exemplary ICT-Based Teacher Education Programmes

UNESCO (2001) conducted a review of successful ICT-based teacher education programme in its Member States. Ten programmes were systematically examined. Following is a brief summary of the results:

Brazil. Broadcast on the non-profit, educational TV-Futura, A-Plus is a television series targeted at educators seeking to further develop their knowledge and skills. The series addresses practical teaching concerns, offers expert commentary, and invites audiences to reflect and comment on the issues presented. A-Plus also encourages agency in the form of activities through the series' Community Mobilization Network, run by 60 officers in various regions.

Burkina Faso. In 1992, the African Network for Education at a Distance (RESAFAD) recognized a need for in-service career development programmes for poorly educated headteachers in rural Africa. RESAFAD therefore collaborated with various regions to develop a programme geared towards building management capability. Print, the simplest and cheapest technology, was used to reach 70 geographically scattered headteachers in Burkina Faso.

Chile. Chile's Enlaces project has created an abundance of computers in schools, and a need for teachers trained in ICTs. The Universidad de la Frontera responds to this need by providing Chile's sole distance education IT diploma programme, aimed at primary-level and secondary-level teachers.

China. Approximately 1 million teachers in China, mostly located in rural areas, are not fully qualified. To make initial qualifications, upgraded skills, and continuing education more accessible, China Television Teachers College (CTVTC) offers award-bearing degree programmes and non-award-bearing diploma programmes. The programmes are aired on two educational channels, China Central TV and China Education TV.

India. A perceived need for a practical child development programme led the National Council of Education Research Training (NCERT) and the Indira Ghandi National Open University (IGNOU) to develop the Certificate in Guidance programme for parents, primary teachers, and

social workers. Though primarily print-based, the IGNOU-run programme combines booklets with audiotapes and videos.

Mongolia. Mongolia's transition from a socialist single-party state and command economy to a democratic multiple-party state and market economy led to new ideas, curricula, and approaches in the education system. To help qualified primary teachers adapt, UNICEF and the Ministry of Science, Technology, Education and Culture (MOSTEC) funded a self-study, non-accredited distance-education programme implemented by the National Institute for In-Service Teaching and the School of Educational Development (SED). The programme used print as a primary medium, as it was accessible, affordable, familiar, and permanent. The affordability of radio was also heavily exploited.

Nigeria. Due to a shortage of qualified primary teachers in Nigeria, the National Teachers' Institute (NTI) created the National Certificate in Education (NCE) programme in order to provide initial qualifications and professional development through distance education. The programme uses self-study print materials, tutorials, field trips, and supervised teaching practice. Supplementary audio and video materials are produced for use in study centres.

South Africa. Given disparities in teacher and school quality in post-apartheid South Africa, the Open Learning Systems Education Trust (OLSET) implemented an interactive radio series called "English in Action" in 1993. While students learn English through half-hour lessons involving music and storytelling, teachers improve their language and teaching skills through structured language curricula, workshops, teachers' groups, and supplemental print materials. The series is broadcast by the South African Broadcasting Corporation (SABC) and by various community radio stations.

South Africa. In the mid-1990s, UNISA implemented Bachelor degree programmes for both primary and secondary teachers. Initially in-service, these programmes can now also be taken as pre-service programmes leading to initial teacher qualifications. The programmes are print-based, supplemented by face-to-face discussion classes and teaching practice. Though the Internet plays only a minor role, UINSA is currently working to integrate Computer-Mediated Communication (CMC) and Web technologies into the programmes.

United Kingdom. During a growing shortage of teachers in the 1990s, the UK Department of Education decided to support a distance education post-graduate Certificate in Education (PGCE) programme at Open University. This 18-month part-time programme integrated various media, including print, audio, and video. Computer conferences and e-mail facilitated student-student and student-tutor interaction.

8.1.3 Technology-Based TVET Teacher Education

TVET teachers require different skill sets if they are to be trained using ICTs. These skill sets can be classified into 15 categories.

1. Specific occupational skills;

2. Specific occupational knowledge;
3. Programme planning, development, and evaluation;
4. Instructional planning;
5. Instructional execution;
6. Instructional evaluation;
7. Instructional management;
8. Guidance;
9. School-community relations;
10. Vocational student organization;
11. Professional role and development;
12. Coordination of cooperative education;
13. Implementing competency-based education;
14. Serving students with special needs; and
15. Assisting students to improve their basis skills.

In most countries, TVET teacher education is a post-specialization programme where individuals receive specific occupational knowledge and skills before being admitted into the programme. Therefore, the use of ICTs for developing these competencies is not an issue in the context of the initial TVET teacher education. However, maintenance and updating of these competencies represent major challenges, which will be discussed later in this section. All of the other competencies are acquired during the initial preparation programme.

The initial training and professional development of TVET teachers has been and still remains a challenge in many countries due to distance. Dual mode TVET teacher education, consisting of on- and off-campus courses delivered by itinerant educators, has been used to overcome this problem. However, declining enrolment at off-campus locations and diminishing travel budgets have forced some teacher education institutions to implement the use of ICTs to reach off-campus learners (Foell and Fritz, 1998). Additionally, the growing demands for TVET teachers and the declining number of programmes dedicated to preparing these teachers are additional incentives for using technology for delivering these programmes. Lamoureux (2002) noted: ODL “has given new energy and has become a required delivery mode to meet many of the critical needs of TVET teacher education and training” (p. 123). In the US, 47.7% of institutions surveyed indicated that they were using distance education to some degree in their TVET teacher education programmes (Zirkle, 2002).

There are various cost factors that must be examined when considering the adoption of ICTs for teacher education and development. These include: programme scale; media or technology used; costs of face-to-face or residential study; costs of student support; costs of teacher practice, examination and supervision; fee-charging policy, and opportunity costs of having teachers leave their schools (UNESCO, 2002a).

Zirkle (2002) asked two critical questions regarding the use of ICTs for teacher education: What pedagogical pieces of teacher preparation can be effectively taught via distance education? Can teacher in-class performance be assessed at a distance? According to UNESCO (2002b), distance education is most effective when used to improve the level of trainee teachers’ general education. Improving teachers’ subject knowledge, however, is challenging when it involves teaching new thinking and practices. As for pedagogy and child development,

these lend themselves to distance education when centred on real-life examples and experiences. Educators of TVET teachers need to address two key questions regarding the adoption of ICTs in their programmes: Can a course or parts of a programme be delivered using ICTs? In what TVET setting is it more appropriate to use ICTs? Learning centres can be used to overcome these difficulties by providing the appropriate environment for developing specific teaching skills that cannot be acquired by distance learning.

Because teacher education is usually governed by specific legislations there are a number of issues that must be considered before developing or purchasing foreign-developed programmes. These issues relate to requirements regarding programme accreditation and recognition, recognition of qualifications, regulations, standards, and monitoring of teaching practices (UNESCO, 2002b).

The two case studies that follow illustrate the use of ICTs for training TVET teachers at the undergraduate and graduate levels.

CASE STUDY 30: The Special Diploma in Technical/Vocational Teaching: Low Tech for High Value in Technical and Vocational Teacher Training

The island states in the Commonwealth Caribbean identified a skill gap among TVET teachers. Many TVET teachers had strong occupational training but no teacher preparation experiences. The Caribbean Community Secretariat (CARICOM) and the Commonwealth of Learning developed the Commonwealth of Learning's (COL) Core Curriculum in Technical and Vocational Teaching to bridge that skill gap. The materials were produced with TVET representation from 14 countries and substantive input from eight Caribbean technical colleges and administrative bodies, in collaboration with CARICOM.

Since this material was intended for independent study and self-directed learning, provision had to be made for recognizing competency development through financial rewards in terms of increases in salary scale. This was achieved with the collaboration of the University Technology of Jamaica (UTech). A franchise agreement was reached to ensure that each institution offers the Special Diploma according to standards and guidelines established by UTech. Additionally, UTech agreed to give successful programme completers entry into its Post-Diploma Bachelor of Education programme.

The materials were developed in a print-based format. On the basis of costs to opportunity analysis, it was decided to circulate the materials on CD-ROM. Audio and videotapes were also developed in limited quantities. It was later observed that the distribution of the materials in CD-ROM format was not appropriate as it shifted the printing costs to the individual states with limited resources.

Tutors were trained by COL to support the offering of the Special Diploma in each state. Local costs related to classroom space, tutors, materials reproduction and distribution and release time were covered by the states. Participating institutions were required to pay a fixed administrative fee for each registered student. Due to resource constraints only two countries have implemented

the programme so far.

Source: Bartram, J. and George N. (2002). The Special Diploma in Technical/Vocational Teaching: Low Tech for High Value in Technical and Vocational Teacher Training. Commonwealth of Learning. Vancouver, Canada.

CASE STUDY 31: Programme Planning in Adult Education/TVET

Programme Planning in Adult Education is a three-credit Internet-based course designed for masters and doctoral students in TVET and Adult Education. This course is offered by Faculty of Education, University of Manitoba, Winnipeg, Canada. The course is delivered through the WebCT learning platform.

Course Objective: Study and application of various theoretical foundations and models for planning education and training programmes for adult learners.

Target audience for this course includes: researchers, administrators, policy-makers, consultants, teachers, industry trainers, human resource managers, workplace educators, and programme planners and developers.

Programme Planning in Adult Education consists of six modules. Each module is divided in units of instructions:

Module 1 Fundamentals Unit 1 Assumptions, philosophies and approaches to adult learning Unit 2 Programme planning models Unit 3 Learning principles with implications for programme planning	Module 4 Programme development Unit 4.1 Content analysis Unit 4.2 Sequencing content Unit 4.3 Teaching strategies Unit 4.4 Teaching and learning aids Unit 4.5 Learner assessment
Module 2 Analysis Unit 2.1 Needs assessment and needs analysis Unit 2.2 Job analysis Unit 2.3 Task analysis	Module 5 Programme implementation Unit 5.1 Modes of delivery Unit 5.2 Facilities Unit 5.3 Instructional staff Unit 5.4 Marketing of programme
Module 3 Programme design Unit 3.1 Programme objectives Unit 3.2 Learning objectives Unit 3.3 Analysis of objectives	Module 6 Programme evaluation Unit 6.1 Theories and models of programme evaluation Unit 6.2 Evaluation plan

This course is delivered entirely on the Internet. Students are expected to commit to a minimum of 120 hours of independent study for this course. Requirements include assignments that must be completed for grades as well as tasks that must be completed in lieu of attending classes, such as: sharing critical reflections on all assigned readings with instructor and peers, and initiating discussions and participating in discussions initiated by other students.

