CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reports on the results of literature review. The purpose of the literature review was to examine what information-communication technologies and their applications entail, especially in nursing education. The historical development of information-communication technologies and trends on computer assisted instruction and computer-based learning were examined. The application of information-communication technologies in healthcare, and the competencies required to utilise these technologies are discussed. The researcher maintained that these competencies could be developed through applying the relevant educational principles, which underlie computer assisted instruction and computer-based learning. The literature review served as a theoretical framework for the structure and substance of the data collection instrument.

2.2 CHALLENGES FACING NURSES AND NURSE EDUCATORS

Technological advances affect the world in general and the healthcare setting in particular. Constant and revolutionary changes associated with technological and scientific innovations resulted in an increasingly complex global order. Society is driven by knowledge, and access to information is becoming a major competitive weapon (De Villiers 2005:56; Unisa. Only Study Guide 2001: 83). People have ready access to more information than at any time in the past (Snedden 1997:42). Nurses are faced by the challenge to acquire the abilities required to participate in a technology and knowledge driven global order. Nursing is rapidly evolving into a technologically sophisticated practice discipline and it is necessary to ensure that nurses are equipped with the information skills needed to deliver effective nursing care (Noesgaard et al.1999:231).

The existence of information-communication technologies and an explosion of sophisticated computerised technology in the workplace demand that nurses become proficient in the use of these technologies (Nagelkerk, Ritola, & Vandort 1998:17). The development of sophisticated information technology networks, the expansion of integrated delivery systems, and the growth

of the electronic patient record are the outcomes of both major restructuring and rapid technological developments in healthcare. As a result, healthcare providers find themselves practicing in an environment that has changed significantly (Carty 2000:2). Electronic health information systems have moved from stand-alone, hospital-based local area network systems to dynamic, interactive, health information enterprise systems supported by integrated delivery systems. An integrated delivery system is composed of healthcare providers, service providers and facilities organised to provide a continuum of healthcare service to a defined population. Nurses require the abilities to manage electronic client files. They must also be able to utilise and manage the various components of an electronic health-information system. The components include clinical, management, financial and consumer-based health information systems. The perception of their scope of practice should include operations in virtual reality.

Nurses and clients utilise information-communication technologies for communication purposes. Time and geographic distance have ceased to be barriers as far as communication is concerned. Electronic communication and digital data transfer technologies enable nurses to make electronic referrals and appointments on behalf of clients, and to transfer client data to other relevant nurses. Nurses therefore require the ability to effectively engage in electronic communication (Carty 2000:11).

Innovations in healthcare technology cover advances in electrophysiological monitoring systems, and technological equipment used for treatment purposes. There is an increasing utilisation of technological equipment for diagnostic investigations, in both nursing and medical care. For example, the heart sonar is highly sophisticated technological diagnostic equipment. Cardiac monitors, ventilators and haemodialysis machines, for example, are utilised to treat patients and monitor their health status. With a multitude of requirements inherent in the computerisation of healthcare, the need to develop practitioners who are knowledgeable in the applications, development, and support of these systems is essential. Registered nurses require a positive attitude towards its utilisation. They ought to be equipped with the skills to operate such equipment. For the immediate future, all nurses should be required to be informed users of the available systems, responsible for understanding the importance of standard language, nursing classification systems and the basic operation of the systems in everyday practice. The educational setting should be a place where nursing learners should obtain the necessary knowledge, skills and attitudes which would enable them to effectively utilise these technologies (Carty 2000:5).

The National Plan for Higher Education proposed that all graduates should be equipped with the skills and competencies necessary to function in modern society, in particular, computer literacy, information management, communication and analytical skills. Therefore, nursing education must incorporate computer skills and technological literacy in their basic educational programmes and ensure that nurses are equipped with the skills needed to deliver effective nursing care (Noesgaard et al.1999: 231). To function as competent nurses in the 21st century, nursing students must be familiar with various forms of information-communication technologies including computer–based resources for information seeking, communication and clinical decision-making in a variety of healthcare settings (Noesgaard et al. 1999:231).

Educational institutions are seriously affected by information-communication technologies. Information-communication technologies are increasingly being used for educational purposes. Recent advances in education relate to learning and facilitation based on the utilisation of multimedia computers and online learning systems. In this study, the researcher proposes that exposure to information-communication technologies in the educational setting, would greatly contribute towards developing the aptitudes and attitudes required to function in a modern world. This could be accomplished by exposing learners to computer assisted instruction and computer-based learning. It is therefore necessary to update existing educational programmes and develop new continuing education programmes to improve the technical and information management skills of nurses (Unisa. Only Study Guide 2001:113). Educational advances are closely related to developments pertaining to information-communication technologies, as indicated in the following section.

2.3 THE DEVELOPMENT OF INFORMATION-COMMUNICATION TECHNOLOGIES (HISTORICAL OVERVIEW)

2.3.1 Early versions of modern day computers

A *computer* is referred to as an electronic devise for storing and processing data according to instructions given to it in a variable program (Reader's Digest Oxford Complete Wordfinder 1996: 293). The contribution of computers is to process and communicate information much more quickly and accurately than a person could (Bennington 2002:4). The first ancient version of a computer, the abacus, was a device used to represent numbers. It consisted of stones that were strung on threads in a wooden frame. More recently a model for a mechanical machine, that was utilised to do computations and which bore some similarity to modern day computers,

was developed. The first general purposes electronic computer, the electronic numerical integrator and calculator, became operational on 14 February 1946. Since the development of the first modern computer there have been many significant advancements in the development of computer technology (Strydom 2000: 9).

The first modern day computers were constructed using electronic tubes. By the late 1950's this technology had been displaced by discrete transistors, which were smaller, faster and cheaper, and produced far less heat than previous technologies. In the mid 1960's discrete transistors gave way to integrated circuits and other components on a silicon "chip". During the 1970's, the mainstream electronic industry began to appropriate new digital electronics and integrated circuits, producing a stream of innovative products such as video games, calculators, and digital watches (Campbell-Kelly & Aspray 1996:151).

2.3.2 Desktop computers

The Apple II, launched in 1977, established the paradigm of the personal computer, namely a central processing unit equipped with a keyboard and screen, and a floppy disk drive for program and data storage (Campbell-Kelly & Aspray 1996:151). Historically, desktop stand-alone computers used the Microsoft Disk Operating System (MS DOS) (Freese 1992: 9). During the 1980's, the MS DOS operating system has become the standard operating system for personal computers as many computer manufacturers adopted this system. Thousands of programs were based upon this system (Campbell-Kelly & Aspray 1996: 263; Freese 1992: 7). The next step in the development of personal computers was the adoption of the Microsoft Windows (MS Windows) as the operating system for personal computers. This operating system was characterised by a graphical use interface. Various versions of this operating system have since appeared on the market (Campbell-Kelly & Aspray 1996: 278-280). The multitasking and large memory features of MS Windows paved the way for concurrent communications and networking operations, using the personal computer (Jordan & Churchill 1992:18).

The next step in the development of computer technology was the establishment of the multimedia computer. Multimedia integrates audiovisual technology with computing. *Multimedia* is referred to as various combinations of text, graphics, animation, sound and video that are integrated, controlled and delivered by the computer. Multimedia computers have a high degree of interactivity (Collin 1996:5; Dodd 1995:136; Joos, Whitman, Smith & Nelson 1996:224).

Multimedia computer programmes can be stored on a CD-ROM. The acronym ROM stands for "read only memory" which means that one can read or copy the information on the disc, but one cannot change it (Wright 1996:44). Multimedia technology supports games, simulations and other interactive applications (Dodd 1995:136). Multimedia applications are made up of pages, each containing a screen full of information. Hypertext links contain embedded references to other pages of information (Comer 1994:293). A hypertext link is a special word, button or picture that provides a link to another page, a piece of text, a sound file, an animation or a video clip. It's used to show more detail about a particular topic, provide interactive experiences with the information on a topic, or to enable users to navigate between electronic pages or files. The user activates a hypertext link by clicking on it with a mouse (Collin 1996:3-5).

2.3.3 Networks

Developments towards the establishment of computer networks complemented the stand-alone computer (Chellis, Perkins & Strebe 2000: 6). Traditional stand-alone computers formed the basis for the establishment of computer networks. A computer network comprises any number of computers that are linked together. A network can be confined to a single building, utilising data cables as linking devices. Where greater distances are involved, the computers that constitute a network are linked by means of satellite links, telephone lines or fibre optic cables (Meyer & Cilliers 2002: 23). When computers are linked together, information can be moved between them swiftly and efficiently. The information moves directly between computers rather than through a human intermediary. A network also allows for information to be backed up at a central electronic location. It is difficult to maintain regular back-ups on a number of stand-alone computers and important information can be lost by mistake (Chellis et al. 2000:11).

