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Literature review: Technological Innovation in Higher Education

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Literature review: Technological Innovation in Higher Education

Some theorists postulate that the innovative kinds of teaching and learning empowered by emerging technologies could transform distance education into distributed learning. They further claim that high-performance computing and communications will make knowledge utilities, virtual communities, shared synthetic environments and sensory immersion commonplace (Drucker, 1985, Dede, 1997).

The rapid development of Information and Communication Technology (ICT) has changed the scene of higher education. All organizations are in the period of transformation including Universities with information technology acting as both a catalyst and an instrument of change. ICT has changed the source and mode of delivery of knowledge. The use of latest ICT benefits the education system in achieving its goals by providing two-way communication in an effective manner. Technology innovation is an established field of study, but as yet limited literature is available on innovation in higher education context.

The annual report 2003 of UGC recommend that modern Information Communication technology (ICT) based syllabus should be included in the university education. The report said “moreover, the UGC's activities should not be confined to only grant activities but the UGC should also work for the development of ICT curriculum of the University” UGC and NCTE are making very organized efforts to deploy new technology for ensuring quality higher education for all and promote excellence.

Business, more than government, is instituting the changes in education that are required for the emerging knowledge-based economy. The reason is provided by Cairncross (1997:118), who states "the Internet has become the most powerful driver for innovation that the world has ever seen. Because of its open, flexible protocol, thousands of small companies, founded by the best-educated group of entrepreneurs ever to blitz a business, are making (or, periodically, losing) huge sums of money developing new ways of using the Internet". Especially public providers of education are lagging behind the transformation in learning that is evolving outside them (Ives & Jarvenpaa, 1996, Gates, 1996, Violino, 1997:70). According to these authors, over the next few decades the private sector could eclipse the public sector as the predominant educational institution. Businesses are moving into the educational market, especially in commerce and information technology by offering life-long in-service training to employees, thereby capturing a market segment previously held by higher education.
Institutions. In addition, massification of education and the shift in education and training to lifelong learning demand different approaches to teaching and learning from what is found in traditional universities. In-house programs provide tailored instruction at times and places convenient to the customer. Businesses have adopted customer-oriented strategies whereas educational institutions do not yet regard students as customers or clients.

In a survey on Desktop Computing and Information Technology in American Higher Education, Green (2000:2) identifies instructional integration as a core concern facing American colleges and universities. Green remarks that the results confirm the transition of information technology from the unique to the ubiquitous and that increasingly there will be a demand for technology innovation in American higher education. Due to the global impact of technology on society as a whole, the same could be said of all higher education institutions around the world.

3.1 Virtual Education

Over the past five years the term Virtual has proliferated to describe the range of technologies applied in higher education institutions. It is used interchangeably with other labels such as 'open and distance learning', 'resource-based learning', 'distributed learning', 'distance education' and 'flexible learning'. Currently, the term most used is 'electronic' as is evident in the concepts of e-education, e-commerce, e-business and e-governance. Similarly the term 'digital' is increasingly popular in this context.

Collis and Moonen (2001:32-33) have a specific view of the term 'virtual':

"Virtual as a vision that anyone, anywhere, can experience the services and products of the university, while remaining at home or at work".

"Virtual as a way of describing how the traditional university can gradually move to be more flexible in the options it offers to students in terms of how, when and where they complete certain course requirements".

"Virtual as a way of describing how the resources and experiences available within the traditional university are being broadened for those within the university".

"Virtual as a way to describe consortia".

"Virtual in terms of a specific informational environment, such a portals, by which learners interact in a virtual learning environment".

Duderstadt notes that the increasingly sophisticated labour market of a knowledge-driven economy is driving new needs for advanced education and training (2000:14).
It could safely be assumed that hundreds of virtual universities have emerged and that these numbers continue to grow.

3.2 Product innovation

In the borderless competitive environment that is discussed in the introduction, the attainment of a competitive advantage will be appropriated through price, quality and access of services and products (Duderstadt, 1999:12). Consequently, new rules are set for the way we do business. It is fundamentally changing many of the rules of competitiveness. Organisations that are positioned to rapidly act and respond to changes will have the competitive advantage. This is endorsed by Nadler and Tushman (1999:97) in their contention that "the organisation's capacity to understand its environment and to make the right kinds of strategic changes at the appropriate point in the cycle will determine its competitive strength".

Leadbeater (2000:112) claims "In some respects universities are models for the new economy, particularly the way they encourage research, experimentation and knowledge-creation by autonomous, self-managing researchers and knowledge workers". He warns though that universities lack entrepreneurial spirit and are "too slow-moving and resistant to change". Slow to change, universities have revolved around a model born in the Middle Ages and solidified by the German research university concept at the turn of the century (Hitch, 2000:21).

With the emergence of a commodity market, virtual universities will unbundle marketing and delivery of services and customised products to users. The most common applications of ICT are found in administration, support services and materials development and distribution (Farrell, 1999:3).