Programme Planning in Adult Education was the winner of the WebCT International Exemplary Course Award, 2001.
Instructor and Course Developer: Dr Chris Chinien, Director, Graduate programme in Adult Education, Faculty of Education, University of Manitoba, Canada; Director, National Centre for Workforce Development Canada, The Canadian Centre for UNESCO's international project on TVET. E-mail: chinien@ms.umanitoba.ca

8.1.4 ICT Literacy for TVET Teachers

It appears that ICTs have made little impact in schools in spite of the seemingly great potential to improve teaching and learning (Miller, 1997). Dyril and Kinnauman (1994) noted, "Technology has transformed every segment of American society – except education…schooling today remains much the same as it was before the advent of personal computers. The lack or inadequate training of teachers is considered to be one the major barriers for the integration of ICTs in TVET (Miller, 1997). Cuneo and associates (2000) argued that lack of staff training in ICTs is a major cause of the digital divide among Canadian post-secondary institutions. Research indicates that the computer literacy of TVET teachers can decrease computer anxiety (Birkenholz and Stewart, 1991) and improve attitudes towards computers (Fletcher and Deeds, 1991). On the basis of these findings Fletcher and Deeds (1991) recommended implementing additional pre-service and in-service ICT training for TVET teachers. According to Allen, Walker, & Morehead (1999), "Many educators are limited in the technological skills needed for successful technology integration in career ad technical education curriculum due to the lack of recent training in the professional field" (p. 5).

There is now a general consensus that teachers are the principal agents for integrating technology in education and training. A study conducted by Marie Jasinski (1998) involving 80 TVET educators indicated that technology does not improve or cause changes in learning. It is well-designed instructions and how teachers make use of the new capabilities, potentials, and options offered by ICTs that can improve learning significantly.

In spite of the importance of ICT literacy skills for TVET teachers, it appears that they are not being adequately prepared to meet the challenge. A study conducted by Miller (1997) indicated that only 50% of teacher education institutions surveyed had implemented a required course in ICTs. The most striking finding of this study is that computers were most frequently being used as "glorified typewriters" in vocational teacher education. A forum on trainer training and e-learning hosted by CEDEFOP Electronic Training Village (ETV) in 2001 indicated that "basic technology skills are often acquired by trial and error learning in day-to-day teaching practice" (ANTA, 2001a, p. 33).

In considering ICT literacy skills for TVET teachers two main skill dimensions must be considered: technical and pedagogical ICT literacy, and occupational ICT literacy. Technical and pedagogical ICT literacy refers to the technical literacy skills for the equipment being used and the specialized skills necessary in its pedagogical application. Occupational ICT literacy refers to the competencies related to the use of technology-based equipment and control systems.

8.1.5 Technical and Pedagogical ICT Literacy for TVET Teachers

The International Training Centre of the ILO (2002) in Turin, Italy has developed a set of Training Technology Competence Standards for TVET personnel involved in distance education and learning technology applications. This comprehensive competency profile includes four major standards and 24 subcategories, as well as specific performance indicators for each. The case study that follows outlines these competencies.

CASE STUDY 32: ICT Literacy for Personnel Involved in Distance Education and Learning Technology Applications

A. ANALYZING TRAINING REQUIREMENTS
A.1 Define a training problem within a geographical area,
A.2 Define a training problem within an organization,
A.3 Identify and analyse competence standards,
A.4. Assess training needs within a geographic area,
A.5 Assess training needs within an organization,
A.6 Analyse the population targeted by a training programme, and
A.7 Analyse the resources available and the constraints for the design and implementation of a training programme.

B. DESIGNING A TRAINING PROGRAMME
B.1 Select the training modalities for a training programme,
B.2 Define the learning objectives, pre-requisite and content of a training programme,
B.3 Design the teaching/learning strategies and the learning assessment strategies for a face-to-face training programme,
B.4 Design the teaching/learning strategies and the learning assessment strategies for a distance learning programme,
B.5 Validate a face-to-face training programme, and
B.6 Validate a distance-learning programme.

C. DESIGNING, ADAPTING AND PRODUCING LEARNING MEDIA AND ENVIRONMENTS

C.1 Define a project for the production of learning media and environments,
C.2 Define the modifications to be introduced in learning media and environments and their integration into a training programme,
C.3 Design learning media and environments,
C.4 Organize the production of learning media and environments,
C.5 Produce learning media and environments, and
C.6 Validate learning media and environments.

D. DELIVERING A TRAINING PROGRAMME

D.1 Plan the delivery of face-to-face training,
D.2 Plan the delivery of distance learning,
D.3 Facilitate face-to-face learning,
D.4 Facilitate distance learning, and
D.5 Assess the individual achievement of competence.

8.1.6 Occupational ICT Literacy for TVET Teachers

There is a long established tradition in TVET for employing expert workers to teach their trades to others. This tradition is based on the assumption that there are two critical requirements for imparting workplace skills. The first requirement points to the need for demonstrating that occupationally specific workplace skills have been acquired through some form of formal training, such as the apprenticeship system. The second requirement is usually formulated in terms of the number of years of relevant work experience in a particular occupation, the minimum requirement being as many as five years.

The occupational ICT literacy skills of TVET teachers consist therefore of a combination of their occupational skills and their work experience. While occupational skills can be readily assessed using competency testing, it is more difficult to assess work experience because the quality of the latter depends on context. The work experience of a tradesperson will vary according to whether the person is employed in a low or high technological environment in a large, medium, or small organization. The shelf life of the occupational ICT literacy skills of TVET teachers is relatively short in some occupations. Therefore, constant updating is necessary to keep TVET teachers abreast of technological development.

8.1.7 Using ICTs for Updating TVET Teachers

TVET programmes are intended to prepare people for gainful employment. To be able to meet that mandate TVET programme content and delivery must be kept up to date with business and industry standards. In most circumstances TVET teachers are responsible for keeping both programme content and delivery up-to-date. The shelf life of the occupational ICT literacy

skills of TVET teachers is relatively short because of the exponential rate of technological development. Therefore constant updating is necessary to keep TVET teachers abreast of technological development. According to Allen, Walker, and Morehead (1999), "Many educators are limited in the technological skills needed for successful technology integration in career and technical education curriculum due to the lack of recent training in the professional field" (p. 5). Participants of a Regional Planning Meeting of TVET Experts from Countries in the Asia Region (UNESCO-UNEVOC, 2002) identified the difficulties encountered in updating teachers as a major issue affecting the quality and relevance of ICTs in TVET.

The UNESCO (2001) Revised Recommendation for Technical and Vocational Education, No. 87 states that:

> TVET teachers: should be encouraged to continue their education and training, whatever their specialized field, and should have the necessary means to do so. Lifelong learning should be made available in a wide range of facilities, and should include:
>
> a. continuous review and updating of knowledge, competencies, and skills;
> b. continuous updating of specialized professional skills and knowledge;
> c. periodic work experience in the relevant occupational sector.

In his review of trends and issues on the topic of updating, Wonacott (2001) concluded that most established techniques are still in current use for updating the occupational ICT skills of TVET teachers, such as work experience, formal advisory committees, informal contacts, workshops, seminars, conferences, membership in professional associations, networking with other teachers, reading professional literature, externships, summer work, field visits, and business partnership (p. 1). Wonacott also noted that ICTs have also led to the use of innovative strategies like teleconferencing, listservs, downloading curriculum materials online and distance learning. The use of ICTs for training TVET teachers can be implemented in a combination of three modes: (a) single mode using an ODL approach, (b) mixed mode using traditional approaches and ODL, and (c) mixed mode using traditional and technology-enhanced learning. Two main issues will usually influence the mode of delivery: costs and effectiveness of delivery mode.

Woolley and Booker (2002) identified two ICT professional development models for TVET teachers in South Australia:

- Adelaidei Global, an e-learning unit at AIT, the staff of which have the responsibility to provide leadership and support to teachers and to further develop the online skills and expertise amongst staff at AIT. Activities of the unit include development and delivery of training associated with online teaching learning or course material development and promotion of e-learning.

- The Online Network for Education (ONE) is an online network for all TAFE staff interested in online learning development and delivery. The network is used to distribute information about online learning, training, funding, projects, events, and people. Activities of the network include delivery of professional development,

maintenance of a web site and organization of events such as “The Games Online” (p. 10).

8.2 New Literacy for TVET Learners

The new literacy of TVET learners can be classified in three main categories: technological literacy, ICT literacy, and occupational ICT literacy.

8.2.1 Technological Literacy

Technological literacy is commonly defined as the ability to use science and technological principles to solve problems. The International Technology Education Association has developed the following technological literacy standards for learners (Newberry, 2001).

1. Student will develop an understanding of the characteristics and scope of technology.
2. Student will develop an understanding of the core concepts of technology.
3. Student will develop an understanding of the relationships among technologies and the connection between technology and other fields of study.
4. Student will develop an understanding of the cultural, social, economic, and political effects of technology.
5. Student will develop an understanding of the effects of technology on the environment.
6. Student will develop an understanding of the role of society in the development and use of technology.
7. Student will develop an understanding of the influence of technology on history.
8. Student will develop an understanding of the attributes of design.
9. Student will develop an understanding of engineering design.
10. Student will develop an understanding of the role of troubleshooting, research and development, invention, innovation, and experimentation in problem solving.
11. Student will develop the abilities to apply the design process.
12. Student will develop the abilities to use and maintain technological products and systems.
13. Student will develop the abilities to assess the impact of products and systems.
14. Student will develop an understanding of and be able to select and use medical technologies.
15. Student will develop an understanding of and be able to select and use agricultural and related biotechnologies.
16. Student will develop an understanding of and be able to select and use energy and power technologies.

17. Student will develop an understanding of and be able to select and use information and communication technologies.
18. Student will develop an understanding of and be able to select and use transportation technologies.
19. Student will develop an understanding of and be able to select and use manufacturing technologies.
20. Student will develop an understanding of and be able to select and use construction technologies (p. 16).

