AN INVESTIGATION INTO THE USABILITY OF ASYNCHRONOUS INFORMATION TECHNOLOGY FOR A VIRTUAL E-LEARNING INFORMATION SHARING ENVIRONMENT AT A UNIVERSITY IN SOUTH-AFRICA

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously, in its entirety or in part, submitted it at any university for a degree.

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ABSTRACT

Institutions for tertiary education are now more than ever realising the advantages of supplying the growing population with more effective and flexible learning environments through the integration of technology based media. Educational institutions are faced with the challenge of embracing technological changes within the educational domain in order to maintain their competitive position within a global arena. The University of Stellenbosch, as many other tertiary educational institutions, are challenged to view them as being part of an integrated knowledge society responsible for the reproduction of knowledge as a national and global commodity. The recent acceptance of an explicit strategy concerning educational processes and the creation of an Electronic Campus ensured that the University of Stellenbosch would maintain their strategic position through the development and improvement of the quality of the central education, research and community service functions within the university.

The purpose of the research conducted within the boundaries of the University of Stellenbosch were to enhance and improve the quality of the learning and information sharing processes between various role players through the exploration of available communication media and the examination of relevant concepts.

The specific objectives of the study comprise the following:

- **Objective One:** Through the use of alternative subjective and objective test methods, including observation and the use of a questionnaire to conduct an empirical study to evaluate the usability of the various asynchronous computer based communication media, with specific focus on course management systems, and video streaming;
- **Objective Two:** Make recommendations based on the findings of the study to potential users of the alternative media and applications in terms of the limitations and benefits;
- **Objective Three:** To use the findings, together with an examination of the user needs and applicable concepts, to make recommendations to assist in future decisions regarding the value of the integration of these media into the creation of a high value interactive virtual learning environment;
- **Objective Four:** Given the findings, to make recommendations for future research.

Empirical tests were conducted in order to examine the usability of WebCT and Microsoft Producer as it was anticipated that the degree to which the communication media adds value and enhances the education and information sharing process will be influenced by the usability

of the specified media and the role players' perceived need for the specific media. Empirical test were descriptive in nature and included survey research methods and usability laboratory tests.

In summary, the data obtained shows that the sample population holds favourable attitudes with regard to the usability of both Microsoft Producer and WebCT. WebCT and Microsoft Producer holds the potential for enhancing and improving the quality of the learning and information sharing processes between role-players within the University of Stellenbosch by providing a useful, reliable, easy to use, consistent, compatible, learnable and likeable system. The integration of WebCT and Microsoft Producer in the context of the University of Stellenbosch will enable role-players to complete their educational and research activities with accuracy in a timely competent and economical fashion.

OPSOMMING

Instellings vir tersiêre opvoeding is nou meer as ooit bewus van die onmiskenbare voordele verbonde aan die beskikbaarstelling van meer effektiewe en buigsame leer omgewings aan 'n groeiende studente getalle deur die integrasie van tegnologie gebasseerde media. Opvoedkundige instellings word toenemend uitgedaag om die geleenthede wat die tegnologiese veranderinge in die opvoedings domein vergesel aan te gryp. Die Universiteit van Stellenbosch word, soos vele ander tersiêre instellings, uitgedaag om hulself te beskou as deel van 'n geintegreerde kennis gemeenskap, verantwoordelik vir die reproduksie van kennis as 'n nasionale en globale kommoditeit. Die onlangse aanvaarding van 'n eksplisiete strategie aangaande opvoedkundige prosesse en die ontwikkeling van 'n elektroniese kampus het verseker dat die Universiteit van Stellenbosch sy strategiese posisie behou deur die ontwikkeling en verbetering van die kwaliteit van die sentrale opvoedings, navorsings, en gemeenskapsdiens funksies binne die Universiteit van Stellenbosch.

Die doel van die navorsing wat binne die grense van die Universiteit van Stellenbosch uitgevoer is was om die kwaliteit van die opvoedings- en informasiedelings prosesse tussen verskeie rolspelers te verbeter deur die verkenning van beskikbare kommunikasie media en relevante konsepte.

Die spesifieke doelwitte van die studie kan as volg uiteengesit word:

- **Doelwit Een:** Om deur die gebruik van alternatiewe subjektiewe en objektiewe toets metodes, insluitende observasie en die gebruik van 'n vraelys, 'n empiriese studie uit te voer met die oog op die evaluasie van die bruikbaarheid van verskeie asinkrone rekenaar gebasseerde kommunikasie media, met spesifieke fokus op kursusbestuurstelsels en videostroomingstelsels;
- **Doelwit Twee:** Om aanbevelings te maak gebasseer op die bevindinge van die studie aan potensiële gebruikers rakende die alternatiewe media en hul gebruike in terme van tekortkominge en voordele;
- **Doelwit Drie:** Om die bevindinge te gebruik in samewerking met 'n evaluasie van die gebruikers se behoeftes en toepaslike konsepte, ten einde aanbevelings te maak wat toekomstige besluitneming sal dryf aangaande die waarde van die integrasie van die bogenoemde media in die ontwikkeling van 'n hoë waarde interaktiewe skynwerklike leer omgewing;
- **Doelwit Vier:** Gegewe die bevindinge om aanbevelings te maak vir toekomstige navorsing.