2.3.3.1 Local area networks

A local area network (LAN) is a number of computers connected to each other by a cable in a single location such as a single healthcare organisation or group of organisations forming one institution (Chellis et al. 2000:60). This allows for data transfer and communication within an organisation or institution.

2.3.3.2 The Internet and the world wide web

In the late 1960's the United States Defence Department created a network that linked military computers together. This eventually gave rise to the establishment of the Internet (Maran, Maran, Maran, Maran, Maran, Maran & Maran 1997: 10). The Internet consists of a series of relationships forming a system of communications that can rest on a number of underlying technologies (Libicki 1995:250). It is a super network that joins together millions of computers, which are scattered, around the world. The backbone of the Internet is a set of high-speed data lines that connect major networks all over the world. This enables many millions of computer users to globally share and exchange information, as a computer user is linked with computer users on the other side of the world.

A modem was initially required to log on to the Internet. This device converts the digital communications of a computer into analogous signals that can be carried over a regular telephone line. A modem has a modulator for sending information and a demodulator for receiving information (Dodd 1995:138; Maran et al. 1997:13; Snedden 1997:4; The Internet 1997:10). Presently, connection to the Internet can be gained without a modem and telephone line, using wireless technologies and satellite systems (Chellis et al.2000: 47, 104 & 570).

The Internet supports access to information on any subject imaginable from around the world (Readers Digest 1999:194). Information can be downloaded from and uploaded on the Internet. Downloading is when information is received from another computers through the Internet. Uploading is when information is send to other computers through the Internet (Maran et al. 1997:13).

The WWW is part of the Internet. It was created in the early 1990's to allow researchers to work together on projects and to make project information easily accessible. The first publicly accessible web-site was created in 1993 (Maran et al. 1997: 11). The web consists of a huge collection of documents stored on computers around the world (Maran et al. 1997:26). The pages of the WWW cover a vast range of topics. The main advantage of using the WWW is that it is easy to navigate, and it can represent information in an attractive way (Price 2003:113). A web page can contain text, images, sounds, video clips and most important of all, links to other web pages. By using a Web browser such as Netscape Navigator or Internet Explorer, a user can cross-link from one server to another at the click of a button (The Internet 1997:58).

2.3.4 Communication using information and communication technologies

Recent advances are characterised by the integration of information and communication technologies. This entails a combination of computers, the Internet and multimedia technologies. Information-communication technologies can be used in various ways for communication purposes. Synchronous communication occurs in real-time using Internet Relay Chat Systems, while all the participants are simultaneously online. Asynchronous communication does not take place simultaneously, as each participant does not have to be online at the very same instant (Ellsworth, 1994: 431).

2.3.4.1 Electronic Mail (e-mail)

E-mail was developed in 1971 and rapidly became a popular mode of asynchronous communication (Campbell-Kelly & Aspray 1996:294). E-mail is an application or suite of applications that allow users, who are connected to the same network or the Internet, to exchange memoranda and files without having to be logged on at the same time.

E-mail mimics the way regular postal mail works (Chellis, Perkins & Strebe 2000: 262). E-mail messages are sent over computer networks or the Internet. Each e-mail user has a unique private address which only he or she can gain access to. Users can compose e-mail messages and send them to the mailbox of anyone with an e-mail account, by including that user's e-mail address in the address line of the e-mail message. One can exchange e-mail with people around the world. It is fast, easy, inexpensive and saves paper (Readers Digest 1999:195).

2.3.4.2 Bulletin Boards

An electronic bulletin board service is sometimes called a computer discussion group or computer conference service (Comer 1994:157). Bulletin boards are areas where running conversations are posted in the form of electronic messages. Anyone can read and reply to any message, adding to the conversation. One can attach files to bulletin board messages (Crumlish 1996: 12). Some bulletin board systems allow limited access to the Internet such as being able to send and receive e-mail (Snedden 1997:16). Bulletin boards support asynchronous communication (Snedden 1997:16).

Bulletin boards enable a person to participate in communication with people who have shared interests. The bulletin board service allows an individual to:

- select one or more discussion groups on the Internet
- periodically check to determine whether new items have appeared in a discussion
- post a note to the discussion group for others to read
- post a note that responds to an item someone else has written

(Crumlish1996:16).

2.3.4.3 Chatting

There are sites on the WWW that allow a person to chat with other people in real-time, using a web browser (Readers Digest 1999:261).

Chatting is an informal type of electronic synchronous communication, which is characterised by an immediate mode of communication in virtual reality, within a small group context. Remarks and comments are keyed in by each participant to appear, real-time, in a message window that constantly scrolls down the screen. As individuals enter the chat room their screen name is added to the list of those already present. Their names are displayed on the computer screen, and attached to the messages that each person posts. When participants leave the chat-room their screen name is removed from the list (Cleverly 2003:112). Special sound set-ups allow people to engage in voice chat. It is even possible to download three-dimensional (3D) interactive environments and meet with people in 3D chat rooms (Meyer & Cilliers 2002: 124).

2.3.4.4 Video conferencing

Video teleconferencing has become a reality with the advent of networks. It enables people who are geographically separated to hold a conference by engaging in synchronous communication in virtual reality. Users can transmit and receive real-time sound and video images between any two computers connected on a high-speed network. This means that those involved can see one another on the computer screen, and hear one another through the computer speakers, although they may be separated by hundreds or thousands of kilometres. Equipments needed include a computer, a camera, a microphone and an Internet connection (Chellis et al. 2000:223; Fluckiger 1995:178-179). Personal computer-based video-conferencing allows for verbal conversations and video-linkages between two home computers that are connected to the Internet, irrespective of their location in the world.

2.4 INFORMATION-COMMUNICATION TECHNOLOGIES IN HEALTH CARE

Developments with regard to the integration of information-communication technologies paved the way for the establishment of health information systems. Registered nurses are required to utilise and manage the health information systems that are in place in the settings where they work. The establishment of health information systems requires the integrated use of principles inherent in the health sciences, computer science and information science. Health information systems provide electronic means for identifying, collecting, processing, and managing data and information to support clinical practice, management, education and research, and to expand knowledge (Unisa. Only Study Guide 2001: 87). Various departments in one healthcare organisation, and sections of a broader healthcare institution are electronically linked. Health information systems support a multitude of administrative and professional functions (Simpson & Kenrick 1997: 37). Nurses increasingly turn to information-communication technologies to access databases, seek decision-making support, document care, justify outcomes, access information and consult with one another (Malloy & De Natale 2001: 191).

2.4.1 Sharing of information

Traditionally, the use of telephones and fax machines enabled healthcare professionals, including nurses, to share information regarding patient care amongst them. Health information systems changed the way in which nurses, and even their clients, gain access to, and disseminate information. Currently databases and patient care records are stored, updated and retrieved in electronic format (Malloy & De Natale 2001: 191). Once data has been entered into the computer, other healthcare professionals are able to access the updated electronic data and information immediately. The data also becomes available and readily accessible for purposes other than the original purpose for which it was generated, such as research (Unisa. Only Study Guide 2001: 85).

2.4.2 Communication and information access in the healthcare setting

Health information systems facilitate electronic communication between nurses, and thus support efficient and effective care delivery. The utilisation of the Internet or Intranet (network within an institution) makes communication among healthcare professionals easier (Unisa. Only Study Guide 2001: 94).

E-mail provides the opportunity for rapid transmission of referral requests, scheduling of referral services, and dissemination of client information. Nurses can also conveniently utilise e-mail and videoconferencing facilities to consult with other health professionals, such as specialists. This enhances effective healthcare delivery, especially in primary healthcare settings. Health information systems enhance communication within and outside the organisation. It has become important to share client information throughout the continuum of healthcare. Health information systems provide healthcare professionals with instant access to the health profile of clients including the records of healthcare received in organisations other than the organisation in which the information is accesses at a particular point in time. This is achieved through the use of electronic documentation as opposed to paper-based documentation. Electronic documentation allows for the rapid electronic transfer of health records between healthcare professionals and healthcare services that are linked to the information systems network (Unisa. Only Study Guide 2001: 94).

E-mail and video conferencing support communication between health professionals (including nurses) and clients, thus improving healthcare to clients who reside in geographically remote settings. It also supports health education initiatives by allowing for electronic means of rendering educational services. Furthermore, clients can be referred to the Internet to obtain additional health related information. Nurses can achieve this by, for instance, inserting hyperlinks to selected web-sites in health educational e-mail messages that they distribute among their clients (Malloy & De Natale 2001: 191).

2.4.3 Telehealth

Information-communication technologies and health information systems support the development of telehealth, which increases access to healthcare. *Telehealth* refers to the use of information-communication technologies to provide and support healthcare when the healthcare providers and recipient are geographically separated (Carty 2000:233; Unisa. Only Study Guide

2001:108). It entails health related activities, services and systems carried out over a distance using information and communication technologies (Carty 2000:233). Telehealth also supports health education of communities, the education of nurses, public health research, and the administration of health services (Carty 2000:232).