8.2.2 Occupational ICT Literacy

Occupational ICT literacy refers to the skill and knowledge needed to handle information and solve problems as well as the competencies needed to operate of technology-based equipment. The occupational ICT literacy is occupation-specific. TVET students develop their occupational ICT literacy skills as they learn the related theory and practice of their chosen occupation.

8.2.3 ICT Literacy

An international panel convened by the Educational Testing Service (ETS) in January 2001 to study the growing importance of existing and emerging ICTs and their relationship to literacy defined ICT literacy as the ability to use "digital technology, communication tools and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society" (Educational Testing Service, 2001, p. 2). The panel further provided the operational definition for the key concepts of their ICT definition:

- Access – knowing about and knowing how to collect and/or retrieve information.
- Manage – applying an existing organizational or classification scheme.
- Integrate – interpreting and representing information. It involves summarizing, comparing and contrasting.
- Evaluate – making judgments about the quality, relevance, usefulness or efficiency of information.
- Create – generating information by adapting, applying, designing, inventing or authoring information (p. 3).

ICT literacy is a critical skills set for students involved in an ICT-mediated learning environment. Research attempting to benchmark ICT literacy skills conducted by Oliver and Towers (2000) indicated that lack of appropriate ICT literacy skills could impede students' learning and their progression in courses and programmes using ICTs.

8.2.4 ICT Specialists

TVET also offers programmes designed to train ICT specialists. For example, in the state of Victoria, Australia, there are over 150 ICT courses being offered in areas of information science, data processing, computing, computer software application, computer science, computer systems, systems programmes, and communication engineering (Keating and Thompson, 2001).

SECTION 9 INTEGRATION OF ICT-MEDIATED LEARNING IN TVET

This section addresses the policy initiatives and necessary planning for integrating ICTs in TVET. Specific strategies for ensuring the effectiveness and efficiency of ICT-mediated learning materials are considered, along with appropriate standards of quality. Finally, health and safety issues related to the use of ICTs are reviewed. Whenever appropriate, a case study is provided to support the discussion.

9.1 Policy Governing the Integration of ICT-Mediated Learning in TVET

This section addresses the policy initiatives and necessary planning for integrating ICTs in TVET. Specific strategies for ensuring the effectiveness and efficiency of ICT-mediated learning materials are considered, along with appropriate standards of quality. Finally, health and safety issues related to the use of ICTs are reviewed. Whenever appropriate, a case study is provided to support the discussion.

An ICT policy is an essential management tool that can facilitate the successful implementation of ICTs in TVET. ANTA (2001c) analysed country policies for integrating ICT-mediated learning in TVET from Botswana, Canada, China, European Union, South Korea, and Malaysia. Results indicated that country policy for the ICT integration evolved around three main categories, namely: people, infrastructure, and content. The people policy included elements dealing with workforce development; equity, culture and society; and lifelong learning. The infrastructure policy was focused on issues related to access to technology, affordability, digital divide, and bandwidth. Finally the content policy was directed to integration of flexible learning into the mainstream and generation of content.

The British Educational Communications and Technology Agency (BECTA, 2001b) defines an ICT policy as "a statement of the beliefs, values and goals of a school's staff working co-operatively in the context of using information and communications technology (ICT) in the operation of that school". BECTA provides some interesting guidelines for formulating a vision statement:

- Where is the school now?
- What, ultimately, is the school's intention in this area?
- Why does the school believe that this is the direction it wants to take?
- What realistic goals can be set towards achieving the ultimate intention?
- How will the school set about achieving these goals?

According to BECTA (2001b), the following areas should also be included in an ICT policy statement:

- The aims of ICTs and how it relates to or contributes to the school's aims
- The distinctive contribution of ICTs to the curriculum
- The contribution ICTs makes to other subjects
- How the subject will be monitored and evaluated
- A strategy for implementation
- Teaching and learning styles
- Recording, assessment and reporting
- Monitoring and review
- Classroom and resource management
- Inclusion and Special Education Needs
- Continuity and progression
- Staff development and training issues
- Leadership and management roles
- Links to the Management Information System (MIS)
- After-hours and community use.

9.2 Planning Model for Integrating ICTs in TVET

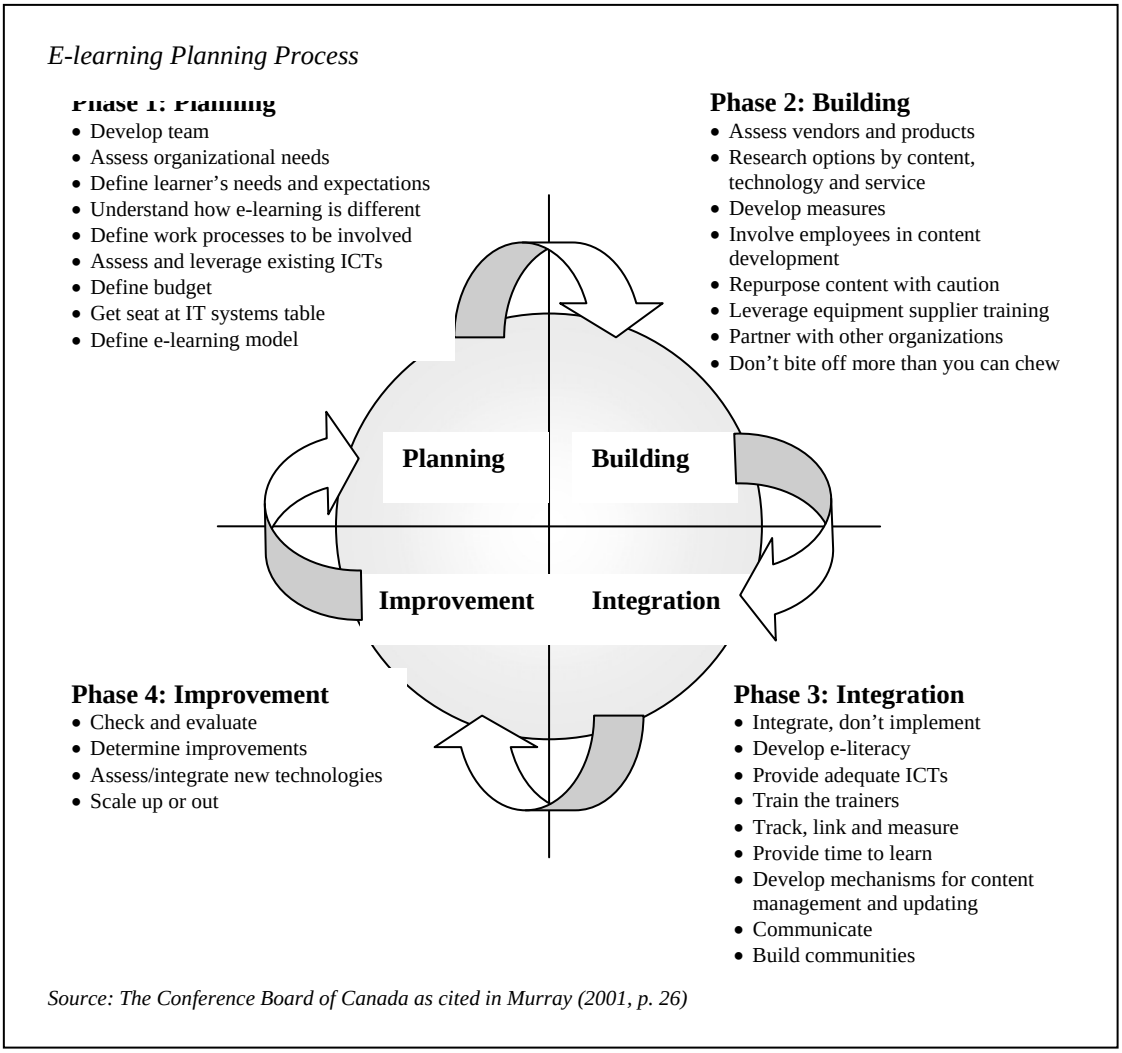
The successful implementation of ICT-mediated learning requires careful planning as there are many pitfalls to be avoided, such as

- Allowing decisions to be driven by technology;
- Jumping on the “everybody’s doing it” bandwagon;
- Overlooking existing educational and ICT systems;
- Underestimating the front-end and ongoing funding requirements;
- Unclear statements of objectives to be achieved;
- Raising unrealistic expectations;
- Failing to keep stakeholders briefed and involved in the decision process (Farrell, 2001, p. 152).

The Conference Board of Canada (2001) has developed a comprehensive planning model for the integration of e-learning in workforce development that addresses these pitfalls. This model

(Figure 5) includes four distinct phases: Planning, Building, Improvement, and Integration. Each of these phases is briefly reviewed in this section.

Figure 5: Planning Model for Integrating ICTs in TVET



9.2.1 Planning

The planning phase involves the assessment of the needs the organization and learners in relation to the capacity of the learning technologies. The planning phase includes the following steps:

1. *Develop a team:* Bring all key stakeholders together to ensure buy-in and sound decision-making.
2. *Assess organizational needs:* Assess previous e-learning experience, and assess support for e-learning and determine benefits.

3. *Define learners needs and expectations:* Establish benchmarks regarding computer literacy, language skills, access to information and communication technologies, and learning needs.
4. *Understand how e-learning is different:* Analyse the differences between e-learning and other traditional delivery approaches such as classroom-based, instructor-led training.
5. *Define the work processes to be involved in e-learning:* Determine the work processes, programme, or courses within which e-learning will be integrated and how technology will be used.
6. *Assess and leverage existing ICTs:* Assess existing infrastructure, equipment, courseware, e-learning experience, and trainers and employee ICT literacy.
7. *Define the budget:* Assess all costs and determine where the money will come from.
8. *Get a seat at the information technology system table:* Build rapport and working relationship with IT colleagues.
9. *Build or buy? Define your model of e-learning:* Determine if you are going to buy services, content, and technology externally, or develop them internally, or apply some combination of these two options.