Empiriese toetse is toegepas ten einde die bruikbaarheid van WebCT en Microsoft Producer te bepaal, aangesien daar verwag is dat die graad waartoe die kommunikasie media waarde sal toevoeg tot die opvoedkundige en informasie delings proses, beinvloed sal word deur die bruikbaarheid van die gespesifiseerde media asook die rolspelers se behoefte vir die spesifieke media. Die empiriese toetse kan as beskrywend geklasifiseer word en behels die gebruik van opnames en bruikbaarheids laboratorium toetse.

Die data toon aan dat die rolspelers se houding teenoor die bruikbaarheid van Microsoft Producer en WebCT uiters positief is. WebCT en Microsoft Producer die het die potensiaal om die kwaliteit van opvoeding en informasie deling tussen rolspelers binne die Universiteit van Stellenbosch te kan verbeter deur die beskikbaarstelling van 'n bruikbare, betroubare, gebruikers vriendelike, konsekwente, verenigbare, leerbare en aangename stelsel. Die integrasie van WebCT en Microsoft Producer in die konteks van die Universiteit van Stellenbosch sal rol-spelers instaat stel om hul navorsings en opleidings aktiwiteite met akkuraatheid en bevoegdheid te voltooi.

To *Theunis Johannes Scholtz and Tertia Scholtz*

my parents, my support in every way, with all my love

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

Educational institutions for tertiary education are under enormous pressure to supply the growing population with more effective, flexible learning environments. The pressure stems not only from the growing population but also the increasing diversification of the population, the government policies promoting education for all and the increasing cost of education. The growth of knowledge itself exerts tremendous pressure. Educational Institutions are now realising the need to change and are increasingly transforming towards the creation and implementation of virtual learning environments as a possible solution to satisfy demands.

To understand the full extent of the transformation of an institution for tertiary education, it is best to turn to the international, national and local context for explanations of trends and demands.

1.1.1 International Context

Academic institutions and leaders in the field of learner centered education have in recent years placed great emphasis and focus on the extraordinary influence that the technological revolution had on the higher educational sector. Although the technological revolution will not necessarily demolish the residential traditional tertiary education model, no educational institution can afford to ignore its influence. The ideal would rather be to successfully integrate technology as a resource within the current model of tertiary education. (Van der Merwe, 2001).

Richard Katz (cited in Van der Merwe, 2001, pp. 9-10) made a number of assumptions regarding the influence that technology will exert on educational institutions and their methods of knowledge sharing, which are listed below.

These assumptions highlight the fact that the successful integration of technology has the potential of adding value to the existing educational models.

- Within the near future, high-speed, economically accessible network capacity will exist not only nationally but to a great extent globally;
- Affordable multimedia-capable computers will be commonplace, and most leading institutions for tertiary education will assume student ownership of such devices;
- Graduate education programs within institutions for tertiary education, will become an export commodity;
- Educational institutions will deliver a larger portion of their instructional offering via communication networks;
- The ability to deliver quality education that meets the prospective students' geographical and scheduling needs will become increasingly important; and
- Laws that govern intellectual property will change significantly.

1.1.2 National Context

The development and implementation of the 1996 Report of the National Commission on Higher Education, the 1997 White Paper on Higher Education, and the 1997 promulgation of the Law on Higher Education, drastically changed the nature and methods of education within tertiary educational institutions (cited in Botha, 1998, p.2; Van der Merwe, 2001, p.12). The most prominent effect of this change is that institutions for tertiary education are now paying more attention to the realisation of the national vision for Higher Education by employing new and improved approaches to learning and education.

The National Commission of Higher Education proposes that the transformation of higher education in South Africa should be focused on the following factors:

- The broadening of the current student population to include various social groups;
- A more conscious observance and reaction to the social needs and interests of South Africa; and
- Improved collaboration between higher educational institutions, the private sector and the government (Botha, 1998; Van der Merwe, 2001).

1.1.3 Local Context: The University of Stellenbosch

The fact that technology will change the future vision of education becomes relevant in developing countries such as South Africa. It is of utmost importance that educational institutions within these countries embrace technological changes if they wish to remain part of the global academic terrain. This also holds true for the University of Stellenbosch. The University of Stellenbosch should without a doubt develop the infrastructure and knowledge in the field of electronic information technology in order to maintain their competitive position within a global arena (US, undated).

The recent acceptance of an explicit strategy concerning learning and educational processes at the University of Stellenbosch are in line with world trends, that does not view education as a private or closed interaction between individual lecturers and a group of students. Educational institutions are challenged to view themselves as being part of a greater 'knowledge society' responsible for the reproduction of knowledge as a national and global commodity (US, 2002).