Telehealth comprises three elements, namely tele-consultations, tele-mentoring and tele-information. Tele-mentoring and tele-consultations are of utmost benefit to those who currently do not have ready access to mainstream healthcare. *Tele-mentoring* means that one healthcare professional (for example a medical doctor) could assist another who is at a remote site (for example a nurse or pharmacist working in a primary healthcare setting), in making a diagnosis and associated clinical decisions. This entails assistance with clinical decision-making and guidance on clinical procedures. Interactive video conferencing technology, supported by information transfer technology, is used for tele-mentoring. For instance, nurses in a rural area can seek guidance from a specialist to diagnose and treat a patient with a complaint that cannot safely be dealt without specialised knowledge and experience. The specialist would diagnose and provide electronic prescriptions, based on clinical data that was digitally transmitted to him/her by a local health professional (Unisa. Only Study Guide 2001:108).

Digital transmission of data means that data is sent over a computer network. Data that could be transmitted digitally include vital statistics, heart sounds and ECG recordings. Other examples are CAT scan, MRI and ultrasound images. The same applies to pathology images and reports. The electronic data and images then become part of the electronic patient record. This transmission of information in the form of, for instance, text and images, is referred to as tele-information (Unisa. Only Study Guide 2001:109).

Tele-consultation means that a client can gain access to specialist healthcare without having to travel to the area of practice of the specialist. Information-communication technologies enable nurses to render healthcare to communities in remote areas, with the help of experts in developed countries. This means that patients are able to get specialist treatment without having to travel to urban centers or to other countries. For instance, a tele-consultation could be held through two-way interactive video conference between a doctor and a patient. Low cost personal computer video telephony is used to provide specialist consultancies and services for rural practices or clinics. Possible applications are speech therapy, clinical specialist consultancies, radiology and psychiatric services (Unisa. Only Study Guide 2001:108).

2.5 COMPETENCIES REQUIRED TO WORK IN TECHNOLOGICALLY ADVANCED HEALTH CARE SETTING

Carty (2000:20) cites Mulholland's (1994) definition of competency, namely the ability to perform particular activities to a prescribed standard. There is a necessity for nurses to have the required competencies to work in technologically advanced healthcare settings, and to utilise and manage electronic health information systems. An overview of the required competencies are given below:

2.5.1 Cognitive competency

Cognitive is referred to as intellectual behaviour that can be attributed to knowledge, comprehension, application, analysis, synthesis and evaluation. Cognitive competence is arrangements of diverse contents including cognitive skills, cognitive processes, motivations for success, and goal–directedness in activities. It entails progressively complex levels of cognitive ability such as thinking, reasoning and problem-solving. To be cognitively competent, nurses must possess certain skills like information skills, scientific inquiry skills and knowledge acquisition skills. Cognitive competence also encompasses skills in reasoning, comprehending, synthesising and evaluating knowledge. A cognitively competent person is able to learn independently, think critically, solve problems, make sound clinical judgements and independently engage in decision-making (De Villiers 2001:32; Schoolcraft & Novotny 2000:60).

2.5.1.1 Information skills

The increasing complexity of nursing practice and healthcare delivery necessitates the development of information literacy in learners to support lifelong learning. Carty (2000:6) states that health information systems encompass data management, processing of nursing data into nursing information, and processing nursing data and information into knowledge. Knowledge is utilised for the purpose of effective patient care. Information literacy is the foundation of critical thinking. It refers to the utilisation of an integrated set of skills to effectively access and evaluate data and information for a given need. It requires the ability to utilise tools and resources used both for healthcare and knowledge delivery, such as the Internet and a variety of Internet search engines (Verhey 1999: 252-253). Nursing learners need to be

familiar with resources for ensuring access to quality healthcare information on the Internet (Carty 2000:47).

Nursing education programmes must ensure that nurses are equipped with the information management skills needed to deliver effective nursing care (Noesgaard et al. 1999:231). Nurses must be able to optimally utilise information-communication technologies to gain access to, process, apply and disseminate information. The quality of information may vary. While some health-related information may be of high quality, others may be inaccurate and misleading. Nursing learners must learn to filter quality information for the delivery of efficient client care. In addition, nurses need to teach clients to safely use health education information resources (Carty 2000: 48). Nurses must therefore be able to critically evaluate the quality and relevance of electronic data and information.

2.5.1.2 Learning skills

Constant social changes necessitate that the nurses possess certain learning skills. Independent self–directed learning, discovery learning and flexible learning are some of the learning skills the learner should possess. To accomplish this, their metacognitive abilities need to be developed. Metacognition is an individual's insight into his/her own cognitive abilities such as memory and thinking processes, and the utilisation of these insights during the learning process. Metacognition enables an individual to plan learning activities based on an understanding of the demands of a particular learning task, learning objectives and variables that influence learning. It entails the application of cognitive knowing strategies such as setting of objectives, assessing whether additional information ought to be acquired, evaluating a learning strategy that is being utilised, and self-monitoring (De Villiers 2001:32 cites Monteith (1994); Halpern 2003:34). Metacognitive knowledge is a prerequisite for accepting self-responsibility for learning (Woolfolk 1990:253 cited by De Villiers 2001:32).

2.5.1.3 Knowledge acquisition skills

Nurses should have the ability to construct knowledge because knowledge is often presented in a deconstructed format in electronic sources. For instance, information on the Internet is often presented in a fragmented and unconnected format. It is necessary to construct knowledge by using various bits of information. This entails acquiring the necessary information and using a person's cognitive structure of existing knowledge, to interpret the new information and to

establish new meanings. The new meanings can then be applied in settings other than the learning setting. Nursing learners are expected to acquire in-depth understanding of a range of subjects allied to nursing including bioscience, social policy, sociology and psychology. They must remain up to date with modern scientific and technological developments and apply their evolving knowledge in their practice. This entails having to make sense of an array of new knowledge and innovations that are constantly been disseminated through the professional literature, general media and the Internet (Carty 2000: 220).

An ability underlying the acquisition of knowledge is the ability to reason. *Reasoning* means the power to think, understand, and draw conclusions logically (New Pocket Oxford Dictionary 2001:749). Analytical thinking, logical thoughts and discovering interrelationships are skills involved in reasoning. Reasoning skills are utilised to reach conclusions by connected thought (Readers Digest Oxford Complete Wordfinder 1996:1275). Nurses therefore require the ability to think analytically and logically, and to make relevant conclusions.

2.5.1.4 Higher order intellectual skills

Higher order intellectual skills include critical thinking, problem solving and decision-making. These skills are discussed below.

- ***Critical thinking***

Critical thinking is the application of those cognitive skills or strategies that increase the probability of a desired outcome. Critical thinking is purposeful, reasoned and goal directed. A person who employs critical thinking is able to evaluate an issue and to judge its merits or weaknesses. Critical thinking also entails judging the reasoning process, which led to the said judgement. Critical thinking therefore also involves reflective thought processes. Problem solving and decision-making are two thought processes that are employed to think critically (Halpern 2003: 349).

- ***Problem–solving***

Solving a problem means finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately understandable (Halpern 2003:35).

Halpern (2003:349) cites Hayes (1978), who states that a problem is a gap, which separates one from where one wants to be. Polya (1962) cited by Halpern (2003:352) refers to *problem solving* as a means of finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately understandable. Problems can be understood by reducing them to their anatomical parts. The anatomy for conceptualising problems has proven useful in understanding the process of problem solving. The anatomy of a problem can be thought of as having a starting or initial state, and a final or goal state. All of the possible solution paths between the initial state and the goal state comprise the problem space. In solving a problem, people search through the problem space to find the best path between the initial state and the goal state, meaning that they consider the alternatives that would lead to the goal, and select the best one. In addition to an initial state, a goal state, and the paths connecting them, there is information that places constraints on the problem. The problem solver requires relevant knowledge to enable him or her to select the best route and by doing so, to find an appropriate solution (Hayes 1978 cited by Halpern 2003:35).

- ***Decision-making***

Decision-making refers to opting to take one kind of action rather than another. People choose actions they think will have the most value for them. The decisions are made before the outcomes are known. The choice of action is based upon the probability that the outcome will have the expected utility (Quinn 2000: 86). The task requires the decision-maker to select the best alternative from among several possibilities. The first stage in decision-making is recognising that a decision is needed, followed by the generation of two or more alternatives that would satisfy a goal, which is implied by the decision. The task for the decision-maker is to choose the “best” alternative. The best alternative could be to engage in some kind of action, or to opt to do nothing at all (Halpern 2003:311).

2.5.2 Technical and psychomotor competence

Nurses require certain technical and psychomotor competencies to enable them to optimally utilise information-communication technologies. *Psychomotor* is referred to as a realm pertaining to specific motor abilities (Schoolcraft & Novotny 2000:60). *Technical abilities* are concerned with the mechanical arts and applied sciences (Reader’s Digest Complete Wordfinder 1996:1602). Verhey (1999: 252) has stated that, nurses must be computer literate and skilled in using the Internet to be able to optimally utilise information-communication technologies.