The move to digital technologies has given rise to new learning enterprises. Barone and Luker (2000:10) note that familiar business models in universities will no longer apply as the roles of producer and consumer shift and evolve. Especially the private sector is capitalising on the technology revolution. An example is the company-owned British Aerospace Virtual University, which has 47 000 students (employees) who access courses offered by the University (Gibbons, 1998:49).

However, the crucial role of universities remains that of the interface with learners in the learning process. Although universities are becoming more like businesses, they are not simply selling products, but have to be the leaders in learning facilitation.

Especially telephone and Internet technologies have grown exponentially and are impacting on higher education. Projections were made that the global Internet user population will exceed 140 million by 2001 (McNee, 1999:3).
Dede (1990:247) makes the point that "Given the rapidly evolving implementation of information technologies, all students will need skills in online interaction and collaboration". Twigg & Oblinger (1996:3) support this by stating that proficiency in using technology is a required competency in the work place. The implication is that higher education institutions need to equip their learners with computer skills because they need these to be competitive in the market place.

A poignant statement is made by Norman and Spohrer (1996:24):

"A revolution is taking place in education, one that deals with the philosophy of how one teaches, of the relationship between teacher and student, of the way in which a classroom is structured, and the nature of the curriculum. At the heart is a powerful pedagogy, one that's been developing over the past 100 years. It embraces social issues, the culture of the classroom, lifelong learning concerns, and technology".

This trend suggests a shift in the primary location of higher education on campus to more flexible, learner-selected options such as home and the work place. A way to accomplish this is through product innovation, i.e. to redesign courses and use technology.

According to Green (2001:36) "the most significant technology challenges ahead for higher education involve questions about the instructional mission - across all sectors of the academic enterprise". In other words, universities have to consider how they need to change their product offering in order to remain competitive.

The response of learners to these changes should be accounted for. They are accustomed to a passive role in which lecturers are paid to teach. In reaction to the use of digital technology in the learning environment, Barone and Luiker (2000:10) remark that "students wonder if faculty are really teaching them if most of their learning appears to take place independently, from learningware accessed via the network". The concern about this statement is the tendency to provide syllabi and content online without an accompanying strategy to facilitate learning.

With the use of computer communication systems for educational delivery and interaction, web-based education is growing rapidly as a field of practice. Driscoll (1998:9) warns that web-based instruction is not simply a new format for instructor-led or self-paced instruction and that merely 'changing the format' tends to result in passive programmes that frustrate learners.

A critical challenge to universities will be to identify their role in disintermediation -information technology sometimes replaces the 'middle man' - and to identify 'those transactions' where humans are 'in the middle' as opposed to those in which they add
value" (Oblinger, 1999:24). This is reminiscent of the factor of cost of producer learning mentioned earlier. In an educational context it means that lecturers would need to add value to the learning process and not simply act as yet another source of knowledge or information. The way in which they facilitate the learning process, doing so increasingly via various technologies; will aid competitiveness. As a consequence of the impact of technology, the new role of the lecturer has become a concern.

Leadbeater (2000:113) contends that universities and academics will become increasingly segmented. The elite will be involved in the 'knowledge-creation'.

Business of research and experimentation; the mass will be involved in the 'knowledge management' business of delivering degree modules. He does not indicate the way in which this will be accomplished. As technology has become a primary means of delivery, it implies that the latter segment of lecturers would have to be skilled in the use of various technologies to facilitate learning. It could be debated whether these roles would be simply value-adding transactions or whether the lecturer-student interaction could be considered as that of being 'in the middle'. Duderstadt (1999:9) indicates that an emerging trend is that of three roles of what was previously packaged into one: that of the lecturer. These roles are content providers, celebrities and learning facilitators. He argues that constraints will make it impossible for one person to fulfil all these roles and remain competent in other responsibilities such as research and administration. Oblinger (1999:24) speaks of the 'unbundling' of traditional tasks. A lecturer might choose which functions to perform, based on aptitude or on those functions in highest demand by the university. Hence she postulates that the current value chain of content generation, courseware production, assessment and research could be dispersed among various individuals or even companies or different institutions. Although it seems to be a feasible solution, successful orchestration of the value chain across functional providers would pose the highest risk. If coordination is not adequate, the learner will experience a fragmented service offering.

3.3 Services Innovation

Disintermediation has a profound impact on existing structures. Distant learners assume that payment and registration can occur online and that online digital library privileges exist. There are many examples of universities that have web-enabled student administration systems to deal with student enquiries. Some higher education institutions are finding that almost sixty percent of student enquiries related to student services can be handled without human intervention (Twigg & Oblinger, 1996:4). Most universities have not redesigned their business processes to suit the needs of students. Unfortunately administrative functions such as admissions, financial aid, and registration processes are mostly set up for the
convenience of the institution, with minimal regard for the needs of the consumer (Twigg & Oblinger, 1996:4).