Recent developments at the University of Stellenbosch indicate that the institution is in no way isolated from the national and international trends with regard to higher education:

- During December 1997, the University of Stellenbosch executed a process of strategic planning with regard to a broad spectrum of activities. The acceptance of the Strategic Planning Framework during April 1999 marked the completion of this process and brought about the development of a workforce responsible for integrating the framework's principles into broader activities;
- The University of Stellenbosch developed an Institutional Plan (2000-2002) with regard to strategic educational decisions that binds it to the delivery of quality education, and focuses their actions on the continual renewal and creation of effective educational opportunities;
- The effective use of technology within the educational arena has been recognised as a priority and reality within the University of Stellenbosch, leading to the creation of the Electronic-Campus Initiative (US, undated; Van der Merwe, 2001).

Besides the successful implementation of technology for educational reasons, it has been the vision of the University of Stellenbosch to be regarded as a research institute of world standard and proportions through the maximisation of communication and information technology. This vision contributed towards the development of the electronic campus (E-Campus) initiative and the formulation of questions regarding the possible creation of a virtual information environment (US, 2001).

1.1.4 E-Campus Initiative

The main driving force behind the E-Campus initiative is the development and improvement of the quality of the central functions within the University of Stellenbosch namely: Education, Research and Community Service. The purpose of the E-Campus is thus to create a "Networked University" by adapting the central function and integrating information and Communication Networks. As a starting point, the University of Stellenbosch created an E-Campus Forum consisting of the Vice-Rector (Education), Vice-Rector (Research), Senior Director (Library Services), Senior Director (Information Technology), Senior Director (Distance Education), Director (University Education), Deputy Registrar, Task Group for Learning and Education (TGLO) e-learning work group representative and the Advisor: Digital Learning and Education. The E-Campus Forum, in collaboration with various stakeholders, will ensure the successful implementation of the E-Campus initiative, its vision and value statements (Van der Merwe, 2001, 2002).

The E-Campus' central vision states that the University of Stellenbosch strives towards the establishment and extension of a high quality academic environment within which information and communication technology has been integrated effectively.

The E-Campus incorporates the following principles and approaches in their general value statement:

- A model combining traditional and non-traditional contact sessions;
- The incorporation of technology in the educational activities of the University of Stellenbosch;
- A student centered approach; and

- An instrumental process approach rather than a deterministic approach to the use of technology (US, undated; Van der Merwe, 2001).

The E-Campus initiative developed a total of 26 general projects, all striving towards the attainment of the above mentioned vision and value statement. The study described in this thesis forms part of the E-Campus Initiative Project known as the Virtual Information Sharing (VIS) Project, under the management of the Information Services at the University of Stellenbosch.

The project consists of two parallel research studies, both studies having the same rationale and overriding definition. The studies differ with regard to their respective focus points, in the sense that the first study focuses on asynchronous (not real-time) computer based communication media while the second study focuses on synchronous (real-time) computer based communication media.

This study reports on the asynchronous elements of the VIS project, which will therefore form the focus point of subsequent discussions.

1.2 RELEVANCE OF THE STUDY

The relevance and value of the study for the University is summarised in terms of the following:

1.2.1 Compliance with the universities strategic priorities

- The project outcomes will contribute towards the development of a community of excellence in that it will provide insight into the usability of asynchronous communication and information sharing systems;
- The project will contribute to research towards improved efficiency through the identification of potential improvements in communication deficiencies between researchers;
- The project focuses on the usability of IT systems with regard to knowledge sharing between students and will thus contribute to the improvement of student centered education principles;
- Information sharing and communication will improve and will in turn contribute to the competitiveness of the University;

- The improvement in information sharing will inevitable improves the quality of education and research;
- The project will contribute to the networking abilities of the University by suggesting usability criteria; and
- The project will contribute to the realisation of information and technology oriented academic community.

1.2.2 Effectiveness and Efficiency

The research results may indirectly influence the expenditure of the University by highlighting limitations of current systems and making contributions towards the effective usage of facilities and systems.

1.3 DESCRIPTION AND RATIONALE OF THE RESEARCH

The rationale of the research is to enhance and improve the quality of the learning and information sharing processes between role-players within the University of Stellenbosch, through the exploration of available communication media and the examination of relevant concepts. The underlining rationale of the study is not to interfere with current academic activities on campus but rather to evaluate the channelling of the academic discourse through the various electronic media channels under investigation. Full recognition is given to the fact that an asynchronous communication media and learning environment are not a replacement for the traditional classroom. The contextual framework of the study can be described in terms of figure 1.1.

