

CONTENTS

INDEX

TITLE	Page(s)
WORKPLACE ENVIRONMENT AND ITS IMPACT ON ORGANISATIONAL PERFORMANCE IN PUBLIC SECTOR ORGANISATIONS Dr. Amit kr. Jain, Dr. J.K Sharma	02
SERVICE QUALITY ASSESSMENT IN SELECTED HOSPITALS WITH SPECIAL REFERENCE TO KURUKSHETRA DISTRICT IN HARYANA Dr. Ranjeet Verma, Parmod Kumar Singhal, Mr. Sunil Kumar	23
PERSPECTIVE ON VALUE ORIENTED TEACHER EDUCATION IN INDIA Dr. Poonam Singh Kharwar	37
THE ROLE OF ICT IN HIGHER EDUCATION FOR THE 21ST CENTURY: ICT AS A CHANGE AGENT FOR EDUCATION Dr. Shivpal Singh, Mr.Rakesh Kumar Keshari	48
<p>पहाड़ी तथा मैदानी क्षेत्रों में निवास करने वाले स्नातक स्तर विद्यार्थियों के व्यक्तित्व का तुलनात्मक अध्ययन प्रो० बी० सी० दुबे ,वर्षा पन्त</p>	61
<p>स्नातक स्तर के ग्रामीण व शहरी विद्यार्थियों के सामाजिक कौशल समस्यात्मक व्यवहार का अध्ययन प्रो० भावेश चन्द्र दुबे , सोनम</p>	72

INTRODUCTION:

Information and communication technology (ICT) is a force that has changed many aspects of the way we live. If one was to compare such fields as medicine, tourism, travel, business, law, banking, engineering and architecture, the impact of ICT across the past two or three decades has been enormous. The way these fields operate today is vastly different from the ways they operated in the past. But when one looks at education, there seems to have been an uncanny lack of influence and far less change than other fields have experienced. A number of people have attempted to explore this lack of activity and influence (eg. Soloway and Prior, 1996; Collis, 2002) There have been a number of factors impeding the wholesale uptake of ICT in education across all sectors. These have included such factors as a lack of funding to support the purchase of the technology, a lack of training among established teaching practitioners, a lack of motivation and need among teachers to adopt ICT as teaching tools (Starr, 2001). But in recent times, factors have emerged which have strengthened and encouraged moves to adopt ICTs into classrooms and learning settings. These have included a growing need to explore efficiencies in terms of program delivery, the opportunities for flexible delivery provided by ICTs (eg. Oliver & Short, 1997); the capacity of technology to provide support for customized educational programs to meet the needs of individual learners (eg. Kennedy & McNaught, 1997); and the growing use of the Internet and WWW as tools for information access and communication (eg. Oliver & Towers, 1999). As we move into the 21st century, these factors and many others are bringing strong forces to bear on the adoption of ICTs in education and contemporary trends suggest we will soon see large scale changes in the way education is planned and delivered as a consequence of the opportunities and affordances of ICT. This paper seeks to explore the likely changes we will see in education as ICT acts as a powerful agent to change many of the educational practices to which we have become accustomed. In particular, the paper will explore the impact both current and emerging information and communication technologies will be likely to have in coming years on what is learned, when and where learning will take place and how the learning will occur.

THE IMPACT OF ICT ON WHAT IS LEARNED

Conventional teaching has emphasized content. For many years course have been written around textbooks. Teachers have taught through lectures and presentations interspersed with tutorials and learning activities designed to consolidate and rehearse the content. Contemporary settings are now favoring curricula that promote competency and performance. Curricula are starting to emphasis capabilities and to be concerned more with how the information will be used than with what the information is.

A. COMPETENCY AND PERFORMANCE-BASED CURRICULA

The moves to competency and performance-based curricula are well supported and encouraged by emerging instructional technologies (eg. Stephenson, 2001). Such curricula tend to require:

- access to a variety of information sources;
- access to a variety of information forms and types;
- student-centred learning settings based on information access and inquiry;
- learning environments centred on problem-centred and inquiry-based activities;
- authentic settings and examples; and teachers as coaches and mentors rather than content experts.

Contemporary ICTs are able to provide strong support for all these requirements and there are now many outstanding examples of world class settings for competency and performance-based

curricula that make sound use of the affordances of these technologies (eg. Oliver, 2000). For many years, teachers wishing to adopt such curricula have been limited by their resources and

tools but with the proliferation and widespread availability of contemporary ICTs, many restrictions and impediments of the past have been removed. And new technologies will continue to drive these forms of learning further. As students and

teachers gain access to higher bandwidths, more direct forms of communication and access to sharable resources, the capability to support these quality learning settings will continue to grow.