3.4 A new management model: Process innovation

As a result of rapid changes in technology and the explosion of information and knowledge, employees require re-skilling more often. According to Twigg and Oblinger (1996:3) the average worker can have up to seven careers. Consequently, lifelong learners make greater demands in terms of educational access and flexibility. Most cannot afford to leave their jobs for lengthy periods in order to further their qualifications. Moreover, school leavers increasingly opt to find work first and then further their qualifications whilst working. Many underestimate the rise in expectations that working students bring with them. As paying clients they are no longer in awe of professors or of rigid structures and processes that do not provide excellent service. They expect quality products and services. Policy makers are concerned whether the salaries spent on duplicative administrative and student services add value to the educational experience (Twigg & Oblinger, 1996:8). Hence higher education institutions need to adapt their processes to support and sustain new products and services.

Adults are exposed to a rapidly changing and complex work environment in which they have to be re-skilled continuously. Without the time available to study full-time at a residential university, flexible learning opportunities have become non-negotiable. Increasing costs, decreasing public funding and a growing population, half of which are adults from diverse socio-economic backgrounds, are causing an increasing market niche for just-in time and just for you (non degree continuing education) instructional offerings. Yet students continue to attach value to formal programme offerings, such as three-year degrees. Perceptions of status and quality associated with degree programmes could be the reason why many still consider short courses to be of less value.

Duderstadt (1999:4) states "Adult learners look for access, customised curricula, flexible delivery and responsiveness to needs". The growing demand for flexible education and training cannot be met by existing management models. Johnson (1997) poses that traditional universities will continue to cater for highly motivated, academic learners, with emphasis on advanced research. Alternative institutions, on the other hand, will focus on non-university, corporate and continuing forms of higher education. Yet, even if this is the case, traditional universities cannot afford to ignore the impact of the knowledge economy, digital technology and the needs of their learners. Teaching and learning models of the future assume universal access to the network (Internet) and will require a new pedagogy (Barone and Luker, 2000:6). New business processes will be required to enable and support this.
Education and advances in technology have become at least as important as capital in contributing to economic growth (Cole, 1998:16). The nature and degree of exposure of employees to lifelong learning and education has led to the term 'knowledge workers'. Academic institutions have essential roles to play in the knowledge economy to serve as sources of knowledge creation and as training ground for knowledge workers (Cohen, 1998:37). Graduates are viewed as the most important asset of universities and concomitantly, a research environment that retains faculty is essential.

Questions about accreditation, standards, intellectual property and articulation have remained mostly unanswered to date and need to be answered to adapt to the new environment. Stallings (2000:3) paints a scenario called 'Dystopian' in which this confusion leads to a quagmire of courses and courses without human presence in which, in the absence of standards and leadership, a dominant model emerges from a body of accredited learning corporations. The researcher is of the opinion that continued regulation of higher education institutions will prevent this scenario from materialising. It will be more difficult to prescribe standards to private providers. The South African Qualifications Authority (SAQA) is an example of a regulating body that attempts to regulate all providers of education and training. The 'Utopian' scenario, similar to the Edujazz scenario by Page-Shipp et al. (2000) sees a growth industry of "performance-enhanced software [that] energises a generation of virtual educators and trainers who become globally recognised... Computer-based instruction increasingly applies artificial intelligence techniques, driving the quality of instructor-mediated courses higher".

According to Twigg and Oblinger (1996:9) a scenario for higher education institutions in 2007 could be characterised by the following:

- Fewer institutions.
- Flexible learning opportunities.
- More for-profit educational enterprises.
- Greater global institutional competition.
- Provision of credit banks and credentialing services by public learning agencies (accreditation bodies).
- Institutions positioned as either content providers or learning brokers.
They state that many companies in the States are dissatisfied with the level of competence of the nation's graduates and that "they are becoming less interested in degrees and more interested in certification of competencies" (Twigg & Oblinger, 1996:10).

In the debate about how higher education must position itself to respond to the needs of 21st century learners, two distinct points dominate:

3.4.1 Pro-traditional higher education

This side argues that there is more to education than providing job-related skills. Unlike training providers, universities also provide guidance, structure and organisation for those students who are uncertain about what they need. This view is contentious, as technical and college institutions could claim to do the same.

3.4.2 Non-traditional higher education

Others contend that education rooted in tradition has become less relevant. External forces, including student needs, market demands and the advancement of communications technologies have decreased the 18-22 year old residential student market. Just-in-time education will become sought after.

Duderstadt (2000:17) points out that only 17 percent of students enrolled in American colleges are in the 18-22 year old group.

3.5 Flexible learning: process, product and service innovation

The use of technology in education has been prevalent since the sixties and has been utilised in especially distance education for decades.