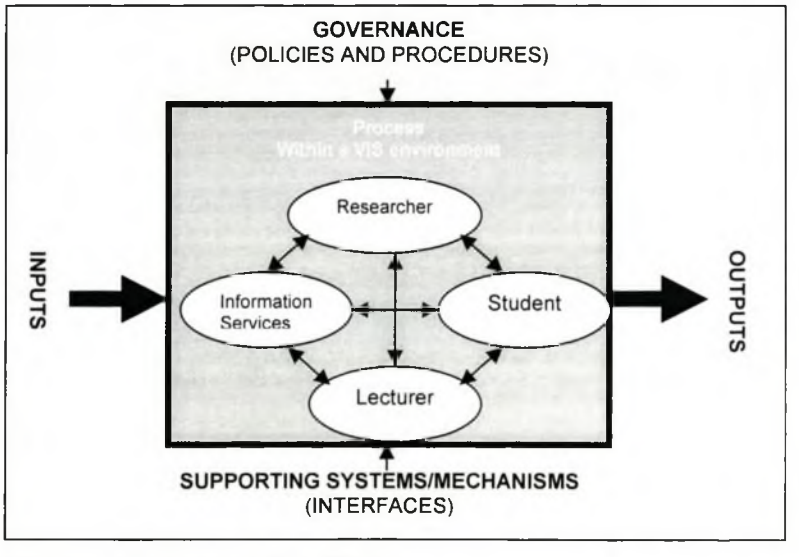

Figure 1.1 Focus of the Study

The key focus of the research centres on a process within a virtual learning and information sharing environment where role-players can communicate and share information. The figure shows that with sufficient inputs from the parties involved, this process will lead to certain outcomes, such as improved learning and information sharing. In order to fully achieve the desired outcomes, the process requires underlying supporting systems and/or mechanisms, such as web-based communication media. The process will also be influenced by the rules, regulations and procedures stipulated within the context of the larger organisation. These rules, regulations, and procedures will impact on the process and thus the outcomes achieved by the process. The research will mainly focus on the examination of the communication and information sharing process and its underlying supporting systems imbedded into asynchronous environments within the scope of interaction between the role-players, as set out in figure 1.2.

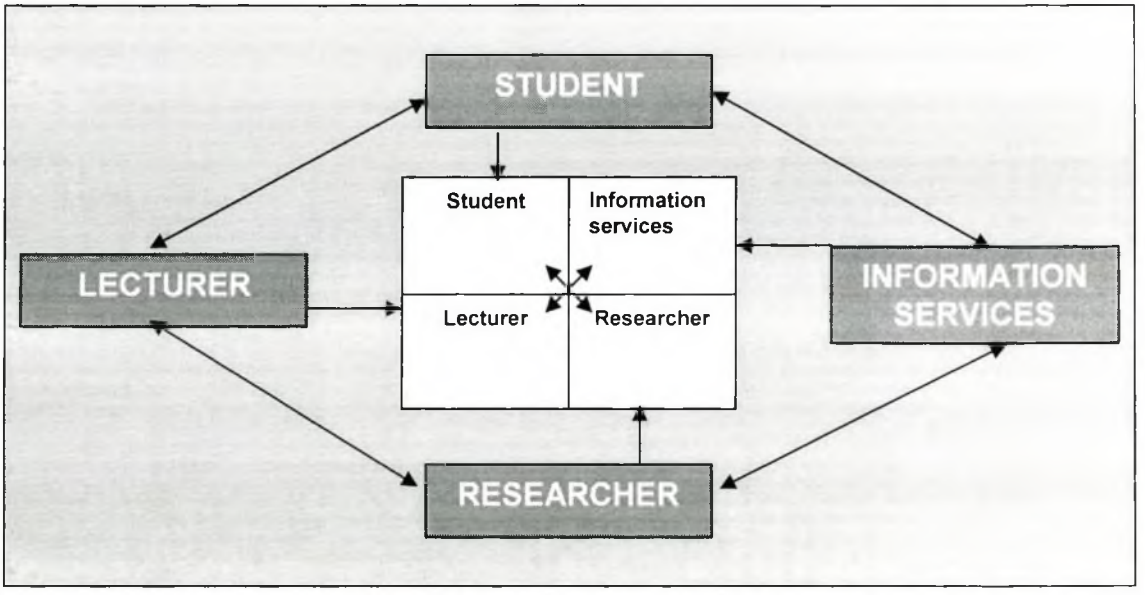

Figure 1.2 Direction of Communication and Information Sharing Processes between Role-Players

1.4 THE AIM AND OBJECTIVES OF THE RESEARCH

The aim of the study is to conduct empirical research in order to quantify and test the usability of asynchronous communication media and learning environments and to examine and describe the end users' perceived need for the specific communication media with specific focus on the application of these media in the on- and off campus tertiary education environment and more specifically, but not exclusively, on postgraduate level.

The specific objectives of the research can be summarised as follows:

- **Objective One:** Through the use of alternative subjective and objective test methods, including observation and the use of a questionnaire to conduct an empirical study to evaluate the usability of the various asynchronous computer based communication media, with specific focus on course management systems, and video streaming;
- **Objective Two:** Make recommendations based on the findings of the study to potential users (information service providers, lecturers, students and researchers) of the alternative media and applications in terms of the limitations and benefits;
- **Objective Three:** To use the findings, together with an examination of the user needs and applicable concepts, to make recommendations to assist in future decisions regarding the value of the integration of these media into the creation of a high value interactive virtual learning environment; and
- **Objective Four:** Given the findings, to make recommendations for future research.

In order to achieve the objectives described above, the following boundaries have been identified as feasible and attainable within the scope of the study.

1.4.1 Description of current asynchronous communication media

- Defining the interfaces to be tested namely, Web-CT and Microsoft Producer;
- Clearly defining usability and identifying the ways in which usability will be tested;
- Testing the usability of the interfaces in order to make clear recommendations in terms of the usability of the two mentioned interfaces; and
- Identifying limitations and benefits of the interfaces, and assist in future decision making regarding the purchasing of certain interfaces and their inclusion in the creation of a virtual learning environment.