B. INFORMATION LITERACY

Another way in which emerging ICTs are impacting on the content of education curricula stems

from the ways in which ICTs are dominating so much of contemporary life and work.

Already

there has emerged a need for educational institutions to ensure that graduates are able to display

appropriate levels of information literacy, “the capacity to identify and issue and then to identify,

locate and evaluate relevant information in order to engage with it or to solve a problem arising

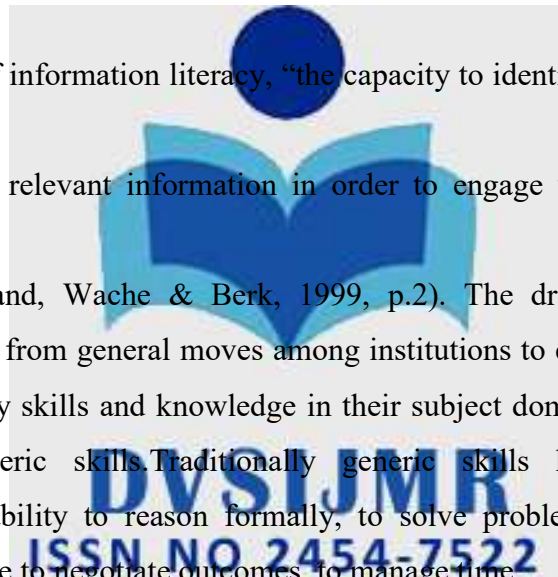
from it” (McCausland, Wache & Berk, 1999, p.2). The drive to promote such developments stems from general moves among institutions to ensure their graduates demonstrate not only skills and knowledge in their subject domains but also general attributes and generic skills. Traditionally generic skills have involved such capabilities as an ability to reason formally, to solve problems, to communicate effectively, to be able to negotiate outcomes, to manage time,

project management, and collaboration and teamwork skills. The growing use of ICTs as tools of

every day life have seen the pool of generic skills expanded in recent years to include information literacy and it is highly probable that future developments and technology applications will see this set of skills growing even more.

THE IMPACT OF ICT ON HOW STUDENTS LEARN

Just as technology is influencing and supporting what is being learned in schools and universities, so too is it supporting changes to the way students are learning. Moves from content-centred curricula to competency-based curricula are associated with



moves away from teacher-centred forms of delivery to student-centred forms. Through technology-facilitated approaches, contemporary learning settings now encourage students to take responsibility for their own learning. In the past students have become very comfortable to learning through transmissive modes. Students have been trained to let others present to them the information that forms the curriculum. The growing use of ICT as an instructional medium is changing and will likely continue to change many of the strategies employed by both teachers and students in the learning process. The following sections describe particular forms of learning that are gaining prominence in universities and schools worldwide.

A. STUDENT-CENTRED LEARNING

Technology has the capacity to promote and encourage the transformation of education from a very teacher directed enterprise to one which supports more student-centred models. Evidence of this today is manifested in: The proliferation of capability, competency and outcomes focused curricula Moves towards problem-based learning Increased use of the Web as an information source, Internet users are able to choose the experts from whom they will learn The use of ICT in educational settings, by itself acts as a catalyst for change in this domain. ICTs by their very nature are tools that encourage and support independent learning. Students using ICTs for learning purposes become immersed in the process of learning and as more and more students use computers as information sources and cognitive tools (eg. Reeves & Jonassen,1996), the influence of the technology on supporting how students learn will continue to increase.

B. SUPPORTING KNOWLEDGE CONSTRUCTION

The emergence of ICTs as learning technologies has coincided with a growing awareness and recognition of alternative theories for learning. The theories of learning that hold the greatest way today are those based on constructivist principles (eg. Duffy & Cunningham, 1996). These principles posit that learning is achieved by the active construction of knowledge supported by various perspectives within meaningful contexts. In constructivist theories, social interactions are seen to play a