Taylor, as cited by McLendon & Cronk (1999:1-2), outlines four generations of distance education delivery, as indicated in Table 3.1.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Associated delivery technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Correspondence model</td>
<td>Print</td>
</tr>
<tr>
<td>II. Multimedia model</td>
<td>Print, audiotape, videotape, computer-based learning, interactive video.</td>
</tr>
<tr>
<td>III. Telelearning model</td>
<td>Audio teleconferencing, videoconferencing, audiographic communication, broadcast TV/radio and audio teleconferencing.</td>
</tr>
<tr>
<td>IV. Flexible learning model</td>
<td>Interactive multimedia, Internet-based access to WWW resources, computer mediated communication.</td>
</tr>
</tbody>
</table>

Table 3.1: Four generations of distance education delivery (McLendon & Cronk, 1999:2)
Distance education is a greatly misunderstood area in the field of education (Roy, 1997:12). If distance learning is a concept so widely misconstrued, how much more so the concept of open learning or, for that matter, flexible learning. Distance education is often thought of as correspondence education. In many countries the terms are used interchangeably, i.e. distributed learning, blended learning, flexible learning, e-learning, online learning and distance learning. Distance education has been described as teaching and learning through the print or electronic communications media, in a place or time different from that of the facilitator/lecturer (Moore & Kearsley, 1996). This would therefore dispel the myth that distance education is education by correspondence per se. A brief review of its growth shows that distance education has evolved through a number of different stages, or generations and could be considered to be an example of incremental innovation. The first generation was correspondence study, where printed media in the form of study guides was sent by mail to students. The addition of tape recordings further enhanced it (Roy, 1997:12).

The founding of the British Open University (OU) in 1969 and other Open Universities in the early 1970s heralded the second generation of distance education (Moore & Kearsley, 1996). Now, in the 1990s, some 30 distance teaching universities are active in various parts of the world and most of them have been modelled after the OU. Whilst adopting a Fordist or large-scale approach, these open universities rely heavily on correspondence instruction and concurrently use broadcast and recorded media, especially programmes distributed by radio, television and audio tapes as supportive media. This approach set the pace for the transmission to the third generation, as suggested by Bates (1995). He proposed that a new model is emerging, based on key elements of interactive communication (via asynchronous computer conferencing) and the learning process. The delivery of course materials by broadcast television videotape, with interaction by telephone, or both delivery and interaction by telephone or satellite, cable or ISDN (Integrated Service Digital Network) lines, characterises this stage of development.

Developments in distance education in the 20th century appear to have taken a two-pronged approach. On the one hand, the advent of information technology and modem media has enabled mass-production or a large-scale approach to be adopted. Open universities, based on the OU model, often produce courses for hundreds and thousands of learners, using just a few tutors. In the single-mode system, distance education is the sole approach to the teaching-learning function. Essentially, open learning refers to the democratisation of education. It does not recognise race, religion, gender, age or prior qualifications and opens the doors to learning. Since everyone has a right to education, open learning was deemed the vehicle to ensure this, unlike many other forms of conventional teaching-learning models (Moore, 1997). Open learning also refers to provisions which try to remove barriers that prevent attendance at more
traditional courses and which suggest a learner-centred philosophy. Proponents of open learning seek to empower learners by breaking down barriers to education raised by conventional institutions. They wish to provide unhindered access to learning resources so that technologically supported freedom of information may be turned into freedom of education for people pursuing their own learning needs (Brown & Duguid, 1996:12).

In a document submitted to the National Commission of Higher Education (Committee of Technikon Principals, 1995), which includes a section on "Mode of Instruction", the idea of "fleximodes" of instruction is recommended.

Collis and Moonen (2001:9) attempt to describe the notion of flexible learning as follows:

"Flexibility can involve options in course resources, in types of learning activities, in media to support learning, and many other possibilities".

Hedberg and Corrent-Agostinho (2000) define it as "providing students with choices about when, where and how to study".

Another definition is provided by Fleming & Levie (1993):

"Flexible learning offers the learner a more actively constructive role by providing a framework in which learning goals can be more independently pursued".

Jonassen et al. (1997) add that a flexible learning strategy increases the quality of learning experiences and complements constructivism.


"While part of the framework for flexible delivery may be borrowed from economics, there are progressive interpretations of flexible learning which are structured around competing social and humanist values which have educational expression through concepts such as constructivism, open education, student centred learning, life-long learning, deep learning and accessible learning structures".

Hence, flexible learning means that the learner is given more control over the time engaged with learning resources and a wider selection of resources, including various technology modes. It could also impact on an institution's accreditation and entrance requirement policies.

Collis and Moonen (2002:15) point out that more flexibility requires more self-direction, self-motivation and choices by the learner. As indicated in the first section
though, many learners would rather have the lecturer make the choices, because they do not feel comfortable to do it themselves.

The authors list the following constraints of flexible learning:

- Flexibility is hard to manage because of limited resources and time of lecturers and the administrative load it creates.

- Flexibility is not acceptable for learners who are familiar with fixed course offerings.

- Flexibility is costly - various options do not allow for economy of scale. Flexibility is not achievable if it really boils down to learner choice.

In this light institutions have to find a balance that fits their culture, market and strategic focuses. Market changes and diversifying demographics reflect the increasing need for lifelong learning. Krempl (1997) notes that the demand for tailor-made courses which contain only relevant content is becoming more prevalent. Relevant outcomes, more so than content, would probably be more suitable for a culture of lifelong learning.