These abilities are required to gain access to information, disseminate information and to communicate electronically. Psychomotor skills such as typing skills, and skills in operating a mouse are also required. Nurses must further have skills in manipulating technological equipment used in healthcare such as electronic monitoring machines. Therefore nursing education must incorporate computer literacy courses in their basic educational programs (Noesgaard et al.1999:231).

2.5.3 Affective competencies

Affective is referred to as the attitudes, opinions, beliefs, values and feelings which are the most important learned responses formed early in life, and which continue as ever present behaviours (Schoolcraft & Novotny 2000:60). Within the context of this study, attitudes towards the utilisation of information-communication technologies are relevant. This is applicable to this study because the researcher believes that nursing learners has to develop positive attitudes early in their educational lives towards the utilisation of information-communication technologies.

2.5.3.1 Appreciation

Appreciation means recognition of the value or importance of something (New Pocket Oxford Dictionary 2001:38). Nurses ought to learn to appreciate the value of information-communication technologies in general, and health information systems in particular, in promoting more effective and efficient nursing education and care. They will further appreciate the value of well-managed and up to date databases.

2.5.3.2 Positive attitude

Attitude is a way of thinking or feeling about someone or something (New Pocket Oxford Dictionary 2001:51). The term *positive* means expressing an agreement (New Pocket Oxford Dictionary 2001:819). Applied to this study, a *positive attitude* therefore refers to a state of mind expressing an acceptance of the value of information-communication technologies and the utilisation thereof in nursing education and clinical practice. Nurses should be equipped to view the introduction of and developments with regard to information-communication technologies as a challenge. Any fears and misgivings should be overcome. For example, a fear of being replaced by computers ought to be addressed.

This also applies to any misgivings about the effect of information-communication technologies on caring relationships in the healthcare setting.

2.5.3.3 Self-confidence

Self–confidence is referred to as a trust in one's abilities, qualities and judgments (New Pocket Oxford Dictionary 2001:819). A person who is sure of himself/herself portrays self-confident characteristics. Nurses must trust their abilities to face and deal with the challenges of utilising information-communication technologies in education and clinical practice. This ought to be accompanied by actions to confidently meet their continuous education objectives, which would enable them to keep abreast with developments.

2.5.3.4 Curiosity

Curiosity means a strong desire to know or learn something new (New Pocket Oxford Dictionary 2001: 215). Given the social changes brought about by knowledge and technological explosions, curiosity is required to motivate nurses to constantly seek new insights, master new skills, and discover new learning resources.

2.5.3.5 Independence

Independence means being free from outside control or influence (New Pocket Oxford Dictionary 2001: 461). Independence is characterised by being separate, not connected with another (The New Pocket Oxford Dictionary 2001: 461). A certain degree of independence is necessary to face the challenges of working, living and learning in a technology and knowledge-driven world (refer to section 2.6.4.2). Independent nurses are able to demonstrate intrinsic motivation and personal autonomy while utilising information-communication technologies to enhance the effectiveness of their learning, and the health care that they render to clients.

2.5.3.6 Levels of affective development

According to Quinn (2000:144) there are five levels of affective development:

- *Level 1* - Receiving (attending): At this level the learner is sensitive to the existence of something, and progresses from awareness to controlled or selected attention (Quinn 2000:144). Applied to this study, at this level the learner would be aware of the existence

of different information-communication technologies, and their importance for enhancing nursing education and healthcare delivery.

- *Level 2* - Responding: This is concerned with the active response by the learner, although commitment is not yet demonstrated (Quinn 2000:144). Based on this study, the learner would react positively to the educator's suggestions to utilise information-communication technologies to enhance their learning and their clinical practice. They would, however, not be committed to spontaneously do this on a continuous basis.
- *Level 3* - Valuing: Valuing entails acceptance and internalisation of the values or attitudes in question. The learner acts out these in everyday life in a consistent way (Quinn 2000:144). At this level, the learner would change his/her attitude of adhering only to the traditional ways of learning and practicing, and rather choose to utilise information-communication technologies frequently and consistently.
- *Level 4* - Organisation: Having internalised the value, the learner will encounter situations in which more than one value is relevant. This level is concerned with the ability to organise values and to arrange them in the appropriate order (Quinn 2000: 145). When applied to this study, the learner would be able to select the most appropriate technologies to perform a specific task. Given the developmental constraints in developing countries, the learner may even appropriately choose to achieve his/her objectives though traditional, low technology means.
- *Level 5* - Characterisation: Having attained this higher order level, the learners have an internalised value system, which has become their philosophy of life. These are the values that characterise an individual (Quinn 2000: 145). When applied to this study, the learner has incorporated the principles associated with information-communication technologies into their value system, and regards its utilisation as a way of life.

2.5.4 Interpersonal competence

Communication is a means of sending or receiving information (New Pocket Oxford Dictionary 2001:175). Information-communication technologies pose the challenge to maintain interpersonal relationships through communication in virtual reality, which is characterised by an absence of face-to-face contact. Special skills are needed to communicate electronically. Nurses must also be able to operate e-mail, chatting and bulletin board applications appropriately to ensure effective communication. They must also be able to apply the etiquette for e-mail communication, chatting and video conferencing.

2.6 THE APPLICATION OF INFORMATION-COMMUNICATION TECHNOLOGIES IN HEALTH SCIENCES EDUCATION

2.6.1 Introduction

Learners need to be equipped with the competencies and specific skills required to work in an environment characterised by a widespread use of information-communication technologies and health information systems. Many competencies and skills can be developed through exposing students to information-communication technologies during their training.

Using information-communication technologies in nursing education provides scaffolding for the novice to acquire essential skills, and realise intended learning outcomes. It may enhance satisfaction with the learning enterprise for both learners and nurse educators (DeBourgh 2001:227). Nurse educators can achieve this by applying the principles and methods of computer assisted instruction and computer-based learning in nursing education. Before these teaching and learning strategies are discussed, an overview is given on the application of information-communication technologies in nursing education.

2.6.2 Using traditional computers

Previously the MS DOS-based and more recently the MS Windows-based computers had specific educational applications. The educational computer software packages supported individualised learning through drill-and-practice. These packages were based on the principles of mastery learning and behaviourism (refer to sections 2.7.4.1 & 2.7.5.1). In nursing education, these types of computer packages were utilised for remedial purposes, where learners lacked typing skills and reading skills, for example.

2.6.3 Using multimedia computers

Recently, the volume of material to be taught in pre-registration nursing education programmes has increased considerably. Multimedia computer-based learning is one area that could help in providing a solution to this problem (Garrett & Callear 2001:382). There is now particular interest in the development of distance and resource based learning techniques.

This provides alternatives to traditional methods of delivery, which assist learners in studying their learning material effectively.

There are multimedia computer packages on, for instance, anatomy, physiology, pregnancy and labour. They provide integrated, interactive learning experiences by incorporating text, sound, graphics, still photos, animation, video clips and material from the WWW (De Young 2003:174; Dodd 1995:136). Hypertext provides linkages between text and/or audio-visual sections, thus providing the learner with integrated learning opportunities that support depth learning.

Multimedia computer packages are accessed by means of CD-ROM or the Internet. Multimedia and CD–ROM technologies have a virtual reality component. The virtual reality component supports the development of educational software that enables educators to create a simulated environment for the application of the simulation teaching strategy (refer to section 2.7.5.5). It also supports the development of software, including educational games, which require the discovery and a problem solving approaches to complete (refer to sections 2.7.5.2 - 2.7.5.4). Multimedia technology enhances collaborative learning (refer to section 2.7.5.6), and fosters interaction between the learners and their learning material. It supports learning based on constructivist principles (Refer to section 2.7.4.2).

2.6.4 Using the Internet

2.6.4.1 Seeking information for educational purposes

Information-communication technologies enable learners to gain access to information via the Internet through independent searches. Educators facilitate this by providing learners with Uniform Resource Locators (URL's) or by including hyperlinks in electronic study material. Learners also have the option to independently utilise search engines. Learners are not limited by time or geographic location, and can thus access the Internet in a computer centre or at home, at a time suited to them.

Because information is often presented in a fragmented form on various web-sites, the principles of discovery learning (refer to section 2.7.5.2) and constructivism (refer to section 2.7.4.2) can be applied to enable a learner to explore a topic in its entirety, or partially to complement other means of information transmission. Information is downloaded from the Internet and used for the purpose for which it was accessed.

2.6.4.2 Enhancing self-directed learning (independent learning)

Self-directed learning has two key elements, whereby learners take increased responsibility for achieving the learning outcomes, and they work at their own pace (Hinchcliff 1999:148). The educators teach the learners how to reason and work independently of them. Independence is regarded as an interactive process, which entails actions by both the educator and the learner (Grundy 1987:151). The educator provides structured guidance by means of assignments to complete or problems to solve, while learners go one step beyond merely searching for and retrieving information. Within the context of this study, the learners are referred to relevant printed and electronic information sources, including the Internet, as well as resource persons. These resources enable them to obtain the information, knowledge and guidance required to achieve the objectives of the given assignment, or to solve the given problem.