Naud and Bremner (2002) described an Action Plan drawn up by the Province of Saskatchewan in Canada for implementing e-learning in TVET. That Action Plan consists of six elements that define roles, responsibilities, and inter-relationships based on the following principles:

- Equity: enhanced access to educational opportunity.
- Quality: content and instructional strategies that meet academic, pedagogical and industry standards.
- Choice: increased choice through flexible, responsive, relevant and timely programmes and services.
- Coherence: increased opportunity and mobility for learners through a coherent and integrated delivery and programme array.
- Sustainability: long term support by organizations and predictable funding.
- Partnership: working together on the basis of complementary and/or mutual interests (p. 5).

9.2.2 Building

The purpose of the Building phase is to develop an e-learning model complete with external vendors and suppliers and outcome measures to assess programme success as described in the following steps:

1. *Assess the vendor market and products:* Develop criteria for assessing vendors of e-learning products.
2. *Research e-learning options by content, technology, and service:* Assess proposal of content providers, technology providers, and service providers. Examine programme requirements to determine if content should be developed internally or externally.

3. *Develop measures:* Identify key success factors and develop an evaluation plan
4. *Involve employee in content development:* Engage employees in the content development. They can be provided with a template that they can populate with their knowledge.
5. *Repurpose content with caution:* Assess existing instructional materials that can be used and packaged so they can fully benefit from the interactive possibilities of e-learning delivery.
6. *Leverage equipment supplier training:* Develop partnership with equipment supplier to gain access to existing e-learning packages.
7. *Partner with other organizations:* Develop partnership with other institutions/organizations to gain access to existing e-learning packages.
8. *Don't bite off more than you can chew:* Begin with a small-scale project that can demonstrate the success of e-learning.

9.2.3 Integration

This phase is designed to promote e-learning to administrators, instructors, and learners, providing professional development as required and collecting data as the process evolves.

1. *Integrate, do not implement:* Implementation is a top-down approach. Integration is a more collaborative approach that can assist in building a successful e-learning community.
2. *Develop e-literacy:* Develop an e-literacy programme to assist learners in becoming familiar with ICTs.
3. *Provide adequate ICTs:* Ensure the availability and accessibility of ICTs in sufficient quantities.
4. *Train the trainers:* The integration of e-learning requires a unique skill set. Provide adequate training to instructors.
5. *Track, link and measure:* Use all data collected to monitor the success of e-learning.
6. *Provide time to learn:* Time is a barrier to e-learning. It is imperative to provide adequate time to all.
7. *Develop mechanisms for content management and upgrading:* Establish a system for managing and updating content.
8. *Communicate:* Communicate the importance of e-learning to all stakeholders.
9. *Build communities:* Build e-learning communities on the basis of specific knowledge or content areas to solve problems, learn together, and construct and share knowledge.

9.2.4 Improvement

This phase of the e-learning integration process focuses on improvement by researching new technologies, approaches, strategies, and techniques.

1. *Check and evaluate:* Analyse all data collected to identify strengths, weaknesses, successes, and failures.
2. *Determine improvements:* Identify areas of e-learning needing improvement.

3. *Assess and integrate new technologies:* Keep abreast of technological development in e-learning and integrate technologies that facilitate and enhance learning.
4. *Scale up or out:* Successful organizations or institutions can at this point develop external partnerships to sell their training programmes in order to recover their e-learning investments.

The following case study briefly describes the effort of the Saskatchewan Institute of Applied Science and Technology (SIAST) in Canada to accelerate the pace of faculty development and the smooth integration of technology in TVET. The success of this model is based on a solid project plan, sound instructional design, high-quality interactive instruction, and rigorous evaluation strategies. In a period of 18 months SIAST has gained recognition as a leader in the online delivery of technical training through its impressive array of online programmes and services. This systematic approach has worldwide application and could assist developing institutions in achieving their goals more quickly with only a modest investment of resources (Naud and Bremner, 2002).

CASE STUDY 33: Building Technology-Literate Organizations

The key to success in building a technology-literate organization is to engage faculty early, develop a cooperative network through technology-enhanced learning, and capitalize on early successes to advance institutional goals. This experience at the Saskatchewan Institute of Applied Science and Technology (SIAST) clearly demonstrates how an entrepreneurial approach to collaboration and partnerships can be leveraged in accelerating the pace of faculty development and the smooth integration of technology.

Given Saskatchewan's relatively small population dispersed over a large geographic area, the establishment of a technological infrastructure and the development of a province-wide plan were deemed critical as springboards for action in technology-enhanced learning. Faced with these challenges, a consortium of universities, colleges, Aboriginal institutions, SIAST, and the provincial government's Department of Learning was formed to develop a technology-enhanced learning plan for the province. The consortium created a vision that encompassed the following: "Saskatchewan post-secondary education and training sector works collaboratively to make appropriate use of technology to serve the learning needs of all residents of the province by enhancing the quality of programmes and extending access". The action plan defined roles, responsibilities and inter-relationships based on the following principles of equity, quality, choice, coherence, sustainability, and partnership.

Achieving a critical mass of champions was essential for institute-wide faculty orientation. SIAST used a collaborative model of skill transfer within the community of peers and a network of learning labs to familiarize faculty with technology, instructional resources, and techniques. SIAST recognized early in the process that the use of technology itself as a medium for teaching was changing the role of faculty and their interaction with students. Consequently, faculty participation was critical in creating an environment that would facilitate change in the use of technology in teaching and learning. That level of involvement occurred at the grass roots level and promoted a sense of community, teamwork, and collaboration. In the first year of operation, 47% of employees took advantage of training.

SIAST also worked closely with partner institutions to build a technology-enhanced learning network that featured a common policy framework and quality standards for content development, design, interactive instruction, and consistent look and feel. Partnerships with industry and the Apprenticeship Commission demonstrated the proof of the concept of delivering applied and skills-based training across the province. The outcomes of these initiatives were articulated in a five-year business plan and the establishment of the virtual campus. This step was important in communicating to internal and external stakeholders that senior management fully endorsed this project, while ensuring that resources and appropriate timelines were in place.

In 18 months, SIAST has become a leader in the online delivery of technical training by developing an impressive array of online programmes and services. This systematic approach has application worldwide and can assist developing institutions in achieving their goals faster and within a modest investment of resources.

9.3 Developmental Testing of ICT-Mediated Learning Materials in TVET

While a general consensus is emerging regarding the need to integrate ICTs in teaching and learning, there is little empirical evidence to support the decision-making process. In fact, over 350 research projects conducted during the past 70 years have failed to establish a significant difference in effectiveness between ICT and traditional methods (Baalen and Moratis, 2001). While these findings tend to suggest that ICTs do not considerably improve teaching and learning, the fundamental question that remains unanswered is: Were the researchers assessing the effectiveness of ICTs or were they simply assessing the effectiveness of instructional products that were less than perfect?

In spite of considerable progress made in the development of instructional materials through the adoption of systematic instructional design, practitioners still have difficulty in producing efficient and effective instructional materials because our knowledge of human learning is still limited. Many of the critical assumptions that are made during the design and development of instructional product are based on learning theories that are weak. The final product is therefore less than perfect (Dick and Carey, 1985, Gagne and Briggs, 1979). Conscious of this inherent difficulty, and recognizing that the design process is not foolproof, instructional developer have included a formative evaluation component in their models (Geis, Weston and Burt, 1984). The purpose of formative evaluation is to provide instructional developers with an opportunity to identify and correct errors and problems within a set of instructional materials while they are still in a developmental stage (Baker and Alkin, 1984; Dick and Carey, 1985; Gagne and Briggs, 1979; Geis et al., 1984; Sanders and Cunningham, 1973). Formative evaluation is defined as the "evaluation of educational programmes while they are still in some stage of development" (Baker and Alkin, 1984, p. 230). Formative evaluation is:

> the empirical validation of many of the theoretical constructs, which are included in earlier components of the instructional design model. If the theory is weak the product is less than properly effective. Since our present theories and practices are imperfect, we need empirical data as a basis for improving the product (Dick, 1977, p. 312).

Formative evaluation of instructional material is an essential activity in the design and development of instruction, because there is a lack of comprehensive theory of learning to guide practice (Nathenson and Henderson, 1980).

> Formative evaluation attempts to appraise such programmes in order to inform the programme developers how to ameliorate deficiencies in their instructions. The heart of the formative evaluator's strategy is to gather empirical evidence regarding the efficacy of various components of the instructional sequence and then consider the evidence in order to isolate deficits and suggest modifications (Popham, 1975, p. 14).

Earlier attempts for trying out and revising instructional materials date back to the 1920s, with educational films and radio (Cambre, 1981). There are two broad questions addressed by formative evaluation activities. The first relates to the content and the technical quality of the material, and the second pertains to its learnability. The evaluation of content and technical quality is addressed through expert verification and revision. It is generally believed that the students are most qualified for providing feedback data to assess the learnability (Nathenson and Henderson, 1980). Figure 6 shows the various components of the developmental testing and model.

9.3.1 Expert Evaluation and Revision

The use of experts' opinion in assessing the worth of an instructional product is probably the oldest evaluation strategy used in education. Experts' opinion is an important evaluation tool because it is quick, it is cost-effective, and it tends to enhance the credibility of an instructional product. Additionally, experts' opinion can be used to modify a product before it is used by students. types of experts are commonly used for the evaluation process, namely: content, language, target, media, format, and delivery system experts (Table 11):

- *The content expert* will ensure that the content is relevant, accurate, and up-to-date.
- *The language expert* will ensure that the language is appropriate for the target population.
- *The target population expert* will ensure that the material is appropriate for the designated group that will be using it. If the target population is adult learners, then the expert will ascertain that the material being evaluated is in agreement with the basic principles, philosophies, assumptions, and established theories in adult education. The five philosophies in common use in adult education, behavioural, liberal, progressive, humanistic, and radical, consist of beliefs about human learning, the roles of learners, and values attributed to learning. These philosophies can strongly influence the orientation given to the learning process, such as active learning, transformative learning, or self-directed learning, to name a few.
- *The media expert* will focus on the cost-effectiveness of the proposed materials. Typical cost considerations include: capital costs, installation/renovation costs, time cost, support personnel, training, maintenance, cost of alternatives, as well as shared costs. The expert can also assess the societal costs of not implementing a technology-based product.

The media expert will assess the particular characteristics of the learning technology in order to determine its appropriateness for addressing the learning needs of the target population.