Table 3.2 is an impact of flexible learning
The impact of adopting a flexible learning strategy is delineated by Hart (2000) in Table 3.2.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible access - students can choose to work independently or to attend traditional classes and can determine where they enter and/or exit from the course.</td>
<td>Revise support to students, administrators will need to devise new means of accrediting and reporting on students, and lecturers would have to support different entry and exit levels and learning styles of a wide range of students.</td>
</tr>
<tr>
<td>Recognition of prior learning - a flexible learning policy takes account of prior formal and non-formal (work experience) learning in developing a suitable course of study for the learner.</td>
<td>Bridging and revision courses, as well as entry tests will need to be provided.</td>
</tr>
<tr>
<td>Flexible content - courses are modularized so that learners can take those they need or for which they have not established prior learning evidence. They can also negotiate the content of a course with university staff and employers.</td>
<td>It implies a set of university-wide agreed standards for course structure and credits and requires rigorous instructional design and a team approach to curriculum.</td>
</tr>
<tr>
<td>Flexible participation - lecturers are available to times convenient to the learners and communication can be synchronous or asynchronous.</td>
<td>No sign on the door of a lecturer saying &quot;I am not available for consultation between the following hours&quot;.</td>
</tr>
<tr>
<td>Flexible teaching and learning methods. The teaching style is based on the requirements of the subject and needs of the individual learner.</td>
<td>Lecturers need more theoretically grounded pedagogical knowledge as well as skills. Learning is individualized, collaboration is encouraged and metacognitive goals are pursued.</td>
</tr>
<tr>
<td>Flexible resources - access to a wide variety of resources are provided on and off campus via technology and other infrastructure.</td>
<td>The university must provide state of the art ICT on an equitable basis to ensure that all learners have equal access.</td>
</tr>
<tr>
<td>Flexible assessment - assessment needs to be based on competency.</td>
<td>Universities need to introduce alternative forms of assessment such as portfolios and collaborative presentations.</td>
</tr>
<tr>
<td>Ongoing education - flexible delivery involves the development, exchange, repackaging and cross-accreditation of modular courses and course elements in multiple media formats.</td>
<td>Evaluation strategies must be built into course designs and results of evaluations must be available to course developers and learners.</td>
</tr>
</tbody>
</table>

Table 3.2 Impact of flexible learning (Hart, 2000)
Technology innovation plays an increasingly significant role in accomplishing greater flexibility. In Table 3.3, Ely and Minor (1994) provide the following essential components of technology planning at this level:

<table>
<thead>
<tr>
<th>The field of educational technology</th>
<th>Definitions, conceptual background, theory, dissemination, organisations, policy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design functions</td>
<td>Resources, tools, models, procedures, techniques, evaluation.</td>
</tr>
<tr>
<td>Delivery options</td>
<td>Hard and soft technologies, telecommunications, media.</td>
</tr>
<tr>
<td>Applications and settings</td>
<td>Implementation, context, case studies, use.</td>
</tr>
<tr>
<td>Emerging issues</td>
<td>Legislation, cost-effectiveness, research findings, trends, futures.</td>
</tr>
</tbody>
</table>

Table 3.3: Technology planning (Ely and Minor, 1994)

Looking at the above framework, it appears to be a useful tool to apply to the overall planning and implementation of any technology. Schrum and Berenfeld (1997:53) recommend a systematic three-step implementation plan of technology into the educational system. Step one is to enhance the existing curricula with supplemental software packages and on-line activities. They note that "Even though the overall teaching strategy remains conventionally teacher and textbook centred, students with access to on-line resources are exposed to an array of information and confront conflicting opinions that require critical thinking" (1997:53). Another advantage is that both learners and lecturers become accustomed to various technologies as instructional tools, without having to redesign their existing curricula completely. The next step is to progress to technology-based modules and finally, to a situation in which technology is fully integrated into the curriculum. This implies, as the authors note, redefining of pedagogical goals and restructuring of curricular offerings. After conducting extensive evaluation studies, the University of Central Florida (UCF) found that students prefer a mixed mode in which some face-to-face contact time remains (Epper & Bates, 2001:8).

3.6 Instructional technology design

Instructional design of learning environments started being applied on a large scale in the late 1950s and has been studied since the turn of the century. Instructional design is purported to augment learning by incorporating various strategies into courseware, for example structuring, ordering and sequencing content in particular ways, depending on the expected learning outcome (Gagne & Briggs, 1974). It is concerned with improving learning by applying various instructional strategies to the learning environment and could be considered to be an example of product innovation. In the early
1960s, researchers started to transfer this concept to electronic environments (Dempsey & Sales, 1993:7). Subsequently, mastery-learning programs with program control (which means the program determines what sequence the learner follows) developed over a period of almost four decades into more cognitive-based, flexible environments with more learner control. Real world educational technology research and development demands a shift in focus from the design of instruction to the design of learning environments (Kozma, 2000:13).

If learning is designed in an electronic environment, it firstly requires familiarity and understanding of the underlying models of the specific technology application, even before the analysis phase commences. This is necessary because different applications are used in different learning contexts.