2.6.4.3 Fostering an interdependent, collaborative learning climate

Collaboration and interdependence can be fostered electronically. Computer-mediated communication allows for the free exchange of information (Billings & Halstead 2005:160). Educational communication occurs amongst learners, between learners and educators, and between learners and other expert resource persons. E-mail, bulletin board, synchronous chatting or video conferencing facilities are utilised. Electronic communication expands learners' horisons, enabling them to correspond with learners and experts in different countries, and opening them up to enriching cultural experiences. Electronic communication has particular educational benefits. The theory is that learners may feel more comfortable expressing themselves in virtual reality, and that facilitators can give more personalised attention to each learner (Andrews 1999:5; Malloy & De Natale 2001:191).

Electronic communication enables learners to collaborate and to complete their assignments without having to share the same geographical space. E-mail is an effective means of asking for advice or sharing of views, ideas and assignment inputs. One can attach electronic documents to mail messages, instantly duplicate and forward mail, and perform many more tasks that are cumbersome or impossible with a paper messaging system.

There is also the possibility of establishing online forums, which are dedicated to a particular educational topic. The Internet supports electronic structured group discussions and sharing of

ideas, which are facilitated by the educator. Electronic forums support focused discussions unlike the traditional group discussion where learners are to come together, and may end up chatting about irrelevant and sociable topics. Available resources are bulletin boards or chatting forums. Learners and the educator can post their views on a particular topic, or their contributions towards a learning assignment, on a bulletin board. This forms the basis for collaboratively contributing towards a learning assignment, and receiving constant educator and peer group feedback. Each new contribution very quickly appears on a screen, under a topic heading for others to read either immediately or later (Price 2003: 117). Responses to any contribution is automatically linked to the contribution and to the other responses. It is therefore possible for learners and educators to follow the line of reasoning. The identified line of reasoning that learners maintain could form the basis for the educator's input. By studying the line of reasoning, the educator is able to identify learning problems or faulty reasoning, and rectify this. From the educational perspective, the typed text typed appearing on the screen of each person participating in the conversation will benefit slow learners. They can go back to the typed text, or print it out, and study it on their own.

An alternative form of group discussion is through chatting. The educator creates a chat room focusing on a specific topic. A specific time and date is set because this is a synchronous communication tool. The educator's contributions are aimed at ensuring that learners' contributions are focussed on the given topic. The educator can also contribute by posing challenging questions or suggestions that would stimulate further discussions (Price 2003: 117).

Video conferencing facilities enable groups of learners and educators, who are geographically separated, to interact (Quinn 2000:260). Video conferencing supports verbal interactions between learners with the added value of providing video linkages. Those who partake in a video conference session are able to see and hear each other. Learners from various geographical areas can form a discussion group without having to travel to a communal setting. It also enables educators to engage in tele-teaching.

2.6.5 Establishing a virtual classroom and online learning

The current paradigm shift in higher education necessitates that educators supplement their teaching in traditional classroom settings with distance education program delivery via the WWW. Higher education is developing towards the establishment of an electronic classroom, which is also referred to as the virtual classroom. The virtual classroom is an imaginary

classroom that is created electronically. The Internet is utilised to simulate a classroom setting in virtual reality, and to foster interdependence, interaction and collaboration without geographic proximity between those involved in the educational venture. Virtual classrooms are characterised by a combination and integration of multimedia learning material, electronic information access and electronic communication (refer to sections 2.6.3 & 2.6.4). The heart of the virtual classroom is a course web-site, which comprises course material delivery, personalised learner web pages and course administration web pages. In addition, provision is made for synchronous and asynchronous electronic communication.

From the perspective of the educator, a virtual classroom supports course delivery, teaching, learner support, educational management and research. From a learner perspective, it supports access to course material and resources, and interaction with peers, educators and field experts. The virtual classroom also enables learners to manage of their own learning. In addition, learners can buy items such as books and computer programs through online shopping (Reader's Digest 1999:195). Virtual classrooms and online learning are appropriate strategies to foster learner centred education that is responsive to their learning needs. It promotes learner autonomy as learners have control over their learning.

Virtual classrooms can be utilised at any setting where a learner can gain access to information-communication technologies. It can be at home, or at a computer centre, which is situated in an educational institution or clinical setting. The virtual classroom supports online and offline learning. Online learning occurs when learners are logged on to the Internet and the Web (Ryan, Carlton & Ali 1999: 272). Offline learning occurs when learners study downloaded learning material without being logged on to the Internet.

A study was conducted in the United States of America, to evaluate learners' perceptions of two educational approaches involving the same topic. One group of learners was exposed to traditional classroom teaching and another group to online learning. The findings revealed that online learning contributed more to the development of learners' technical skills than the classroom teaching option. It also promoted the development of critical thinking to a greater extent than the classroom teaching option. While some learners preferred face-to-face contact with the educators and their peers, others preferred the online learning option. The overall finding of this study was that learners tended to favour online learning. The findings also revealed that effective technical support contributes towards minimising the stress levels and frustration among learners and educators (Ryan et al. 1999: 272-276).

A nursing program in a Southwest university incorporated an interactive computer classroom as part of its baccalaureate curriculum. To improve attendance and participation in a final semester management course an electronic meeting system, also known as group support system, was introduced. This system combined a computer network and computer software tools that support group interaction. The learners had the option to attend the classroom sessions, or to log on to the classroom proceedings while at home or work. The distant learners used a keyboard to participate in-group activities that occurred in the classroom. Those learners who attended class were able to see the distant learners' inputs on a large screen in front of the classroom. The distant learners followed the proceedings on their individual monitors at home or at work. The research revealed that this combined approach enhanced the learning process by stimulating group involvement, increasing group interaction, and improving critical thinking skills (Andrews 1999:5).

2.7 COMPUTER ASSISTED INSTRUCTION

2.7.1 Introduction

Developments in research, knowledge generation and technology require that nursing learners move beyond merely relying on textbooks in their quest of gaining knowledge. Other resources, such as electronic resources, need to be utilised. Furthermore, in the clinical settings nurses ought to be able to utilise and manage advanced healthcare technologies and health information systems. The competencies that they require have been outlined in the previous section. In this study, the researcher proposes that exposure to computer assisted instruction and computer-based learning would equip learners with various skills that are required for effective healthcare delivery. In this section the researcher covers aspects related to computer assisted instruction, which would support computer-based learning.

2.7.2 The essential characteristics of computer assisted instruction

Computer assisted instruction refers to educational programs that provide learning experiences guided by the computer (or more recently information-communication technologies, which include the computer) (Joos et al.1996:225). Computer-based learning is a term used to cover the utilisation of a wide variety of teaching applications, which provide learners with interactive

learning experiences while utilising electronic information, communication and educational resources (Quinn 2000:261).

Computer assisted instruction encompasses all educational activities that require and involve information-communication technologies (Schoolcraft & Novotny 2000: 156). These technologies are utilised to integrate a number of teaching functions such as:

- presenting learning material in text and/or multimedia format
- providing supplementary learning material in addition to the traditional textbook
- facilitating information searches by using the Internet
- facilitating interactive learning activities by utilising videoconferencing facilities
- diagnosing learning needs and problems
- assessing learning engaging in remedial activities

(De Young 2003: 177; Quinn 2000:260-261).

Nurse educators have initiated several efforts towards integrating computer technology in the curriculum. Some of the earliest work centred on in-class or learning resources centre applications such as computer assisted instruction tutorials, simulations and interactive video. This entailed using computer assisted instruction complementary to traditional teaching. Recently, nurse educators have developed strategies for introducing nursing learners to the information superhighway. This is achieved by utilising the Internet for educational purposes. Learners study a given topic independent of educator input in the traditional sense of the word (De Young 2003: 177; Elfrink, Davis, Fitzwater, Castleman, Burley, Gorney-Moreno, Sullivan, Nichols, Hall, Queen, Johnson & Martin 2000:136).

2.7.3 The educator's role and responsibilities in computer assisted instruction

The implementation of computer assisted instruction and supplementing paper-based with electronic-based information constitute revolutionary developments in education. This has taken place in an educational environment that itself is undergoing revolutionary change (Cleverly 2003:117). These revolutionary changes necessitate that educators change their educational practices accordingly. It is the responsibility of the educator to orientate learners towards the educational applications of information-communication technologies in general, and computer assisted instruction in particular. They must ensure that learners are computer literate. Furthermore, learners ought to be clear about the roles and responsibilities of educators and

learners. Learners are encouraged to reflect on their own attitudes towards these technologies and the educational applications as part of their overall orientation (Cleverly 2003:16).