1.4.2 Describing the value of the identified media

Identification of the value added to communication and learning processes, in terms of asynchronous modes of communication. This will be done by means of a literature study of the relevant concepts and learning principles.

1.4.3 Analysis and description of the users' perceived need for specified media

- Description of specific communication and information sharing needs identified by role-players before the usability testing by means of a needs analysis questionnaire;
- Description of specific communication and information sharing needs identified by role-players after the usability testing by means of a needs analysis questionnaire; and
- Identification of discrepancies between pre-and post needs analysis. Discrepancies will assist in the identification of future training and interface exposure needs.

1.5 ORGANISATION OF THESIS

Chapter 2 of the thesis presents a review of the relevant literature aimed at placing the study in the context of virtual learning environments with specific focus on theories pertaining to distance education and web-based education.

Chapter 3 of the thesis presents an in-depth view of the usability issues relevant to the study and places usability within the context of ergonomics and human-computer interaction. This chapter further includes a definition of usability and a description of the usability performance measures and the available usability evaluation methods.

Chapter 4 describes the research methodology used to conduct the research. The research problem, hypothesis and research design are described in a systematic manner. Chapter 4 also includes a detailed description of the sampling methods and the measuring instruments employed in the study.

Chapter 5 presents a descriptive discussion of the key results obtained from the objective and subjective measurements.

In Chapter 6 the final conclusions are made and the main findings of the research are discussed. Chapter 6 further presents the problems and limitations of the study as well as recommendations for future research.

CHAPTER TWO
REVIEW OF LITERATURE: GENERIC CONCEPTS

2.1 INTRODUCTION

Schneider and Godard (1996, p.1) proposed that "Virtual Environments for education, research and life are integrative cyberspaces where many users can communicate and collaborate in various ways. They can also build virtual like offices, books, blackboards, artificial persons and more. Virtual Environments should also provide optimal support for information storage, retrieval and manipulation".

This survey of literature aims to investigate the current status of available systems which facilitate learning and communication between various role-players, by making education and resources available and accessible to a wider audience.

The creation of integrative virtual learning environments is becoming increasingly important, due to the fact that increasing numbers of people need and desire education, leading to an increase in the variety of student characteristics encountered in the educational arena. A growing number of prospective part-time students with families to support are demanding flexible distance education methods in order to accommodate their current lifestyle. In recent years, due to economical changes, education has become not only an investment in time, but also an investment in financial terms. This necessitates educational institutions to provide students with a service that justifies the cost. Lastly, the alarming rate at which knowledge is produced motivates the transgression towards adaptable learning environments that will enable people to maintain contact with current knowledge (McCormack & Jones, 1998).

Various concepts worthy of discussion and examination become evident when the transgression towards an Integrative Virtual Environment is considered, which form the basis of the survey of literature. Figure 2.1, depicts the proposed relationship between the concepts.