- *The format expert* will determine if the material has been packaged to maximize its effectiveness and efficiency.
- *The delivery expert* will ascertain that the material meets standards established by best practices. The effectiveness of instructional material depends to a large extent on how well instructional developers have been able to support internal learning processes with external events. Research has identified nine critical events of learning (Gagne and Driscoll, 1988). Delivery expert evaluation must determine if all the events of learning are present.

Events of Learning

1. Gaining attention
2. Informing the learner of the objective
3. Stimulating recall of prior learning
4. Presenting the stimulus
5. Providing learning guidance
6. Eliciting performance
7. Providing feedback
8. Assessing performance
9. Enhancing retention and transfer

9.3.2 Learner Verification and Revision (LVR)

Learner Verification and Revision (LVR) consists of a three-stage approach (Dick and Carey, 1985). These stages are: one-to-one evaluation, small group evaluation, and field test (refer to Table 11).

One-to-one evaluation

The one-to-one evaluation occurs in the earlier phase of development (Dick and Carey, 1985). It serves to "identify and remove the most obvious errors in the instruction, as well as to obtain the initial student's reaction to the content" (p. 199). At least three students representative of the target population should be selected for this process: one with above average ability, another with average ability and a third with below average ability. In a one-to-one evaluation the student is exposed to the instructional materials as well as to all pre-tests, post-tests and embedded tests within the material. The one-to-one evaluation is an interactive process between student and evaluator. Data are collected through observation, interview, embedded tests, post-tests, and an attitude questionnaire. The data can either be for making on the spot revisions for minor problems or delayed revisions for more complex ones (Thiagarajan, 1978, see Table 11).

The one-to-one evaluation can enable the developer to uncover gross misconceptions in information processing. Once these misconceptions are uncovered, the material can be easily modified to address the problems.

Small group evaluation

The second stage of formative evaluation is conducted with a group of eight to twenty students representative of the target population (Dick and Carey, 1985). The small group evaluation has two main purposes: to validate modifications made to the material following the one-to-one evaluation, and to ascertain if the student can use the material without the help of the evaluator.

The term “small group” refers only to the number of students involved in the evaluation process. Small group evaluation does not imply that all students should be assembled in one location, and be evaluated all at once. In a small group evaluation, the students are provided with all instructional materials and tests. They are instructed to study the material at their own pace. The evaluator intercedes only if a major problem occurs prohibiting the student from proceeding without help. After interacting with the materials and tests, the students are given an attitude questionnaire in order to obtain their reactions. Data gathered during the small group evaluation are used to further refine the instructional material (Table 11).

Field test

The field test or summative developmental evaluation is designed to verify the effectiveness of previous verifications and revisions performed during earlier phases of evaluation. The field testing also helps to ascertain if the instructional material will function smoothly, and whether it will be accepted by students, teachers, and administrators in the intended setting (Dick and Carey, 1985). The focus of the evaluation is on the merit of the instructional product in terms of achievement, attitude, or study time.

Risk assessment

In spite of the importance of formative evaluation, research indicates that less than 1% of instructional products used in the US have been systematically evaluated. The costs and time required are two main deterrents to including formative evaluation in the instructional development process. A risk assessment can help to weigh the time and the costs constraints against the consequences of making an inappropriate decision when adopting a technology-based learning product.

Although most experts recommend a three-stage formative evaluation process (Geis et al., 1984), there is some empirical evidence in the literature (Wager, 1980, and Kandasawmy 1976) suggesting that small group evaluation can be eliminated without significantly affecting the overall effectiveness of the revised product.

Although the importance of formative evaluation is well evidenced in the literature, the state-of-the-art is still an underdeveloped, underconceptualized field of inquiry. There is a paucity of empirical foundations or rationales to support the guidelines and recommendations for the process. Research efforts are needed to improve and validate formative evaluation methodologies in current use, so as to give more credibility to the formative evaluation process.

In spite of these shortcomings formative evaluation works. Research indicates that instructional materials evaluated by even one learner is significantly more effective that the original unrevised version. Let us hope the educators will make more extensive use of formative evaluation so that the use of ICTs in TVET will not compromise previous commitments and progress made regarding education for all. Formative evaluation can assist us to identify and remove dispositional, institutional, situational, and informational barriers that could prevent some groups of people form participating in training designed for highly demanded, highly skilled, and highly paid occupations.

Figure 6: Framework for Assessing the Effectiveness/Efficiency of ICT Learning Materials

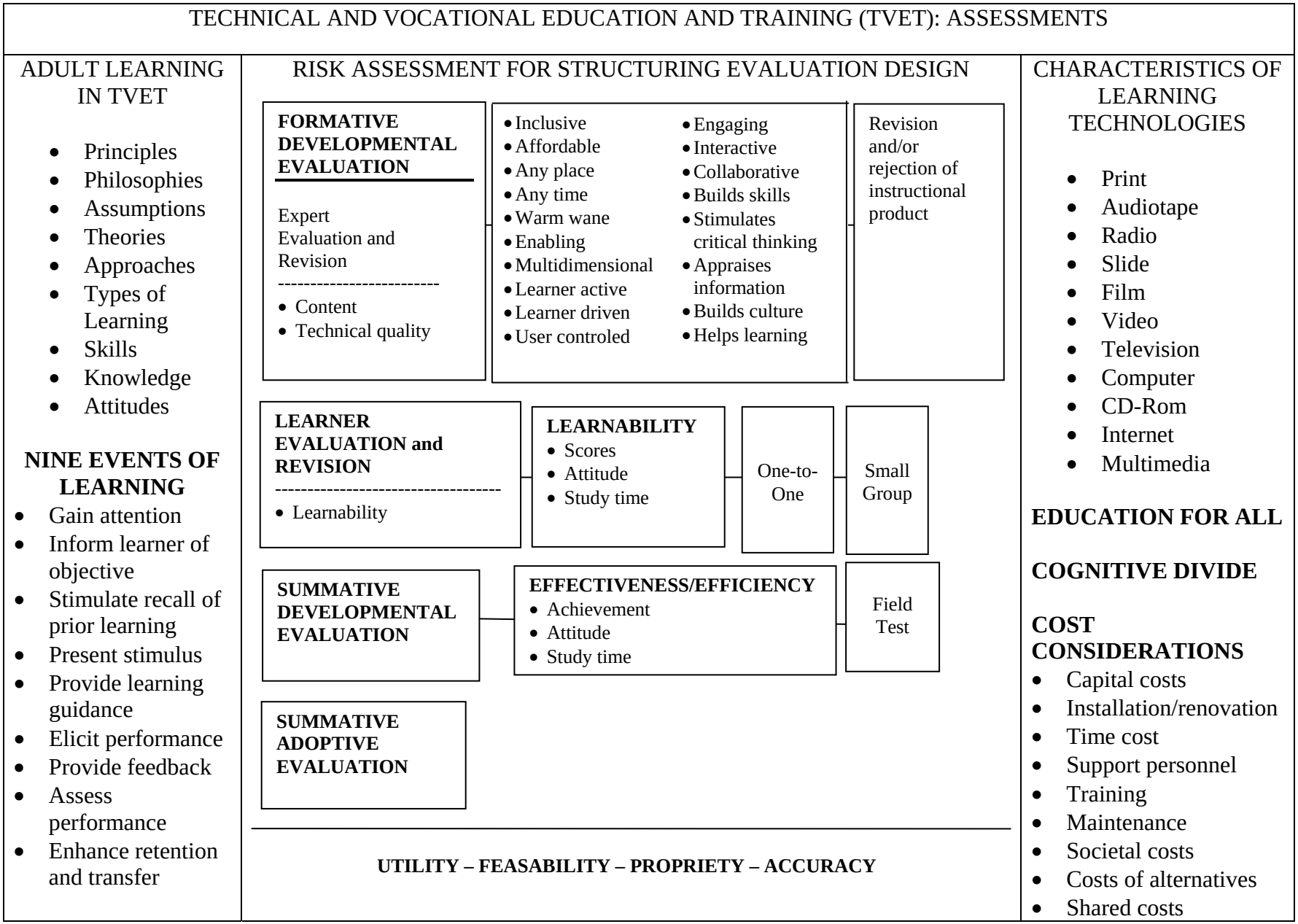


Table 11: Experts and Students' Evaluation of Prototypical Products

Data Source	Questions Asked	Methods of Collecting Data	Types of Data Collected	Data utilization
Expert Subject Matter Expert Language Expert Delivery Expert Pedagogical Expert Instructional Design Expert	Is content adequate, accurate, up-to-date, and relevant? Is reading level appropriate? Is delivery medium appropriate and cost-effective? Does it meet quality standard? Are objectives, content appropriate? Is the material appropriate for the target population? Were instructions designed according to systematic process and based o sound theories of learning?	Check list Panel discussions Interviews	Feedback information in form of: • Narrative reports • Completed checklist • Records of panel discussions Recommendations • Interview transcripts	Feasibility analysis for implementing recommendations. Modify material Discontinue if revision is too involved and/or costly
One-to-One Evaluation Select learners representative of population. Include: • Learners of high, medium, and low ability. • Males and females. • Young and inexperienced, and mature and experienced learners.	Is the material learnable? What are the most obvious errors, problems, and weaknesses within the material? What are the learners' reactions to the material? Are pre-, embedded and post-tests appropriate?	One-to-one learner/evaluator interaction. Think-aloud procedure. Learners' verbal feedback, body language. Observation, interviews. Unobtrusive measures. Reaction questionnaire. Pre-, embedded, and post-tests. Debriefing interview.	Think aloud protocols Comprehension Appeal Errors Problems Weaknesses Pre-, embedded and post-tests data	Analyse learners' feedback and make inferences for changes During each try-out implement minor revision on the spot and present modified version to learners for confirmation. After each try-out revise material on the basis of learners' feedback.
Small Group Evaluation Select 10 to 20 learners representative of target population Material is handed to test subjects. Evaluation intervenes only when test subjects need assistance.	How effective are changes made during one-to-one evaluation? Are there additional problems and errors in the material? Can learners achieve objectives? Were exercises, tests, and feedback appropriate and adequate?	Pre-, embedded and post-tests Observation Unobtrusive measures Attitude questionnaire Debriefing interview	Pre-, embedded and post-tests scores Observation records Interview data Learners' reactions Non-verbal data	Analyse learners' feedback data and make inferences for revisions Modify material on the basis of inferences made from learners' feedback data
Field Test Select one or more groups of learners (30 each) representative of the target population from urban and rural areas	Can learners achieve objectives when using material alone? Are previous revisions effective? Will material be accepted by learners, teachers, and administrators?	Evaluation of material in natural setting and context Pre-, embedded and post-tests Attitude questionnaire	Pre-, embedded and post-tests scores Reactions of learners, teachers, and administrators to material	Analysed feedback data and implement any additional revisions necessary to address new problems

9.4 Quality Standard for E-Learning in TVET

Although many TVET teachers embrace the use of ODL, many others are still uncomfortable with its quality. Proponents of quality in distance education do not agree on what constitutes a quality standard. Some strongly believe that the same quality standards used for classroom instruction can be applied to distance education, while others are convinced that specific standards must be developed for the accreditation of distance learning. Olson, Coyner and McCann (2000) stated: "While distance education has many characteristics that make it appealing to a wide audience, some of those same characteristics may provide challenges to providing evidence of quality" (p. 12). After reviewing accreditation concerns for distance education raised by accrediting agencies, government entities, professional organizations, and special interest groups, the authors concluded that many of these concerns have comparable themes, namely:

- Consistency with institutional mission,
- Curricular integrity,
- Resources,
- Faculty support,
- Student support,
- Student outcomes and programme evaluation, and
- Certification and accreditation.