The educator must ensure that there is a proper fit between the chosen educational software and the learning outcomes. For example if the outcome is to change learners' attitudes towards the elderly, an interactive case study may be more appropriate than a content-based tutorial about the basic needs of the elderly. Likewise, appropriate educational computer software must be chosen to enable learners to master the course content, to develop their psychomotor, technical and intellectual skills, and to ensure their affective development (De Young 2003:177).

Educator guidance is required to provide some structure to independent learners in the learning environment. Educator guidance is given in the form of tasks and activities that learners need to complete. The educator also refers learners to the necessary electronic resources, which would enable them to complete their learning tasks independently. The educator can refer the learners to the web sites that comprise collections of documents relating to a specific topic, to search for information. In this regard URL's should be made available to the learners (Quinn 2000:264). This will promote learners' independence in the learning process within the boundaries of professional education.

Nurse educators ought to extend their area of practice by including virtual reality. E-mail has brought about a revolution in the way learners and educators in education communicate with each other. E-mail has proved to be extremely useful for maintaining tutorial contact with learners. It is particularly useful for learners' comments on draft assignments, facilitating a very quick turnaround of feedback to the learners. E-mail tutoring is computer-mediated-tutoring or computer-mediated conferencing, a type of computer conferencing, which allows learners and educators to engage in asynchronous discussions issues in "virtual groups". Hence, an educator may initiate activities by placing it onto the server, and the learners in a virtual group can respond at any time of the day or night. Learners and educators may initiate and respond to each other's inputs just like a live seminar but with the advantage of not having to be in the same place at the same time (Quinn 2000:263-264).

2.7.4 Theoretical foundations of computer assisted instruction

Learning theories communicate their proponents' views of people and the way they learn. Learning theories provide frameworks for studying the processes associated with learning. As

such they endeavour to answer questions about the key elements of learning (Nicklin & Kenworthy 1995: 23). As indicated in the following sections, several learning theories underlie computer assisted instruction.

2.7.4.1 Behaviourism

Behaviour is defined as a muscle movement. It is a result of a series of conditioned reflexes, emotions and thought processes. Peoples' behaviours constitute responses to specific stimuli. Behaviour is learned through conditioning (De Young 2003:16). The behaviourist learning theories emphasise the importance of associations between stimuli and responses during the learning process (Quinn 2000:14). Even complex learning occurs through conditioning. Classic conditioning occurs when a natural reflex occurs in response to a stimulus (Behaviorism: http://www.funderstanding.com/behaviorism.cfm). Learning is demonstrated through observable behavioural changes. Learners demonstrate the new knowledge or skills that they acquired, through observable and measurable actions (Welsh & Swann 2002:41).

The behaviourist learning theories maintain that learners are exposed to appropriate learning stimuli in logical sequences and in increasing levels of complexity. Behavioural theorists propose that stimulus–response bonds are strengthened by reinforcement. Thus behavioural or operant conditioning occurs when an appropriate response to a stimulus is reinforced (Behaviorism: http://www.funderstanding.com/behaviorism.cfm; De Young 2003:16). Reinforcement occurs by rewarding appropriate or punishing inappropriate learner behaviours immediately after it has been demonstrated (Behaviorism: http://www.funderstanding.com/behaviorism.cfm; Quinn 2000:111). Educators who apply operant conditioning would therefore develop an appropriate reward system to reinforce appropriate learning. Behaviourism supports an educator-centered educational approach. Educators who adhere to the behaviourist approach would apply computer assisted instruction that is based on the principles of programmed learning, mastery learning, and drill and practice (refer to section 2.7.5.1).

2.7.4.2 Constructivism

Constructivism is based on the premise that knowledge cannot be transferred from one person to another. Knowledge is an understanding, which is generated from past and present learning experiences. New knowledge is constructed within individuals through their personal

experiences. Learners are ultimately responsible for their own learning. Learning has occurred when internalisation has taken place. Internalisation is manifested in the ability to carry out, independently in similar settings, the skills that the learner has acquired in collaboration with others. Constructivism supports learner-centered learning. Cognitive constructivism focuses on how an individual learner gains understanding of things, and social constructivism emphasises that meanings and understandings grow out of social encounters (De Villiers 2001:36; Vygotsky 1978: 56-57).

Cleverly (2003:19-20) and Vygotsky (1978: 56-57) propose characteristics that typify constructivist learning environments. Individuals construct new knowledge by interpreting and giving meaning to their experiences or circumstances. Constructivist learning environments therefore emphasise knowledge construction instead of knowledge reproduction. Learners are actively involved in a process of knowledge generation, as opposed to being passive recipients of the educator's teachings. Learners utilise their minds to understand and make sense of what they encounter while they interact with the learning material, educators, peers and learning resources. Reflective learning is therefore encouraged. This enables learners to make sense of their learning experiences by linking new information with their cognitive structure of existing knowledge. Learners' autonomy is acknowledged, since the processes of the search for meaning, and the substance of meanings are unique to each individual (Jonassen 1994 cited in Constructivism: http://www.coe.uh.edu/-ichen/ebook/ET-ITconstr.htm).

Constructivist learning environments provide multiple representations of reality to capture the complexity of the world, thus avoiding over-simplification. Learners are exposed to various perspectives and contexts to enable them to gain in-depth understanding of the learning material. Constructivism emphasises authentic tasks in a meaningful context rather than context-free abstract instruction. Real-world or case-based learning experiences, instead of predetermined sequences of instruction, are provided. Learning is not limited to classroom settings and is rather closely related to reality. Linkages with reality are established by exposing learners to real life or simulated settings (Cleverly 2003:19-20).

Jonassen (cited in Constructivism: http://www.coe.uh.edu/-ichen/ebook/ET-ITconstr.htm) and Vygotsky (1978: 56-57) further stated that constructivist learning approaches facilitate context and content–dependent knowledge construction through interactive learning. It requires engagement with the learning task whether working individually or collaboratively with others. Learners become interactively engaged with the learning material, learning contexts, peers and

educators. Constructivism supports inquiry-based learning. Learner-centred education is provided by applying the principles of, for instance problem-based learning (refer to section 2.7.5.3). The role of the educator is conceptualised as a facilitator who assists learners in becoming increasingly independent in developing their cognitive abilities.

The educator promotes learners' progress towards higher levels of cognitive abilities. The educator does this by providing guidance when learners are unable to perform tasks independently, while allowing learners increased independence as their abilities required to perform the said tasks develop. The educator mediates between information-communication technologies, learning experiences, the learning content and the learners. She/he poses questions or assignments to learners, and can place obstacles in their way in order to stimulate learners' creativity and problem-solving abilities.

Social constructivism suggests that the learner is actively involved in a joint enterprise with the educator and fellow learners in creating new meanings. It emphasises how meanings and understandings grow out of social encounters (Constructivism http://www.coe.uh.edu/-ichen/ebook/ET-ITconstr.htm).Learning is viewed as a socio-cultural process, whereby learners grow into the intellectual life of those around them. Through social interaction the external social world of the individual is linked to his/her internal mental process (De Villiers 2001:35-36).

Multimedia technologies (refer to sections 2.6.3 & 2.6.4) and learning packages which support discovery learning, problem-based learning and simulations (refer to sections 2.7.5.2, 2.7.5.3 and 2.7.5.5) are in accordance with constructivism. Social constructivism can be applied in computer assisted instruction by utilising the principles of collaborative learning (refer to section 2.7.5.6). This can be done by organising learners in learning groups, either within a shared geographical space or in virtual reality (refer to section 2.6.5).

2.7.5 Educational approaches associated with computer assisted instruction

Computer assisted instruction can be rendered by applying various educational approaches, as indicated below.

2.7.5.1 Mastery learning and programmed learning

Mastery learning is an approach that is based on behaviourism (refer to section 2.7.4.1). Its main goal is the attainment of excellence of performance (Quinn 2000:118). Mastery learning takes the view that there are individual differences in terms of learners' abilities to achieve the required levels of achievement. However, it is premised on the assumption that all tasks can be learned by learners provided they are exposed to the appropriate stimuli, and are given sufficient time to master the content. A sequential approach to learning is therefore maintained. Learning tasks are sequenced from lower to more complex tasks. The sequences are designed to ensure that virtually every learner can reach the required level of achievement, namely the mastery level. Learners who struggle achieve mastery of learning are supported and encouraged by the educator. This is done through, amongst others, repetitive learning. Emphasis is based on making learning to be fun and learners to be active participants (Quinn 2000:118-119).

Mastery learning can also be facilitated through programmed learning. The fundamental notion of programmed learning is that of reinforcement of learning. Programmed learning is applied through electronic self-learning modules (Quinn 2000:117). De Young (2003: 156) defines a self-learning module as a self-contained unit or package of study materials, which learners study on an individual basis. For each topic to be mastered, the learners are guided through sections comprising pre-tests, learning objectives, learning content, learning activities and learning assessment (post-test). The learning material is organised so that learners are guided through increasing levels of complexity (in terms of scope and depth) of the learning material.