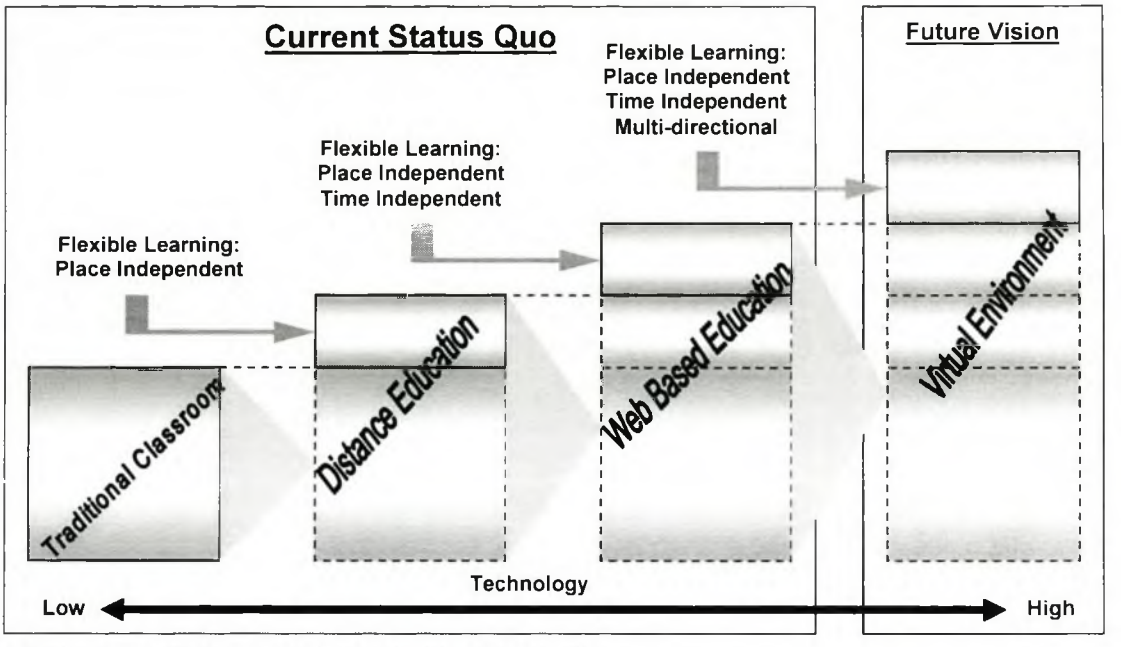

Figure 2.1 Relationships between Concepts

Figure 2.1 depicts various levels of educational advancement, with each level building on the principles of the previous level. The traditional classroom context can be viewed as the most primitive communication medium available. The traditional classroom also represents the most widely used media, with the least technological constraints. Adding the principle of flexible learning and place independent education to this equation forms the next level of education, namely distance education. Time independence, if added place independence, lead to the creation of web-based education. The highest level of educational advancement, the integrative virtual learning environment, adds an advanced element, namely multi-directional communication. This level, however, represents the media with the most technological constraints, which also currently makes it the least available and accessible media. The figure also shows the first three levels as representing the current status quo of education in South Africa, while the last level represents the future vision towards which the educational arena are progressing, specifically in terms of communication media.

The literature review to follow will provide a knowledge base about the generally regarded 'ideal situation' versus current state of affairs. This contributes towards the development of conceptual models which can be investigated in future research in this domain. Firstly the various levels of educational advancement is discussed, starting off with the future vision, and then turning to an in depth look at usability testing, as relevant to educational media.

2.2 FUTURE VISION: INTEGRATIVE VIRTUAL ENVIRONMENTS

The term 'virtual' refers to "...something whose existence is simulated with software rather than actually existing in hardware or some other physical form" (Hiltz, 1995, p.5). Virtual Reality is a highly interactive, computer-based multimedia environment in which the learner becomes an equal participant with the computer in a virtual world (Kim & Soo-Song, undated). The words of Micheal Benedikt (cited in Loeffler, undated, p. 2) more accurately describe the full extent and depth of the concept of virtual reality.

> "In this world, onto which every computer screen is a window, actual, geographical distance is irrelevant. Objects seen or heard are neither physical, nor, necessarily, representations of physical objects, but are rather – in form, character, and action – made up of data, of pure information."

Microcomputers were first used in educational setting in the late 1960's. Since then, instructional designers have sought ways to use the available technology to make a real difference in education and training. This vision led to the development of virtual reality, a technology that began in military and university laboratories more than 20 years ago. Virtual Reality is a rapidly growing medium for training, entertainment and education, and offers significant opportunities for improvements in both access to and the quality of education. Virtual Reality can also provide many opportunities to enhance student learning and solve particular educational problems by increasing the consistency, reliability and quality of what is delivered to the student (Jorge, 1995; Moshell & Hughes, 1996; Rice, Owies, Campbell, Snow, Owen & Holt, 1999; Schneider & Godard 1996).

Virtual Reality will lead to improvements in the quality of education for the following reasons: firstly these unique environments are collaboration tools, secondly the immersion quality of virtual environments can enhance learning, and thirdly virtual environments also offer a chance to renew or change pedagogues (Jorge, 1995; Moshell & Hughes, 1996; Rice et al., 1999; Schneider & Godard, 1996).

As education media, these teaching and learning environments are located within a computer-mediated communication system that is accessible at any time and place. These communication structures can either resemble facilities and procedures used in traditional classrooms, or they can support forms of interaction that would be difficult or impossible in the traditional classroom environment, such as supporting a group-oriented educational experience for an online community of learners. Virtual environments

typically integrate multiple communications and media layers that adapt to the users and not the other way round. A virtual classroom is in essence a complex set of ever-shifting states where the subjective perspectives of the participants equally contributes to what happens in the virtual classroom as does the technology (Hiltz, 1995; Schneider & Godard 1996).

Virtual environments can focus wider than the individual classroom and the activities thereof. A truly integrative virtual environment can be established to shift its focus to all elements pertaining to, for example, the campus setup of educational institutions. It is, therefore, possible to integrate various activities besides the lecturing activities, such as research activities, and the information services with related activities. The integration of these activities also allows for the incorporation of various role-players who could in some way contribute to the communication, information sharing, knowledge acquisition and learning processes within the environment. Within the virtual environment a scenario can be created that allows multi-directional communication to take place, where role-players can acquire information, organise information, preserve information and ultimately make information available to a larger audience. These environments can lead to the acquisition of knowledge and the more effective management of knowledge which, in turn, can add tremendous value to the learning and researching processes of the role-players.

Traditional classrooms do not permit the full integration of the above mentioned activities and role-players and is limited to mainly one-way communication between the lecturer and student. On the other hand, the technology imbedded within a virtual environment does allow for this type of integration to take place. Virtual environments allow for innovative, flexible ways to represent, manipulate, and access information. It also provides alternative ways of communication and promotes the accessibility and generation of new resources. This is especially true for the research arena, where the virtual environment can facilitate the assembling of critical masses of intellectual and economic resources to create new, more advanced forms of research and teaching. These environments allow for facilitation of new levels of inter-institutional and international collaboration, making learning and resources widely, almost universally available.