Simulations are examples of single-purpose software. A simulation is a software application that represents certain features of a real situation to achieve a training objective (Dempsey & Sales, 1993:199). It is used to instruct by imitating or replicating reality; the learner learns through doing. The basic aim of the underlying model is to present a scenario in which an action is required and to update the system based on the feedback of the learner. Simulations have proven to be extremely effective tools for learning (Fleming & Levie, 1993). The development of high-performance simulations allows learners to control the simulation interactively, e.g. modify the laws of physics and study the effects immediately. An example is The Living Textbook Project: Interactive Learning on the Information Highway, which delivers the results of virtual reality to illustrate tornado prediction models, financial modelling, real-time three-dimensional (3-D) interactive journeys through geographic terrain (Brown & Duguid, 1996:10).

A drill, on the other hand, is used to practise certain knowledge or skills already acquired. The learner learns through rote repetition until automaticity is achieved. In terms of the underlying model, an item is selected from a pool and the learner must respond to it (question and answer). The response is then judged, feedback is provided and another item, which the learner has not yet done or which was previously answered incorrectly, is selected (Alessi & Trollip, 1985).

The constructivist approach to instructional design moves away from direct instruction and systematic design procedures towards participative learning where knowledge is encountered in the context of real-world problems. Whereas the learning theories discussed in Section 2.3 are descriptive theories that describe how learning occurs,
Section 3.4 covers *prescriptive* theories that set out procedures for developing instruction (Bruner, 1967).

### 3.6.1 Cognitive instructional technology design

The scope of this study does not allow an in-depth analysis of instructional design models and theories, but rather focuses on cognitive and constructivist design strategies. According to Winn (1990) behavioural roots remain evident in three areas:

- The reductionist premise that the parts of the whole must be identified, and if these are taught, then the whole has been learned.
- The practice of separating design from the actual implementation of instruction.
- The belief that, if design procedures are correctly applied, good instruction will result.

The general process involved in incorporating cognitive strategies in courseware (Smith & Ragan, 1993:94) is as follows:

- "Analyse the requirements of the learning task".
- "Analyse the learners’ ability to complete the task, including the predictable demands on and limitations of memory".
- "Select/invent an appropriate strategy" [such as a concept map or a flow chart].
- "Apply the selected strategy".
- "Evaluate the effectiveness of the strategy used".
- "Revise as required".

Tracey (1992:242) provides the following instructional design guidelines:

- Initiate the sequence with materials that are familiar.
- Give learners a framework to use in organizing what they are to learn.
- Place easily learned tasks, broad concepts and technical terms that have application throughout the instructional process early in the sequence.
- Place practical application of concepts and principles close to the point the
initial discussion of the concepts and principles.

- Provide for practice and review of skills and knowledge that are essential parts of tasks to be introduced later in the activity.
- Introduce a concept or a skill in the task in which it is most frequently used.
- Structure learning objectives in closely related, self-contained groups.
- Avoid overloading any task with elements that are difficult to learn.
- Place complex or cumulative skills late in the sequence.
- Provide support for practice of required skills, concepts, and principles in areas where transfer is likely to occur.

West, Farmer and Wolff (1991) propose practical cognitive strategies to foster metacognition and facilitate active creation of mental schemata:

*Chunking* - rational ordering and classification of knowledge.

Frames- grids to structure concepts, categories, and relationships – either provided by the instructor or partially developed by learners themselves.

*Concept maps* - visual arrangements with links to represent relationships.

*Advance organizers* - brief prose introductions prior to new material.

*Metaphor/Analogy/Simile* - creative links to show similarity between known and new concepts.

*Rehearsal* - reviewing, asking questions, predicting - with learners playing an active role.

*Imagery* - mental visualization as a learning aid.

*Mnemonics* - artificial memory aids, for example, first letter coding.

Another way to foster metacognition is to create a learning environment in which learners interact with each other, as is the case in cooperative learning and constructivism.

### 3.6.2 Constructivist and open-ended technology design

Jensen (1995:5) contends that the brain is poorly designed for formal instruction and that most group instruction situations that have been tightly and logically planned will have
been wrongly planned for most of the group. The result is that learning is ultimately inhibited, distorted or prevented.

The challenge posed to lecturers is to create a rich learning environment, which is situated in real-life, or which closely resembles real-life within which the learner can construct meaning (White, 1996:69). Opportunity to manipulate the learning environment is crucial, in fact, the more the learner can manipulate the environment, the better. Within an outcomes-based learning system, emphasis is placed on activity-based learning (cognitive apprenticeship) where opportunities are provided to learners to explore ideas and concepts and practise skills. Furthermore, co-operative as well as individual learning contexts should be provided to equip learners with individual and team working skills (Lubisi et al., 1997:26).

In traditional contact and distance education it is almost impossible for lecturers to provide such individual scaffolding and instruction. At best they can create rich learning environments. This notion is supported by Richey (2000:17) who states that students should be flexible and talented enough to be able to work in diverse settings - hence it is almost impossible to design a unique learning environment based on individual preferences and profiles.