Baker (2002) has developed the following quality guidelines for assessing the quality of e-learning in Canada. These quality guidelines are generic and are therefore broadly applicable to any area and level of education, including TVET. This material is reproduced in this document with the permission of the author.

Canadian Recommended E-learning Guidelines (CanREGs)

1. Quality Outcomes from E-Learning Products and Services

1.1. The student/learner will acquire content skills and knowledge that are:

1.1.1. relevant to employment and/or the best thinking in the field;

1.1.2. transferable between work and learning situations, i.e., employability, communication and technology skills;

1.1.3. specific enough to lead to work or further learning opportunities, i.e., content or technical knowledge.

1.2. The student/learner will acquire the learning skills necessary for:

1.2.1. successfully completing the course or programme, explicitly

- sources of information and retrieval processes;
- analytical and critical thinking;
- reading and writing skills in context;
- exam taking;

1.2.2. continued lifelong learning, including:

- a systematic introduction to the field of study;
- a comparative or contextual framework for viewing the field of study;
- generic or transferable skills;

1.2.3. self-directed learning management, through:

- creation of a portfolio of acquired skills and knowledge;
- awareness of personal gaps in skills and knowledge and relevant learning;
- opportunities;
- exercise of good judgement in making personal learning decisions;

1.2.4. effective and efficient use of Information and Communications Technologies, including:

- information retrieval skills and quality assessment tools;
- communicating through, e.g., e-mail and attachments, chatrooms;
- creating through word processing, spreadsheets and graphics;
- ethics of computer-assisted information access and use.

1.3. When finished, the student is awarded course credits or credentials that are:

1.3.1. recognized by a relevant professional accreditation body and by employers;
1.3.2. recognized by other education institutions – locally and internationally;
1.3.3. of the same value as on-site delivery;
1.3.4. transferable within programmes and institutions, and between provinces/territories and countries.

1.3. The learner experiences an adequate return on investment evidenced by:

1.4.1. course effectiveness, i.e., achievement of personal learning goals;
1.4.2. course efficiency, i.e., best use of student finances, time and energy;
1.4.3. satisfaction with processes and practices (see #2 below);
1.4.4. adequacy of producer/provider inputs/resources (see #3 below).

2. Quality Processes and Practices in E-Learning Products and Services

2.1. The management of students incorporates:

2.1.1. registration procedures that include:

- a clear statement of expectations of learners;
- an orientation programme/service for those desiring it, e.g., a demonstration course.

2.1.2. intake and placement procedures that provide:

- individualized programme / career counselling;
- assessment and recognition of prior learning;
- appropriate placement.

2.1.3. management of student records for:

- documentation of student achievement in each course and at completion of a programme;
- confidential treatment of records;
- student access to records;

2.1.4. assistance with the technologies being used, that is, with:

- the purpose of the technology(ies);
- the etiquette involved;
- the skills and knowledge required manipulating and interacting with the technologies being used.

2.2. The delivery and management of learning includes:

2.2.1. approaches to learning that:

- foster active learning;
- build on learner's strengths and acquired skills and knowledge;
- support interaction and the development of learning communities;
- increase learner control over time, place and pace of instruction;
- include assistive devices for persons with disabilities.

2.2.2. instructional strategies that:

- communicate expectations;
- provide prompt, constructive feedback to students;
- recognize the diversity of learners, learning needs, learning contexts, and modes of learning;
- incorporate an appropriate student-teacher ratio;
- deliberately use synchronous and/or asynchronous learning tools;

2.2.3. scheduling and timetabling that is:

- available as needed and when needed;
- flexible and responsive to learners;
- adequate and realistic.

2.2.4. assessment of learning that is:

- authentic, i.e., accurate representation of the contexts encountered in the field of study or in real-life tests faced by learners;
- against stated learning outcomes;
- frequent and timely;
- appropriate and responsive to the needs of the learners;
- in various forms such as written and oral assignments, self-assessment, demonstrations, portfolio assessment, and exams;
- competency-based;
- valid and reliable;
- conducted by trained assessors.

2.3. Technologies – computers and other ICTs – are appropriately used to:

2.3.1. engage and support learners;
2.3.2. accommodate and promote individualization;
2.3.3. create opportunities for students to do meaningful work;

2.3.4. increase proficiency at accessing, evaluating, and communicating information;
2.3.5. improve student abilities to solve complex problems;
2.3.6. nurture artistic expression;
2.3.7. enable active engagement in the construction of knowledge;
2.3.8. meet national and international standards for students with disabilities.

2.4. Communications facilities, processes, and practices provide:

2.4.1. contact between students and faculty, students and students, and the larger learning community;
2.4.2. flexible opportunities for interactions and problem-solving;
2.4.3. the opportunity for student collaboration;
2.4.4. the opportunity for students to interact with experts in the field.

3. Quality Inputs and Resources for E-Learning Products and Services

3.1. Intended learning outcomes are:

3.1.1. clearly stated;
3.1.2. relevant, that is, useful and appropriate for the intended learners;
3.1.3. observable/demonstrable;
3.1.4. measurable;
3.1.5. achievable and realistic;
3.1.6. appropriate to the rigor and breadth of the degree or certificate awarded;
3.1.7. consistent with the mandate of the provider.

3.2. Curriculum content is:

3.2.1. credible with sources identified;
3.2.2. accurate;
3.2.3. relevant;
3.2.4. balanced and free of bias;
3.2.5. updated consistently and routinely;
3.2.6. documented;
3.2.7. appropriate to the learning outcomes;
3.2.8. culturally sensitive;
3.2.9. consistent with current copyright laws in the jurisdiction of the provider.

3.3. Teaching/learning materials are:

3.3.1. prepared by qualified content experts (author identified) working with qualified design experts (identified);
3.3.2. readily available;
3.3.3. learner friendly;
3.3.4. interesting in content and layout;
3.3.5. well-organized;

3.3.6. free of cultural, racial, class, age, and gender bias;
3.3.7. accessible to those with disabilities;
3.3.8. free from errors;
3.3.9. adaptable to learner needs and abilities.

3.4. Product/service information for potential students is:

3.4.1. in writing;
3.4.2. clear;
3.4.3. current;
3.4.4. accurate;
3.4.5. comprehensive;
3.4.6. complete;
3.4.7. readily available.

3.5. Learning technologies are appropriate to:

3.5.1. the field of study or subject matter content and skills;
3.5.2. the intended learning outcomes;
3.5.3. the relevant characteristics and circumstances of the learner;
3.5.4. cost and benefit for the learner.

and are suitable for:

3.5.5. providing multiple representations of content;
3.5.6. enabling concept mapping within the learning environment;
3.5.7. making available real-world situations and simulations;
3.5.8. providing assistance, guidance, and communications to the learner.

3.6. Learning materials and delivery reflect sound technical design so that they are:

3.6.1. navigable;
3.6.2. easily updateable and frequently updated;
3.6.3. complemented by multimedia, rather than distracted by them;
3.6.4. inclusive of “live” links to relevant and previewed documents subject to copyright law;
3.6.5. reliable;
3.6.6. sensitive to bandwidth constraints of students;
3.6.7. compliant with current technology and ICT standards.

3.7. Appropriate and necessary personnel include:

3.7.1. instructors/teachers/professors with:

- recognized qualifications in the subject area;
- teaching experience at the relevant level (for example, secondary school, adult);
- relevant work experience and/or current knowledge in the field;
- appropriate skills for teaching online;

3.7.2. content support persons, such as:
- course/academic counselling;
- library staff;
- tutors and mentors;

3.7.3. process support persons, such as:
- technical support;
- learning skills support;
- career planning and employment counselling;
- problem-solving.

3.7.4. programme management accountable for:
- student management and students' rights;
- learning management;
- technology planning and utilization;
- recruitment and selection of appropriate personnel;
- planning and evaluation of all aspects of the product/service;
- responsiveness and flexibility to the student and to changing learning;
- requirements;
- maintaining links within the education and business communities;
- research and continuous improvement;
- financial viability and continuity.

3.8. Learning resources, in addition to teaching materials, are:

3.8.1. varied;
3.8.2. easily accessible;
3.8.3. copyright authorized;
3.8.4. relevant.

3.9. A complete learning package includes:

3.9.1. course description;
3.9.2. learning objectives;
3.9.3. assessment and completion requirements;
3.9.4. information about the instructor(s);
3.9.5. learning/lecture notes and additional learning resources;
3.9.6. course activities and assignments;
3.9.7. quizzes and examinations;
3.9.8. access to answers for questions/quizzes;
3.9.9. a framework for portfolio development.

3.10. The comprehensive course package (all materials and technologies) is:

3.10.1. appealing in appearance;
3.10.2. user-friendly;
3.10.3. customisable;

3.10.4. inclusive of all institutional services and activities (registration, payment, advising, tutorial assistance, library services);
3.10.5. complete;
3.10.6. reviewed and evaluated routinely.