The pre-test helps learners evaluate which sections of the module they may skip over and which ones they need to study in depth. Learning activities are designed to help the learner to achieve the learning objectives. The post-tests are used to determine whether the learners have mastered the module objectives. Based on the results of the post-test, the learners proceed to a next level of the same module, or repeat the learning material, which was not mastered. The intention is to assist the learners to achieve the level of mastery. Once the content of a particular module has been mastered, the learner would proceed with another module (De Young 2003:158). Modules are either linear or branching. Linear modules offer information in very small steps with immediate reinforcement in the form of feedback of correct or incorrect answers, and scores obtained. The learners proceed through a pre-defined series of topics. Branching programmes provide the learners with a series of choices. In this multiple choice situation the learners are required to select an answer to a question raised in each frame form a choice of answers

supplied. Each particular choice would determine the direction of the subsequent learning experiences, which may include remedial work (Quinn 2000:118).

Both mastery learning and programmed learning can be applied in computer assisted instruction. An example would be a linear or branching module on the anatomy and physiology of the nervous system. The computer can determine mastery before allowing the learners to proceed to more advanced levels of content and learning assessment. These programs automatically keep electronic record of the learners' progress, which can be accessed by the educator (Conrick 1998:2).

2.7.5.2 Discovery learning

Discovery learning is an educational approach during which educators create opportunities for learners to embark on a process of self-directed inquiry, which would result in learning. Discovery learning is predicated on the existence of an intrinsic motivation, in humans, to learn. Discovery learning involves learners in discovering the structure of a subject through active involvement as opposed to memorising seemingly unconnected facts. It can be divided into pure and guided discovery. Discovery learning occurs in an interactive learning climate. There should be cooperation between the learners and educators for discovery learning to be a success (Knowles 1990:83-84,90; Quinn 2000:98).

In applying discovery learning, the educators act as facilitators of learning, who have confidence in the learners' abilities to make appropriate plans and arrangements for their learning. The educators guide the learners towards utilisation of learning resources (Knowles 1990:84). They ensure that any new material being taught is first explained in terms of its basic structures and principles. This is done by providing a general overview of the main principles and concepts until learners are well immersed in them. The educator's role is to pose questions, related to the topic areas that would stimulate the learners to seek advice, discover new information, generate ideas and evaluate ideas. The learners then embark on a mission of discovering the finer detail, which would enable them to answer the posed questions, using whatever resources, that are available (Quinn 2000:99). Within the context of this study, the resources include information-communication technologies. The information access, communication and educational delivery properties of these technologies support discovery learning.

2.7.5.3 Problem-based learning

Problem-based learning is an approach to learning that involves confronting learners with real life problems that provide a stimulus for critical thinking and self-directed learning (De Young 2003:153; Quinn 1995:19). It can be utilised in conjunction with discovery learning. An educator creates a problem having a solution in mind. That problem is then presented to the learner to solve. To solve the given problems, the learners must have a clear idea of the problem or goal being sought, and gain the necessary information that would support problem solving. They must be able to recall and apply previously learned rules that relate to the current learning situation (De Young 2003:28). Problem-based learning encourages open-minded, reflective, critical and active learning (Welsh & Swann 2002:119).

Problem-based learning provides the learner with the opportunity for guided discovery learning. The educator gives guidance in the classroom setting where computer assisted instruction is used complementary to traditional teaching, or electronically if the virtual classroom is utilised (Quinn 2000:19). The learners have control over their own learning within the framework of the problem that they have to solve. The problem can be given in class, or be disseminated electronically. In solving the problem the learners are required to utilise relevant sources to gather the information, which is required to engage in informed decision-making. The learners are usually provided with potential sources of information from which to draw their solution. They can use many resources, including electronic resources to obtain information and expert assistance to assist in the problem-solving process. The learners can explore and seek solutions to problems by gathering electronic information, and seeking assistance from experts in the given field (Quinn 2000:19).

Recent advances in information-communication technologies and educational software, paved the way for the development of computer-based multimedia learning packages that use complex scenarios which are aimed at helping the learners in developing clinical judgement and problem solving skills. The learners have to solve a series of problems and make appropriate judgements to be able to successfully proceed through the learning packages (Joos et al. 1996:224).

2.7.5.4 Gaming

Multimedia computer technology supports the gaming teaching strategy. Electronic educational games focus on either the content or the process of learning. Content games focus on teaching or

reinforcing factual information. Process games are those that emphasise problem solving, decision-making or application of information. Games can also be used for learning assessment purposes. Electronic educational games incorporate a set of rules, and an element of competition and fun. Computer games require one or multiple players. Educational computer games provide most enjoyable learning experiences, which increases motivation for learning. Gaming increases interaction among learners and allows even quiet reserved class members to participate (De Young 2003:147). Networks and the Internet enable groups of learners to participate without the players having to use the same computer, or having to share a geographical space.

2.7.5.5 Simulation

Simulation is an imitation of some facets of life, usually in a simplified form. It aims to put learners in a position where they can experience some aspect of real life by becoming involved in activities that are closely related to it (Quinn 2000:382). De Young (2003:183) states that a simulated situation can be created in virtual reality in which learners interact with a virtual world. An example of electronic simulation computer software is multimedia anatomy packages, which allow learners to build the human skeleton by dragging and dropping individual components in the appropriate location. The computer would accept appropriate and reject inappropriate placements.

Intelligent simulation software can be used to create patient care settings, which require decision-making. The simulated settings allow the learners to make decisions, as opposed to merely learning the theory of decision-making. These software applications allow the learners to engage in decision-making without causing any damage, as inappropriate decisions will not harm a simulated patient. When they make decisions in a simulation of reality, they can see the immediate consequences. If the results are undesirable, they can backtrack and look at the factors that led to a poor decision. An educator can assist the learners in gaining insight into why a decision was either effective or ineffective. The learners will therefore learn the consequences of their decisions. The use of intelligent simulation to develop clinical decision making skills is also ideally suited to a problem based learning approach (De Young 2003:145; Garrett & Callear 2001:382).

2.7.5.6 Collaborative learning

Collaborative learning provides opportunities for teams of learners to cooperatively complete their learning assignments, or engage in problem-based learning. The talents of each learner are used to solve problems and they learn form each other. Participation in problem solving groups encourages critical thinking and is also motivating, as the solutions are creatively derived from the contributions by the group members (Quinn 1995:19). For the learners to work collaboratively they need to engage in learning strategies that involve active learner participation (Billings & Halstead 2005:160). Such strategies include discovery learning (refer to section 2.7.5.2), problem-based learning (refer to section 2.7.5.3), gaming (refer to section 2.7.5.4) and simulation (refer to section 2.7.5.5).

This cooperation can occur in the real life setting or through electronic means. The learners can form face-to-face or virtual groups (De Young 2003:226). Collaborative learning can be promoted in virtual reality by establishing an interdependent, interactive learning environment (refer to section 2.6.4.3) and by creating a virtual classroom (refer to section 2.6.5). The educators enable the learners to participate in group discussions, share their insights with others and collaboratively work on assignments. Communication can be verbal, through e-mail, bulletin boards, chatting, and video conferencing. The learners can further be directed to relevant web sites and experts that would assist them in gaining the relevant information to complete their learning assignments. The completed assignments can be placed on bulletin board or on a personal web site created especially for completed work, and which form part of the virtual classroom. Reward systems are group oriented rather than individually oriented.

2.7.6 Benefits of computer assisted instruction

Graverly and Fullerton (1998:186) cite Kooker and Richardson (1994) who said that recent advances in computer technology offer several advantages and opportunities.

2.7.6.1 Access and quality

Computer assisted instruction increases the quality and standards of education systems and institutions (Mangena 2002:16). Well-developed software eliminates the problem of poor lesson presentation, which often characterises lecture presentations. Aspects such as fatigue, boredom and loss of attention could be minimised (Quinn 1995:214). Computer assisted instruction also

excludes human error, as computers do not forget to include information as humans sometimes do.

Computer assisted instruction is viewed by many as the solution to the education crisis faced by many societies (De Young 2003:169; Strydom 2000:11). It supports the endeavours of educators to increase access to education through the provision of distance education. In nursing education the distance component enables the learners to engage in computer-based learning at home or at a remote clinical setting, in addition to the traditional college-based approach. Due to the improved access, learning can be formalised on a continuous basis even when learners are allocated to the clinical settings to gain clinical experience.

2.7.6.2 Benefits for learners

Computer assisted instruction enables the learners to exercise control over where and when to study, and it allows them to direct their own learning (Rouse 1999:171). It also assists the learners to set their own pace of studying. The learners can switch the computer off and go for a walk to restore their concentration, even before a lesson has been completed (Quinn 2000:262). Being comfortable with the pace of learning, gives learners the freedom to embark on a voyage of discovery (Joos et al.1996:226; Modly et al. 1995:136).