3.7 Web-based instructional design

Similar to neural networks in the brain and multidimensional, complex subject matter, hyper media consists of a web of interconnectedness, made possible through hypertext - also known as Hyper Text Markup Language (HTML). Ross (1993) draws a parallel between hypertext design and Bloom's taxonomy and argues that certain designs, such as a highway design, enable the facilitation of learning outcomes on an evaluation level. A highway design allows for interconnectivity between various subjects within a curriculum and combines linear, exploratory, hierarchical and web-like contents. An active, experience-based learning mode associated with the Internet fits well with adult learning (Yakimovicz & Murphy, 1995). Kornmerr et al. (1996:5) recommend concept maps to assist the learner with navigation. The concept maps could provide graphical overviews that show which nodes have already been visited and via which links a previous link can be reached.

The need for rearranged instructional sequences, multiple dimensions of knowledge representation and multiple interconnections across knowledge components make hypertext protocol a potential enabler to cope with ill-structured knowledge domains.

Supporting this view, Mayer (1983) note that knowledge represented as networks is more complementary to the mental organisational structures that individuals use. Four key knowledge structures that are involved in understanding are concepts, semantic networks,
schemata and cases (Davalos, 1997:233). However, Tergan (1997:258) argues against the following assumptions:

Structural and functional features of hypertext/hypermedia mimic the structure and functioning of the human mind (known as the 'plausibility hypothesis') (Tergan, 1997:258).

Weak environments occur where isolated features or steps of hypermedia software are presented in absence of any predisposed sequence or context, and contextually strong environments are characteristic of a strict sequencing of events or actions imposed by the instructor or software (Reed et al., 1997:288). Their conclusion is that, to enable learners to better learn the commands, tools or features in a hypertext learning environment, hypertext designers should not restrict learners to the number of mental models, i.e. linear and non-linear. Therefore, in designing courseware, it is instructionally sound to provide frames/scripts and semantic networks (linear), as well as concept maps and schemata (non-linear). In this way, learners can also choose how they construct their own mental models.

This finding supports the notion by Jensen (1995) that the brain prefers a rich learning environment which is not too structured yet contains enough cues. Some structure is necessary in hypertext learning environments, otherwise navigation is blind and the learner gets lost. Yet many attempts would familiarise the learner with the architecture and prompt a construction of a mental model. Calvi (1997:314) finds that the majority of learners preferred using the concept map (non-linear) when they were involved in task-oriented navigation, and conversely the majority of learners preferred using the content list (linear) when they were engaged in free-navigation. She attributes this to the fact that the map is more complete and was therefore regarded as more appropriate when specific information was sought. Ultimately, Calvi (1997:317) concludes that a correlation exists between comprehension and memory for location (space), which she endorses with the following quote by Bolter (1991, cited in Calvi, 1997:317): "Writing is always spatial and each technology in the history of writing (e.g. the clay tablet, the papyrus roll, the codex, the printed book) has presented writers and readers with a different space to exploit".

Kommers et al. (1996:5) note that learner control enhances metalearning and the elicitation of prior knowledge during the learning process. This is endorsed by Apps (1991) who states:

"While there is no universally superior mode of learning, mature, motivated adult students learn best when they are in control of their learning and can reconstruct the
material in their own terms and in the context of their own interests". Thus virtual learning environments could facilitate learner-centredness.

Hyperlinks (hot spots) could be used to provide additional information, as footnotes do in print-based material, to verify or explain certain concepts, or to provide more knowledge depth if the learner requires it. The learner should be viewed as an autonomous and responsible individual who retains scope for initiative. A fine balance should be sought between providing learner control and a hypertext system that guides the learner in browsing through the information base. Some possible solutions are provided by Kommers et al. (1996:38) which should:

- include a navigational device that shows the learner the current position and distinguish between 'need to knows' and 'nice to knows',

- embed goals in the learning activity in such a way that the learner has to investigate all hyperlinks in order to complete specific learning tasks, and

- accommodate variety through holistic and serial structuring of information.

Another possibility would be to require, as part of the learning task, that the learner add other relevant hyperlinks and motivate the chosen links.

Inherent in an electronic platform is the fact that one can access it at any time and place, and at one's own pace. This is similar to what one would find in self-paced print-based study material, because the learners work through units whenever and in whichever way they wish. Some of the electronic advantages for the learner include immediate feedback, record keeping, tracking of progress and live, interconnected links where hypermedia is concerned. In an empirical study by Reed et al. (1997:285-304), it was found that learners with different learning styles performed the same in a hypertext learning environment, which could indicate that hypermedia learning environments accommodate all learning styles. Jensen (1995:129) makes a point that "the whole notion of learning styles becomes irrelevant when we consider how much variety the brain works with".

3.8 WWW-based course-management systems

With the advent of web-based education, innovators at the University of British Columbia created a web-based course management system that would make it easier for lecturers to offer their courses online. The product, called WebCT (WebCourseTools) has become a market leader globally. At the same time various initiatives resulted in a range of products that are used at universities and other institutions to facilitate e-learning.
Examples include Blackboard, currently the other market leader, TopClass, FirstClass, Learning Space and other, in house developed examples like the Teletop system at the University of Twente (Netherlands). A comprehensive list of approximately 60 commercially available systems is available online (Landon, 2001).