3.11. Evidence of programme success seen through routine review and evaluation of:

3.11.1. course content and objectives;
3.11.2. learning materials;
3.11.3. instructional design;
3.11.4. instruction and instructors;
3.11.5. student learning and student achievement;
3.11.6. policies and management practices;
3.11.7. operational procedures;
3.11.8. customer satisfaction;
3.11.9. learner support services.

3.12. Programme plans and budget include:

3.12.1. written policies for all aspects of the course/programme;
3.12.2. an adequate budget to achieve stated programme goals;
3.12.3. enabling legislation (public education/private enterprise);
3.12.4. financial and administrative commitment to the continuation of a programme for a period sufficient to enable students to complete a degree/certificate;
3.12.5. integration of e-learning within the institution's overall policy framework;
3.12.6. a technology plan defining technical requirements and compatibility needed to support the learning activities;
3.12.7. security of systems to ensure the integrity and validity of information shared in the learning activities;
3.12.8. a requirement for ongoing professional staff development.

3.13. Advertising, recruiting and admissions information includes:

3.13.1. pre-requisites and entry requirements;
3.13.2. the curriculum overview;
3.13.3. specific delivery format;
3.13.4. course level and credit points;
3.13.5. course length and degree requirements;
3.13.6. types of assignments and grading methods;
3.13.7. learning assessment procedures and evaluation criteria;
3.13.8. all fees: registration, tuition, books and materials, equipment, other;
3.13.9. institutional regulations: residency requirements, workload requirements, extensions, grade appeals, withdrawals and refunds, costs and payment policies;
3.13.10. the nature of the faculty/student interaction;
3.13.11. entry-level technical competence and skills;
3.13.12. technical equipment requirements, and availability of rentals;

3.13.13. academic support services and learning resources;
3.13.14. technical support services;
3.13.15. programme success from evaluations;
3.13.16. financial aid resources.

Source: FuturEd Inc. Web site: www.FuturEd.com

9.5 Health and Safety Issues: Using ICTs in TVET

TVET educators are in general very safety conscious and they strive to eliminate all hazards associated with potentially hazardous equipment and materials in the training environments. The same safety consideration should be applied in the integration of ICTs in the learning environment. Although the safety issues regarding the use of ICTs may not appear as hazardous as working with high-speed woodworking machinery or high voltage current, there are still some critical health and safety concerns that must be addressed. Following is a brief review of the Health and Safety guidelines developed by the BECTA (2002) regarding the installation of ICTs in schools.

1. All electrical systems and equipment must be constructed and maintained in safe condition.
2. Power cables must be carried out in trunking that separates them from voice and data cables. Power cable should be secured and covered, and should never trail.
3. Provide a minimum of four power sockets for each workstation.
4. Provide power cutout switch and earth leakage circuit breaker at appropriate locations.
5. Use a cable management system when necessary.
6. The level of lighting recommended in ICT area is 300 – 500 lux to provide good contrast between screen and background environment. There should be adequate provisions for controlling glare and reflections.
7. Temperature should be maintained between 18-24 degrees Celcius.
8. Humidity level should be maintained between 40%–60%.
9. Provide good ventilation and heat extraction when necessary.
10. Flooring or carpet should be non-slip and anti-static.
11. Provide a minimum of 1,000 mm between workstations for one learner.
12. Provide adequate desk space for peripherals and paperwork at each workstation.
13. Allow at least 850 mm of clear space in front of computer table.
14. Allow at least 1,200 mm of aisle to allow wheelchair access.
15. Design workstation to meet needs of persons with disabilities.

16. In determining the height of the workstation the eye line should be level with the top of the monitor. The recommended height of workstations is 610-680 mm for secondary school learners and 730 mm for adult learners.
17. Use a variable height workstation if possible.
18. Work surface should be at least 800 mm deep. Allow between 450-750 mm form the monitor to the edge of the desk to enable learners to rest their arms and wrist on the desk when keyboarding.
19. Use height and tilt-adjustable chairs. Recommended chair heights for secondary school learners are between 370-420 mm and 450 mm for adult learners.
20. Use ceiling-mounted projectors whenever possible.
21. Teachers and learners must be made aware of the potential danger of staring directly into the projector's beam.
22. When using mobile equipment, trailing cables must be covered and secured.
23. Select lighter weight portable computers, 3 kg or less.
24. Wireless networks involve health risks associated with radiation. Some equipment are supplied with signs warning users to keep clear for at least two inches from a wireless LAN PC card and eight inches form a base station. These distances should be increased when using external antennas.
25. Training in using ICT learning equipment should include health and safety issues.

SECTION 10 INTERNATIONAL COOPERATION AND ICTs

To achieve TVET for All, more developed countries will need to help developing countries. This assistance is discussed in the framework of capacity building and the transfer of technology. The use of ICTs for combating HIV/AIDS that is responsible for the death of a significant number of TVET teachers and learners from developing countries is also discussed. Whenever appropriate, a case study is provided to support the discussion.

10.1 Capacity Building in Least Developed Countries.

The Director General of UNESCO promotes capacity building as a key strategy to expand the use of ICTs for teaching and learning in its Member States (UNESCO, 2002c). UNESCO has established the UNESCO Institute for Information Technologies in Education in Moscow to enable the organization to contribute more fully to the development of capacity building in the use of ICTs in education and training.

The UNESCO and ILO (2002) recommendation 98 has important implications with regards to the need for more developed countries to assist TVET practitioners from developing countries in using ICTs for teaching and learning:

Member States should encourage international cooperation with a view to capacity-building in developing countries, especially in the areas of acquisition, adaptation and application of technology, through:

- offering fellowship and exchange programme for teachers/trainers, students, and administrators/managers;
- establishing sustained cooperation between similar institutions in different countries, such as through twinning arrangements;
- providing work experience abroad, particularly when opportunities at home are limited;
- encouraging countries to present and make known their educational programmes outside their national boundaries (pp. 50–51).

CASE STUDY 34: Twinning UNEVOC Centres

UNEVOC Philippines (Western Visayas College of Science and Technology (*www.i-iloilo.com.ph/users/wcst*) and the UNEVOC centre of Canada, the National Centre for Workforce Development (Faculty of Education, University of Manitoba, *www.umanitoba.ca/unevoc)*.

UNEVOC Philippines and the National Centre for Workforce Development signed a Memorandum of Understanding confirming a mutual interest for institutional linkages and collaboration. The objectives of this agreement are as follows:

1. Improve flow of information
2. Share experience and problem solving ideas
3. Enhance international collaboration
4. Plan bilateral joint projects
5. **Develop web-based courses**
6. Conduct joint research
7. Host international interns

With funding assistance from the Canadian government's Human Resources Development Canada, the National Centre for Workforce Development has sponsored approximately 100 international interns in 20 countries. The purpose of the internship is to give unemployed and underemployed youth international experience to kick-start their career. The centre has sponsored four interns to the Philippines in collaboration with UNEVOC-Philippines.

10.2 Technology Transfer to Least Developed Countries.

With the revolution in the use of ICTs for teaching and learning, many developed countries are looking at open and distance education as an export commodity. This means countries are expecting a return on the investment made in their national education systems. While this appears to be good business practice, it is negating the ability of ICTs to reduce the knowledge gap and disparities between developed and developing countries. There is a need for more developed countries to assist developing countries in implementing the use ICTs in TVET. UNESCO and ILO (2002) acknowledged that international cooperation in TVET is critical "as a

means of narrowing disparities between North and South and as a bridge to a more prosperous and peaceful future" (p. 51). These UN organizations consider international cooperation a critical element for renovating and sustaining TVET systems. They recommend the use of ICTs for enhancing the sharing of intellectual property. UNESCO and ILO recommendations numbers 95 and 97 have implications regarding the use of ICTs in TVET.

Recommendation 95

There is a significant scope for countries to share their experience in technical and vocational education. There is a need for mutual cooperative assistance between countries, regardless of their state of development. Provision should be made at the national, regional, and international levels for regular exchanges that make use of contemporary information and communication technologies, other information, documentation, and materials obtained from research and development. In particular:

(a) publications concerning comparative education, psychological and pedagogical problems affecting general and technical and vocational education, and current trends
(b) information and documentation concerning curriculum development, methods and materials, study opportunities abroad, and employment opportunities, including human resource requirements, working conditions and social benefits
(c) ideas, innovations and new teaching/learning/training materials
(d) mass media programmes of an informational or pedagogical character (pp. 49–50).

Recommendation 97

The development of teaching and learning materials that use information and communication technologies and are suitable for international or regional use should become a priority. These materials should contribute to the progressive establishment and recognition of common standards for professional competencies/qualifications acquired through technical and vocational education. Moreover, such teaching and learning materials should encourage deliberate international collaborative teaching and learning among institutions (p. 50).

The recent decision of the Massachusetts Institute of Technology to make some of its courseware available on the Internet free of charge is perceived by developing countries as a very encouraging move. Professor Senteni from the University of Mauritius recently noted that a coordinated Open Courseware initiative would enable developing countries experiencing acute knowledge and skill gaps to catch up and leapfrog in many areas.

The goal of the Open Courseware concept is to provide educational resources that college and university faculties can adapt in accordance with their curricular and pedagogical requirements. These resources can include course descriptions, syllabus, calendar, lecture notes, demonstration, simulations, illustrations, learning objects, reading materials, assessments, and projects (UNESCO, 2002d).

At the conclusion of the Forum on the Impact of Open Courseware for Higher Education in Developing Countries, organized by UNESCO, the participants recommended developing the Open Educational Resources so that it will be available to all humanity. The case study that

follows describes two UNESCO initiative for facilitating the transfer of technology among its Member States, especially in developing countries.

CASE STUDY 35: UNEVOC Centre: UNESCO's International Centre for Technical and Vocational Education and Training, Bonn, Germany

The General Conference of UNESCO, at its 25th session in 1989, invited the Director-General of UNESCO to carry out a feasibility study on the establishment of an International Centre for Technical and Vocational Education to facilitate the development and improvement of TVET in UNESCO's Member States. Based on that feasibility study, which was completed early in 1991, the General Conference of UNESCO decided, at its 26th session in 1991, to launch the UNEVOC Centre, International Project on Technical and Vocational Education (UNEVOC).