Computer assisted instruction increases the possibility of having enjoyable learning experiences. The individualised nature of computer assisted instruction leads to decreased experiences of peer pressure or pressure on the part of the educator. The learners experience more freedom to learn from their mistakes, or to repeat sections, which they struggle to understand. This promotes learning retention. (Joos et al.1996:226).

Information-communication technologies support a variety learning activities. The learners have increased access to updated course material, which is disseminated in electronic format. These technologies are valuable for generating and storing study notes, retrieving information, completing projects, and writing papers and presentations. The learners' engagement in the various applications associated with computer assisted instructions contributes towards the development of a variety of skills in learners. Examples are higher cognitive, psychomotor, and technical skills which are increasingly important in the modern healthcare environment (De Young 2003:169,177). Computer assisted instruction is also utilised to facilitate learning in the cognitive and psychomotor domains. The learners can learn procedures like physical assessment

by means of multimedia computer packages. This technology would enable the learners to watch the procedure repeatedly, while also engaging in cognitive activities related to the gathered data. During a follow-up session, the procedure can be practised, under the supervision of the educator, by using a model or involving a real patient (De Young 2003:174).

Computer assisted instruction provides the learners with an interactive learning climate (Rouse 1999:171). The learners become involved in the learning experience (Nicklin & Kenworthy 1995:64). Learner involvement enhances interest in learning and improves retentive memory (Rouse 1999:171). For example, multimedia technology provides the learners with integrated learning experiences, which involve seeing, hearing and doing. Learners retain knowledge better if they see, hear and act in the learning process. Research indicates that learners retain 20% of what they hear 40% of what they see, and 75% of what they see, hear and do (Rouse 1999:171).

Computer assisted instruction supports flexibility with regard to engaging in independent or collaborative learning in the process of discovery learning (De Young 2003:169; Joos et al.1996:226). The learner can show initiative in discovering new knowledge, and then share the newly gained knowledge with their peers. Alternatively knowledge can be sought collaboratively. Computer assisted instruction enables the learners to communicate with their peers, educators and relevant field experts around the world, irrespective of time or geographical constraints (Schoolcraft & Novotny 2000:156). Synchronous and asynchronous communication applications enable the learners to discuss issues in virtual groups. Video conferencing supports tutorial group meetings (Quinn 2000: 264). Their newly acquired knowledge can be disseminated to their peers and the educator by means of electronic presentations. Such tutorial meetings provide excellent opportunities for learners to develop their electronic presentation skills, using MS PowerPoint, for example.

Computer assisted instruction and the utilisation of information-communication technologies, enable learners to keep up to date with the latest developments in the health sciences, because it provides easy access to the latest information and knowledge. This is in contrast to text-books, which are infrequently updated and become rapidly outdated.

In South Africa a study by Myburgh et al (1999:41) revealed that a computer assisted instruction initiative provided stimulating learning experiences to nursing learners. Co-operation between the group members, the sense of security associated with group work, the sense of competition between the various groups and the hands-on learning approach contributed towards an

environment conducive to learning. The educators became actively involved in teamwork, and interacted with the learners. The nursing learners experienced a sense of empowerment because they were forced to think outside their normal frame of reference. The learners also experienced a sense of achievement based on their capability to generate solutions to problems.

2.7.6.3 Benefits for educators

Computer assisted instruction frees the educators from the repetitious aspects of teaching and enables them to become more of a facilitator of learning and communication, than a transmitter of information. It eases their workload and allows more time for course development (Schoolcraft & Novotny 2000:156). Information-communication technologies empower the educators to creatively utilise a wide variety of teaching applications that stimulate the development of higher order thinking skills and problem-solving skills in learners (Malloy & De Natale 2001:191).

Computer assisted instruction enables the educators to electronically disseminate learning material and information to the learners in a time saving way (De Young 2003:169). They are also able to constantly update the course material. Furthermore, MS PowerPoint has enabled educators to develop creative presentations, which can incorporate text, sound, animations, photographs and video clips (De Young 2003: 174). These electronic slide presentations can be either presented in class or disseminated electronically to learners. The presentations can be sent by e-mail, or posted on the WWW (Quinn 2000:261).

Computer assisted instruction facilitates educational administration. The educators can track the progress of the learners and identify learning problems. Records of the learners' performance can be kept on the computer. The educators can enter these performance records into the computer. However, many electronic educational applications automatically save data related to learners' performance in its data-base, as the learners proceed through the tutorials (De Young 2003:169). Electronic learner data-bases save time as it becomes unnecessary to manually manage and update paper-based learner files. Furthermore, it provides easy access to learner information.

2.7.7 Problems associated with computer assisted instruction

There are various problems that hamper the effective utilisation of information-communication technologies to render computer assisted instruction.

2.7.7.1 Infrastructure problems

Access to information-communication technologies may be hampered due to financial reasons and inadequate infrastructures. These equipments are expensive to buy. Learners from a poor background cannot afford to buy, update and maintain expensive electronic equipment. In many developing countries frequent power failures, unreliable telephone connections, and high electricity and telephone costs hamper effective implementation of computer assisted instruction. Inappropriate equipment and software, poor maintenance of equipment, poor technical support and out-dated systems are obstacles to effective computer assisted instruction and computer-based learning. Furthermore, the educators may experience frustration due to slow equipment delivery and installation where well-equipped computer centers do not exist (Papo 2001:95). Too often, hardware and facility improvements are funded without the resources necessary to help educators make significant changes in courseware and teaching methods.

2.7.7.2 Problems related to the learners

Computer assisted instruction becomes problematic if learners are forced to participate in this teaching and learning strategy. Each and every learner has his/her preferred way of learning. Some learners prefer attending lectures and consulting textbooks. Some may feel insecure, still preferring the presence of an educator in the teaching-learning situation. Many learners are not technologically minded. Fear of change and lack of self-confidence in utilising information-communication technologies are serious problems. Some learners may be very slow in developing the attitudes and skills required to effectively utilise these technologies. There is also a possibility that the learners will focus more on the hardware than on their learning outcomes (Quinn 2000:262).

At times information-communication technologies may lead to a loss of personal contact among the learners, and between the educators and learners. This can lead to feelings of alienation, perceived lack of support, and the absence of a sense of community among those involved in the educational venture.

2.7.7.3 Problems related to the educators

Negative attitudes and poor educator commitment may exist. Technology means little unless the educators and learners are committed to using it in a class-room setting as a teaching and learning tool (Mangena 2002:16). As already explained in section 1.2.3, there may be reluctance on the part of educators to use information-communication technologies as a way of improving their teaching practices (Papo 2001:95). This reluctance may be a result of outdated views on education, opposition to change, lack of training, or inappropriate equipment and software. The result may be that educators do not utilise information-technological equipments optimally and effectively.

In many instances, educational institutions supply sophisticated equipment and skilled programmers, but fail to offer the relevant training and support to the educators. Often there is inadequate provision for time to master the new technologies and their educational implications (Wilson & Nativio 2002:47-48). A lack of proper training may result in a trial and error approach, which can lead to breakage of the equipment or ineffective time management, which may hamper course delivery (Schoolcraft & Novotny 2000:157). Furthermore, it may lead to feelings of insecurity among educators, which would negatively impact on their performance. While some educators are flexible and not afraid of change, others may fear new challenges, prefer to remain within a comfort zone, and resist change. As a result, they may still rely on the traditional methods of learning like the lecture method, irrespective of the availability of information-communication technologies at the educational institution. In this case there will be inconsistency among the educators as far as their facilitation practices are concerned, and this may hamper learning by learners.

2.7.7.4 Problems related to the institution

Computer assisted-instruction requires a significant investment on the part of the educational institutions, educators and learners. Adequate resources must be available for the educators to ensure the successful introduction and development of computer assisted-instruction. There are high costs involved in establishing and maintaining the facilities supporting computer assisted instruction. Hardware, educational software, support services, and training require investments on an ongoing basis in order to remain current. Often where relevant training and technical support are lacking, a cycle of misuse, broken equipment, disruptions and high costs of repair

ensue. Furthermore, broken equipment, equipment under repair, and equipment being upgraded can cause disruptions in delivering the educational programme if planning is not properly done (Joos et al. 1996:226; Schoolcraft & Novotny 2000: 159).

2.8 CONCLUSION

The development of computer assisted instruction applications coincided with the historical development of information-communication technologies. Social changes and technological developments in health information systems necessitate that nurses possess certain competencies. Nursing learners have to acquire the required competencies to work in technologically advanced healthcare settings, and to utilise and manage electronic health information systems. The researcher maintained that the required competencies could be developed through exposure to information-communication technologies in the class-room setting. This can be achieved through computer assisted instruction, which can be applied in various formats. Computer assisted instruction has many benefits, but also poses certain problems, which need to be overcome. The researcher envisioned that this research study would contribute towards optimising computer assisted instruction in nursing education. The research design and method are outlined in the next chapter.