Collis and Moonen (2001:78) define a WWW course management system as follows:

"A WWW course management system is a comprehensive software package that supports some or all aspects of course preparation, delivery and interaction and allows these aspects to be accessible via a network". Focusing on web-based learning, Bonk et al. (2000) suggest a web integration continuum to incorporate the web into the learning environment.

3.9 Changing role of the lecturer

One of the greatest challenges faced by lecturers is to create a learning community. Bonk & Wisher (2000:27) maintain that e-learning students are usually very task driven. This results in very little exploration, engagement and discussion. If combined with a teacher centred style by the lecturer, even less interaction takes place.

The following five skills are singled out by Wlodkowski (1999:26) as the most critical skills of an instructor:

Expertise
Empathy
Enthusiasm
Clarity
Cultural responsiveness

Bonk & Wisher (2000:11) add the following qualities that are required in an e-learning environment:

- Patient
- Positive
- Friendly
- Responsive
- Caring
- Flexible
- Web-smart

They also note that a lecturer who offers web-based courses requires the following competencies (Bonk et al., 2000):

Social skills: nurture social interaction and interpersonal relations, be sensitive to learner social and cultural background, ability to interface with technical support staff,
telematic staff, colleagues involved in offering the same programme, create an ethos of mutual support and community.

**Managerial and research skills:** planning and management of learning environment, adopt a systems perspective - bigger picture of integration of content/resources, learning process and technologies, regular updating of materials, knowledgeable about relevant web-sites in subject-field.

**Pedagogical skills:** foster curiosity and intrinsic motivation, provide individual feedback and praise, promote thinking and reasoning strategies, guide and pace learners, practice cognitive apprenticeship - learning situated in real-life situations, structure lesson materials and activities in such a way that interaction involves reflecting, annotating, questioning, answering, pacing, elaborating, discussing, enquiring, problem-solving, linking, constructing, analysing, evaluating, and synthesizing, provide clear expectations.

**Technical skills:** understand technology and know how to use it to augment learning, understand why it aids the development of higher order cognitive skills and knowledge acquisition, ability to adapt to changing technology.

Kulp (1999) points out that small team collaboration in e-learning requires more time and effort and recommends the following student roles:

- Leader/coordinator
- Resource investigator
- Summariser
- Scribe
- Encourager
- Specialist
- Implementer
- Checker

Mason (1998) advocates the organizational, social and intellectual roles of the online lecturer. A pragmatic statement about the nature of education is made by Wilson & Mosher (1997:5) that regardless of the model of pedagogy, communication is central to the learning environment: "The learning 'conversation' is a communication process in which meanings are negotiated to student understanding of curriculum material". Curtis and Lawson (1999), cited in Bonk and Wisher (2000:24) designed a scheme for analysing online discourse. They identified types of interactions typically found in collaborative learning situations:

- Receiving help and feedback.
- Exchanging resources and information.
- Explaining and elaborating on information.
- Sharing knowledge with others.
- Challenging others' contributions.
- Advocating increased effort and perseverance among peers.
- Engaging in group skills.
• Monitoring the efforts of others.

3.9.1 Training and support of lecturers

Schifter (2000: 43) lists the following motivating factors that could help lecturers to become involved in learning facilitation via technologies:

• Personal motivation.
• Opportunity to develop new ideas.
• Opportunity to improve teaching.
• Opportunity to diversify programme offerings.
• Greater course flexibility for students.

Interestingly, administrators listed incentives, such as credit toward promotion or additional money as the second highest motivating factor.

An illuminating finding by Henderson (2001) is that lecturers' motives for teaching online are good predictors for their perceptions of the efficacy of teaching with technologies and that lecturers who are motivated by additional money are often not good lecturers. Other findings include:

• Sometimes faculty and student goals don't match particularly well. More can be done to communicate goals to students.
• Good instructional practice does not always result in high levels of student satisfaction.
• Include strategies for helping students understand with greater clarity why

Education is the pillar for the development of any society. Education should not concentrate only to academics; it is the medium for the overall development of personality of the student. The quality of a nation depends upon the quality of its citizens. The quality of its citizens depends not exclusively but in critical measure upon the quality of their education. Education plays a great role in every learner's life. It is rightly said that today's bud is tomorrow's flower and if we take care of the bud today, we will have a nice flower tomorrow. The invention of information technology industry has given a new shape to the learning process, which involves reading, understanding and gaining information, which becomes knowledge. Particularly, Internet technology has changed the way people find information, communicate, do business, network, find jobs and have fun. It is also changing the way people learn. The simplest definition of e-learning is the use of internet technology to facilitate learning. It can be delivered in many ways – via a PC, digital TV, or mobile phone. E-learning has many benefits and it allows one to get the knowledge one's needs, when he needs it and where he needs it. With more systematic support the new generation learners finds him equipped with lot of information.