The UNEVOC Project became operational in 1992. The objective of this project was to improve and strengthen the development of TVET in the Member States. UNEVOC was designed to address three programme areas:

- to contribute to the development of systems of technical and vocational education,
- to promote infrastructures in research, development, and planning, and
- to facilitate information and communication in these fields.

The UNEVOC Project was implemented collaboratively by UNESCO Headquarters, the Implementation Unit in Berlin and the major field offices: Regional Office for Education in Africa (BREDA), Regional Office for Education in the Arab States (UNEDBAS), Principal Regional Office for Asia and the Pacific (PROAP), and Regional Office for Education in Latin America and the Caribbean (OREALC). The implementation Unit also served as a hub of the UNEVOC Network that includes 206 UNEVOC Centres and Associate Centres located in some 130 countries. The project has achieved considerable success in assisting the Member States with improving their policy-making and institutional capacities by facilitating cooperation and information exchange.

The use of ICTs has contributed significantly to the success of the UNEVOC Centre. The Centre's Knowledge Management programme features documentation, clearing-house services, and dissemination of printed and digital information, as follows:

- **Forum (www.unevoc.de/forum)**
  The Centre manages the E-Forum, a worldwide e-mail list that comprises experts and stakeholders in TVET. It is regularly fed with information from participants for participants, facilitated by the Centre. The constant flow of information brings together those who know with those who need to know, be they Member States,

institutions, or individuals.

- **Publications (www.unevoc.de/publications)**
  The Centre also relies on more traditional forms of information sharing. It publishes books and monographs, conference proceedings, seminars, and workshops. These documents are available on the web and can also be requested in paper format or on CD-ROM.
- **Bulletin (www.unevoc.de/bulletin)**
  The UNESCO-UNEVOC bulletin is currently published in English, French, Arabic, and Spanish. Through its newsletter, the Centre communicates with individual experts and institutions on the field of TVET, across approximately 150 countries worldwide. Members of the UNEVOC Network are invited to contribute to the content of the newsletter
- **Web site (www.unevoc.de)**
  The web site offers information about TVET, the Centre's activities and its publications. It also serves as a means to disseminate information and knowledge related to innovation, idea s, and experience in technical and vocational education. For those without access to the Internet, an off-line version is available on CD-ROM.

At its 30th session in Paris, 26 October to 17 November 1999, the General Conference of UNESCO has adopted a resolution on the Establishment of an international long-term programme for the development of technical and vocational education. In that resolution, the General Conference has authorized the Director-General "...**to establish a UNESCO International Centre for Technical and Vocational Education and Training in Bonn, in close cooperation with ILO and other international partners in TVET**". This was officially launched in September 2000. This centre has a mandate to support UNESCO's long-term International Programme in TVET:

- Strengthening TVET as an integral component of lifelong learning,
- Orienting TVET for sustainable development,
- Providing TVET for all,
- Improving Member States' TVET policy-making capacity,
- Assisting Member States' institutional capacity building, and
- Enhancing international cooperation.

Source: UNESCO's International Centre for TVET, www.unevoc.de, January 2003.

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CASE STUDY 36: UNESCO Institute for Information Technologies in Education, Moscow, Russian Federation

The UNESCO Institute for Information Technologies in Education (IITE) is an autonomous Institute, forming an integral part of UNESCO. The mission of the UNESCO Institute for Information Technologies in Education is to strengthen the national capacities of UNESCO Member States for applying ICTs in education. This mission is accomplished using a three-prong approach: (1) conducting research related to ICT-mediated learning; (2) developing and delivering training programmes in ICT-mediated learning; and (3) maintaining a clearing house dedicated to ICT-mediated learning.

While accomplishing this mission during the period of the first IITE Medium-Term Strategy (2002–2007), the Institute assists UNESCO Member States in providing the following: an effective educational strategy, overcoming the digital knowledge divide between developing and developed countries and within them, and the creation of necessary conditions for their full value participation in the development of the evolving information society.

The UNESCO Institute for Information Technologies in Education hosted an international expert meeting in April 2002, to discuss the integration of ICTs in technical and vocational education and training. Report of this meeting: *Final Report and Selected Materials of the Expert Meeting on ICTs in TVET* is available on the IITE web site: http://www.iite.ru/iite/publications/

Following is list of recent IITE publications related to ICT-mediated learning that will be of interest to TVET stakeholders.

Analytical surveys:

- Distance Education for the Information Society: Policies, Pedagogy and Professional Development
- Information and Communication Technology in Special Education
- Current WWW Information Systems on Information Technologies in Education
- Digital Libraries in Education

Methodological and training materials:

- *Multimedia in Education.* Specialized training course. (International working

group headed by Prof. Andresen, Denmark)

- *ICTs in Distance Education.* Specialized training course. (International working group headed by Prof. Moore, USA)
- IITE High Level Seminar for Decision-Makers *Towards Policies for Integrating Information and Communication Technologies into Education.* Support materials for decision-makers
- *Internet in Education.* Support materials for educators (in printing 2003)
- *Guide and Instruction Book on Preparation of Educational Personnel for Distance Education (7 volumes) (in printing 2003)*

Other Materials

- Proceedings of the Second International UNESCO Congress on Education and Informatics
- Medium-Term Strategy of the UNESCO Institute for Information Technologies in Education for the years 2002–2007
- *Basic ICT Usage Indicators in Secondary Education in the Baltic and CIS States.* Statistical report
- *ICTs in Providing Quality Education for Information Society*
  Position paper (in printing 2003)
- *Distance Learning in the CIS Countries: Monitoring of Educational Needs and Perspectives*. Review (in printing 2003)

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10.3 Combating HIV in TVET Using ICTs

HIV/AIDS is devastating the education and training systems of many countries, especially those in Sub-Saharan Africa. The Main Working Document of the UNEVOC Workshop focused on Learning for Life, Work and the Future (2000) lists the following effects of the AIDs epidemic on education and training:

- Enrolment figures have declined as HIV/AIDS has spread. The overall demand for general education, technical and vocational education and tertiary education has dropped.
- The number of people dropping out of the education sector has increased.

- Pessimism about the value of education and training has spread as parents, expecting their children to die early, are thus are unwilling to spend their limited resources on education and training.
- Gains in gender equity in education and training sectors will be set back for various reasons.
- Disparities in access will grow as the impact of HIV/AIDS increases the number of marginalized young people: orphans, out-of-school and working youth in both formal and informal sectors.
- High morbidity and mortality of teachers, tutors, trainers, and administrators have severely affected the supply of education and training services in schools and vocational training institutions.
- Teaching time and quality are erratic in most affected countries as HIV/AIDS interferes with both tutor/teacher and student attendance (pp. 16–17).

Workshop participants concluded that the "impact of HIV/AIDS and the role of ICT in TVET systems are emerging as particular challenges which should be considered across all projects" (p. 17). Research supports the assumption that education can have a positive impact on HIV/AIDS (UNAIDS, 1997). UNESCO promotes preventive education in its fight against the HIV/AIDS pandemics (UNESCO, 2002e). The AIDS Education Global Information System (ÆGIS) suggested that ICTs can be used to foster the understanding and knowledge that will lead to better care, prevention, and a cure to the global AIDS pandemic (2002e). ÆGIS's initiative is illustrated in the following case study.

CASE STUDY 37: Using ICTs for HIV/AIDS Prevention

ÆGiS was established in 1990. Its mandate is to provide access to timely and accurate information about treatment advances, drug interactions, and other issues relating to HIV infection. Current estimates indicate that 40 million people on earth were living with HIV/AIDS.

ÆGiS utilizes a web site and an e-mail list server to deliver the information on HIV/AIDS. This network links 32,000 electronic bulletin boards from 66 countries.

CONCLUSIONS

There is a general consensus that human capital is the key ingredient for achieving and maintaining competitiveness in world trade. There is also a widespread acceptance among nations that the workforce must be carefully prepared and that employees' skill sets maintained continuously. This need for lifelong learning requires a flexible system of education and training. ICTs provide the flexibility to meet diverse learners' needs anytime, anywhere.

A wide variety of ICTs are now available for teaching and learning, ranging from simple printed materials to sophisticated Internet-based learning. The penetration of ICTs in education across UNESCO's Member States varies considerably and generally seems to be proportional to economic conditions. The digital divide between the haves and have-nots is a major issue. In the context of ICT-mediated instruction, the emphasis is placed on self-directed learning rather than teaching. Consequently, the ability to acquire, process, store, retrieve, and use information is becoming a critical element for successful learning. This condition is responsible for a cognitive divide, which is debilitating for people with limited cognitive skills.

TVET educators have always been early adopters of innovations related to ICT tools, equipment, and system controls. The same is true regarding the use of ICTs for supporting the delivery of TVET programmes. There is a paucity of information on the extent to which ICT-mediated learning is being integrated in TVET. While there are pockets of exemplary TVET programmes that have successfully implemented ICT-mediated learning in different parts of the world, Australia, Canada, and the United States appear to have reached a more advanced level of integration. There are many barriers that hinder the integration of ICTs into teaching and learning in TVET. The most significant are infrastructure, availability of suitable materials, job threat, appropriateness of the methods, and credibility of programme content. Although there are some anecdotal records of successful attempts regarding the use of ICTs for teaching affective and practical skills, there is no hard evidence in support of these claims.

Developmental testing must be an integral part of the development of all ICT-mediated instruction in order to ensure the efficiency and effectiveness of the product. Effectiveness can be viewed within a framework encapsulating three elements, namely achievement, study time, and attitude. Research attempting to assess the effectiveness of ICT-mediated learning is flawed and inconclusive. It is still very difficult, if not impossible, to establish the cost-effectiveness of ICT-mediated learning.

TVET teachers need to keep up to date in order to maintain their occupational literacy skills. Those involved in the integration of ICT-mediated learning need training in the pedagogical applications of ICTs for teaching and learning. Students also need a set of ICT literacy skills in order to succeed in ICT-mediated learning environments.

Counties with more advanced economies need to assist developing countries in establishing the necessary ICT infrastructure and capacity building in TVET. The open courseware initiative and public repository of learning objects must be encouraged to minimize the effects of the digital divide.

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