The virtual environment has the potential to change the nature of the relationship between role-players. The student's intellectual inquisitiveness, properly stimulated, will replace the didactic force of the teacher as the main driving force to learning and

communication. Role-player becomes in a sense equal partners in the quest for more effective and efficient learning, communication and information sharing (Jones & Pritchard, 1999).

Leading directly from the advantages of Virtual Learning Environments is the promotion and enabling of communities of practice.

2.2.1 Communities of practice

Communities of Practice are in essence groups of individuals with a common purpose and who share some common background, language, experience or other fundamental characteristic. Communities of practice enable participants to engage in a wide range of topics with their peers and subject matter experts, providing a unique opportunity for networking. The main purpose of communities of practice is to provide members with a forum for knowledge sharing, collaboration and knowledge management. Organisations are realising that knowledge within the organisation should be treated as a vital resource especially in times of globalisation and information overload. Knowledge management involves the identification, sharing creation and development of knowledge, providing the members with the opportunity to learn from one another. Numerous organisations are currently employing communities of practice in order to effectively manage knowledge within the organisation as a resource (Hildreth, Kimble & Wright, 1998; Khan, 1997).

Despite the obvious advantages stated previously, virtual learning environments still present some obstacles and barriers in terms of development and implementation that need to be accounted for.

2.2.2 Obstacles facing virtual reality learning environments

The introduction of Virtual Reality Learning Environments in the educational sector, promising as it might seem, faces two major obstacles. First and foremost there is a problem with funding. The introduction these environments can be a highly expensive exercise and with declining budgets it seems unlikely that many educational institutions will set a high priority when it comes to Virtual Reality. Secondly, many educators still resist the introduction of computer-technology by hanging on to tried and tested methods of education. In addition, most educators

already labour long hours, and few have time or the desire to incorporate a tool as sophisticated and unfamiliar as Virtual Reality into their curriculum. Role-players may also resist the new technology because it will require them to alter their perceptions, models of thinking, working and learning. New technology also requires the acquisition of new skills. Virtual Reality in the educational domain is still in early developmental stages and not much research has been done on the true value that Virtual Reality adds to the learning process. This leads to resistance from educators who find it difficult to account for learning in a virtual environment (Higgins, 1997; Homan, 1994).

2.2.3 Five dimensions of learning

Learning within any educational setting occurs across five complex interrelated and interdependent dimensions. Within virtual learning environments it is especially important to account for learning across all five dimensions as listed below:

- **Confidence and Independence:** Educators often underestimate confidence and independence as an essential aspect of learning, mostly due to the fact that it is difficult to account for this dimension using conventional methods of evaluation. However, they are essential dimensions of a learners' development and can be observed and interpreted over time;
- **Skills & Strategies:** This dimension represents the "know-how" aspect of learning. When learning has occurred along this dimension, students will be able to function successfully in certain situations. This dimension thus refers to the specific 'performance' and 'mastery' of the student;
- **Use of Prior and Emerging Experience:** This dimension refers to the student's ability to apply their knowledge obtained from prior experience as well as emerging experience to new situations;
- **Knowledge and Understanding:** Knowledge and understanding is the most familiar dimension and the easiest dimension to account for. Knowledge and Understanding focuses on the 'know-what' aspect of learning; and
- **Reflections:** Reflections refers to the student's ability to consider a given situation critically and analytically, with growing awareness of his or her own learning processes (Syverson & Slatin, 1995).

2.2.4 Research within the field of virtual reality

Besides the obvious lack of research pertaining to the value added to learning, Virtual Reality poses a number of pressing research challenges. Biocca (1992) identified six broad categories of research challenges, namely:

- Research on the diffusion of Virtual Reality Technology;
- Communication Design and Cognition;
- Interpersonal Communication and Cooperative Work in Virtual Environments;
- The Psychological Presence of Virtual Reality;
- Virtual Reality and Work, Power, and Leisure; and
- The Cultural Presence of Virtual Reality.

No medium including Virtual Reality as a medium for communication and education is truly 'revolutionary'. New media such as Virtual Reality usually builds on the codes, conventions and principles of past and currently used media. Therefore, in creating a research agenda to study Virtual Reality technology, researchers should build on what is already known of the processes and the effects of the current media (Biocca, 1992).

In accordance to the definition stated above, virtual environments can be seen as a more advanced future distance learning and web-based education tool and should abide to the theories concerning currently used distance learning and web-based education in order to be affective as an educational tool. In the paragraphs to follow, distance learning and web-based learning will be reviewed as key focus areas of the study.

2.3 DISTANCE EDUCATION

> "Distance education takes place when a teacher and student(s) are separated by physical distance, and technology, often in combination with face-to-face communication, is used to bridge the instructional gap" (Willis & Dickinson, 1997, p.81).

Distance education and distance learning are interchangeable terms, both referring to a process that connects learners and instructors who find themselves in different locations. Distance education has moved away from simple correspondence courses, video and

satellite broadcasts, to a more ambitious and flexible process that incorporate a variety of technologies, learning methodologies, on-line collaboration and facilitation techniques. The ultimate goal of distance education is to provide a flexible, anytime/anywhere educational experience in order to achieve a high degree of applied learning results not possible from traditional education (Jackson, 2002).