critical role in the processes of learning and cognition (eg. Vygotsky, 1978). In the past, the conventional process of teaching has revolved around teachers planning and leading students through a series of instructional sequences to achieve a desired learning outcome. Typically these forms of teaching have revolved around the planned transmission of a body of knowledge followed by some forms of interaction with the content as a means to consolidate the knowledge acquisition. Contemporary learning theory is based on the notion that learning is an active process of constructing knowledge rather than acquiring knowledge and that instruction is the process by which this knowledge construction is supported rather than a process of knowledge transmission (Duffy & Cunningham, 1996). The strengths of constructivism lie in its emphasis on learning as a process of personal understanding and the development of meaning in ways which are active and interpretative. In this domain learning is viewed as the construction of meaning rather than as the memorisation of facts (eg. Lebow, 1993; Jonassen & Reeves, 1996). Learning approaches using contemporary ICTs provide many opportunities for constructivist learning through their provision and support for resource-based, student centered settings and by enabling learning to be related to context and to practice (eg. Berge, 1998; Barron, 1998). As mentioned previously, any use of ICT in learning settings can act to support various aspects of knowledge construction and as more and more students employ ICTs in their learning processes, the more pronounced the impact of this will become.

THE IMPACT OF ICT ON WHEN AND WHERE STUDENTS LEARN

In the past educational institutions have provided little choice for students in terms of the method and manner in which programs have been delivered. Students have typically been forced to accept what has been delivered and institutions have tended to be quite staid and traditional in terms of the delivery of their programs. ICT applications provide many options and choices and many institutions are now creating competitive edges for themselves through the choices they are offering

students. These choices extend from when students can choose to learn to where they they learn.

A. ANY PLACE LEARNING

The concept of flexibility in the delivery place of educational programs is not new (eg. Moore &

Kearsley, 1996). Educational institutions have been offering programs at a distance for many years and there has been a vast amount of research and development associated with establishing

effective practices and procedures in off-campus teaching and learning. Use of the technology, however, has extended the scope of this activity and whereas previously off-campus delivery was

an option for students who were unable to attend campuses, today, many more students are able

to make this choice through technology-facilitated learning settings. The scope and extent of this

activity is demonstrated in some of the examples below.

- In many instances traditional classroom learning has given way to learning in work-based settings with students able to access courses and programs from their workplace. The advantages of education and training at the point of need relate not only to convenience but include cost savings associated with travel and time away from work, and also situation and application of the learning activities within relevant and meaningful contexts.
- The communications capabilities of modern technologies provide opportunities for many learners to enroll in courses offered by external institutions rather than those situated locally. These opportunities provide such advantages as extended course offerings and eclectic class cohorts comprised of students of differing backgrounds, cultures and perspectives.
- The freedoms of choice provided by programs that can be accessed at any place are also supporting the delivery of programs with units and courses from a variety of institutions, There are now countless ways for students completing undergraduate

degrees for example, to study units for a single degree, through a number of different institutions, an activity that provides considerable diversity and choice for students in the programs they complete.

B. ANYTIME LEARNING

In concert with geographical flexibility, technology-facilitated educational programs also remove

many of the temporal constraints that face learners with special needs (eg. Moore & Kearsley,1996). Students are starting to appreciate the capability to undertake education anywhere, anytime and any place. This flexibility has heightened the availability of just-in-time learning and provided learning opportunities for many more learners who previously were constrained by other commitments (eg. Young, 2002).

- Through online technologies learning has become an activity that is no longer set within programmed schedules and slots. Learners are free to participate in learning activities when time permits and these freedoms have greatly increased the opportunities for many students to participate in formal programs.
- The wide variety of technologies that support learning are able to provide asynchronous supports for learning so that the need for real-time participation can be avoided while the advantages of communication and collaboration with other learners is retained.
- As well as learning at anytime, teachers are also finding the capabilities of teaching at any time to be opportunistic and able to be used to advantage. Mobile technologies and seamless communications technologies support 24x7 teaching and learning. Choosing how much time will be used within the 24x7 envelope and what periods of time are challenges that will face the educators of the future (eg. Young, 2002).

The continued and increased use of ICTs in education in years to come, will serve to increase the

temporal and geographical opportunities that are currently experienced. Advancements in learning opportunities tend to be held back by the ICT capabilities of the lowest common denominator, namely the students with the least access to ICT. As ICT access increases among students so too will these opportunities.

EMERGING ISSUES

A number of other issues have emerged from the uptake of technology whose impacts have yet to be fully explored. These include changes to the makeup of the teacher pool, changes to the profile of who are the learners in our courses and paramount in all of this, changes in the costing and economics of course delivery.

A. EXPANDING THE POOL OF TEACHERS

In the past, the role of teacher in an educational institution was a role given to only highly qualified people. With technology-facilitated learning, there are now opportunities to extend the teaching pool beyond this specialist set to include many more people. The changing role of the teacher has seen increased opportunities for others to participate in the process including workplace trainers, mentors, specialists from the workplace and others. Through the affordances and capabilities of technology, today we have a much expanded pool of teachers with varying roles able to provide support for learners in a variety of flexible settings. This trend seems set to continue and to grow with new ICT developments and applications. And within this changed pool of teachers will come changed responsibilities and skill sets for future teaching involving high levels of ICT and the need for more facilitative than didactic teaching roles (eg. Littlejohn et al., 2002).

B. EXPANDING THE POOL OF STUDENTS

In the past, education has been a privilege and an opportunity that often was unavailable to many students whose situation did not fit the mainstream. Through the flexibilities provided by technology, many students who previously were unable to participate in educational activities are

now finding opportunities to do so. The pool of students is changing and will continue to change

as more and more people who have a need for education and training are able to take advantage

of the increased opportunities. Interesting opportunities are now being observed among, for example, school students studying university courses to overcome limitations in their school programs and workers undertaking courses from their desktops.

C. THE COST OF EDUCATION

Traditional thinking has always been that technology-facilitated learning would provide economies and efficiencies that would see significant reductions in the costs associated with the delivery of educational programs. The costs would come from the ability to create courses with fixed establishment costs, for example technology-based courses, and for which there would be

savings in delivery through large scale uptake. We have already seen a number of virtual universities built around technology delivery alone (eg. Jones International University, www.jiu.edu). The reality is that few institutions have been able to realize these aims for economy. There appear to have been many underestimated costs in such areas as course development and course delivery.

The costs associated with the development of high quality technology-facilitated learning materials are quite high. It has found to be more than a matter of repackaging existing materials and large scale reengineering has been found to be necessary with large scale costs. Likewise costs associated with delivery have not been found to diminish as expected. The main reason for

this has been the need to maintain a relatively stable student to staff ratio and the expectation of students that they will have access to teachers in their courses and programs. Compared to traditional forms of off-campus learning, technology-facilitated learning has proven to be quite expensive in all areas of consideration, infrastructure, course development and course delivery. We may have to brace

ourselves for the advantages and affordances which will improve the quality of education in the near future to also increase components of the cost.

STAKEHOLDERS AND INFLUENCES

The ideas that have been discussed in this paper suggest that while ICTs may not have had a large impact to date, their use will grow to play a significant role in many aspects of the design, development and delivery of educational programs in the coming years. The various influences that have been discussed provide examples of an agent that has the capacity to influence education at all levels and hence to be an agent supporting and encouraging considerable change. When the future of education is considered in this way, it is interesting to speculate among the stakeholders, for whom the change will be the greatest. Table 1 lists the principal stakeholders and suggests how the various issues discussed in the paper might influence each. Clearly the stakeholders for whom technology would seem to proffer the most influence and change are the

students. So while institutions are pondering how they will be influenced in years to come, whatever the outcomes, the beneficiaries of the activity and change will be the students. This would seem to be the outcome everyone would want to see.

Table 1: The influence of ICT on education and its stakeholders

	What is learned and how much	How it is learned	When it is learned	From whom it is learned	Who is learning	What it costs
Students	x	x	x	x	x	x
Employers			x	x		
Teachers	x	x	x	x		
Institutions	x		x	x		x
Government	x	x	x	x	x	x

SUMMARY AND CONCLUSIONS

This paper has sought to explore the role of ICT in education as we progress into the 21st century. In particular the paper has argued that ICTs have impacted on educational practice in education to date in quite small ways but that the impact will grow considerably in years to come and that ICT will become a strong agent for change among many educational practices. Extrapolating current activities and practices, the continued use and development of ICTs within education will have a strong impact on:

- What is learned;
- How it is learned;
- When and where learning takes place;
- Who is learning and who is teaching.

The upshot of all this activity is that we should see marked improvements in many areas of educational endeavour. Learning should become more relevant to stakeholders' needs, learning outcomes should become more deliberate and targeted, and learning opportunities should diversity in what is learned and who is learning. At the same time, quality of programs as measured by fitness for purpose should continue to grow as stakeholder groups find the offerings matched to their needs and expectations.

To ensure that the opportunities and advantages are realized, it will be important as it is in every other walk of life to ensure that the educational research and development dollar is sustained so that education at large can learn from within and that experiences and activities in different institutions and sectors can inform and guide others without the continual need for re-invention of the wheel. Once again ICTs serve to provide the means for much of this activity to realize the potential it holds.

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