2.4 WEB-BASED LEARNING

Figure 2.1 depicts the concept that web-based learning represents the last level of the current educational advancements, which is also the level nearest to the realisation of the future vision.

Web-based learning can be defined as the innovative delivery of interactive training or education to remote audiences using the Internet or Intranet as delivery medium. It is the structured transfer of skill or knowledge that utilises the attributes and resource of the World Wide Web to create a meaningful learning environment. The way this interactive learning is designed and implemented varies greatly among institutions (Khan, 1997; Mark, undated).

Depending on the design and implementation, web-based learning programs can lead to the realisation of many potential advantages.

The formal goal of web-based education systems is to improve both access to and the effectiveness of education and research. Web-based programs achieve this goal by the provision of flexible location and time, less travelling and wasted time, shared work space, participation opportunities and regulated feedback (Hiltz, 1995). Refer to figure 2.2 for further possible advantages and disadvantages of web-based programs for improving access and effectiveness.

FACTORS RELATED TO EDUCATIONAL ACCESS

ADVANTAGES	DISADVANTAGES
Location (Where you are)	Limited offerings
Flexible time	Equipment requirements
No travel	Delayed feedback
Less wasted "overhead"	Textual skills required
Shared work space	Technical skills required
Participation opportunity	

FACTORS RELATED TO EDUCATIONAL EFFECTIVENESS

ADVANTAGES	DISADVANTAGES
Collaborative learning opportunities	Absence of audio-visual media
More active learning	Requires motivation/regular participation
Availability of other computer resources	Potential "information overload"
Complete notes	

Figure 2.2 Advantages and Disadvantages of Web-based Education for the Improvement of Access and Effectiveness

(Hiltz, 1995, p.14)

2.4.1 Advantages of web-based learning

- A major advantage of web-based learning is that it provides total flexibility in the time to learn. Students can continue according to their individual tempo and participate at any time of the day or night, never feeling pressured to rush through an assignment. There is no need to keep pace with anyone else because the desire to learn awakens from within. Students have the opportunity to delve more deeply into areas of genuine interest, helping them to better understand and grasp the material at hand;
- Students may take any course from any instructor from any institution in the world;
- An advantage of web-based learning is that students can potentially receive feedback faster. Lecturers will have more flexibility to provide timely feedback to the student's questions and ideas, while at the same time monitoring their progress. Opportunities for feedback from the instructor and interaction with other students are not limited to a few scheduled interface sessions per week;

- Well designed web-based learning emphasises learning, not mere memorisation. By means of providing challenging assignments, elimination of the need for frequent exams a reduction in associated stress can be manifested. The student's ability to assimilate learning may be measured rather than the ability to excel under pressure;
- Theoretically comprehension may improve. Students can begin to comprehend and retain more of what they learn because they may feel more relaxed using web-based instructional programs;
- Web-based learning programs deliver stimulating course work by using multiple human senses. Information can be presented stimulating audio and visual senses through digitised dynamic visual presentations with graphics and animation, including video;
- Web-based learning allows students access the most up-to date information;
- Web-based learning holds the potential to maintain student interest, as a curriculum can be designed to become interactive and capture more attention, in turn unlocking the student's natural creativity and inventiveness;
- Web-based learning, being more impersonal, allows all students an equal opportunity to ask questions and make comments, even if they find it difficult to formulate ideas into words;
- Web-based learning creates a unique environment which allows active interaction between role-players, promoting the exchange of information that would have been difficult in a traditional classroom setting;
- The learning process becomes flexible and self-directed, encouraging and empowering students to develop their own methods of study. This holds particular value for adult education;
- Web-based learning allows students to explore academic subjects in the same way that they explore the world around them, given the potential flexibility;
- With web-based learning students are able to publish work for a wider audience and is no longer dependent only on lecturer feedback. This makes learning more rewarding since students receive feedback from peers and other interested parties; and
- Lastly, web-based programs have the potential of making course work more assessable to a larger audience of students with diverse customs, manners, expectations and literacy levels (Eustace, 1994; Hiltz, 1995; Springs, 2001).

Following directly from above mentioned advantages, web-based learning supports the following notions:

- Catering for diversity;
- Metacognitive processes;
- Flexibility in learning styles;
- Social integration;
- Commitment to learning through active engagement and learning communities;
- Web-based learning thus acknowledges that learning and teaching is transformational, allowing students and lecturers to collaborate more intensely; and
- Web-based learning is cost effective, and encourages anytime, any place, any role and anywhere learning, exposing them to the ideas and knowledge of colleagues and mentors (Langford, 1999).

2.4.2 Disadvantages of web-based learning

- Only a select group of educational institutions offers a limited choice of web-based courses;
- Within every web-based program certain equipment requirements exist, making access inconvenient for those who do not have enough resources to obtain the equipment needed;
- Web-based learning requires a certain level of self-discipline, and some passive learners may fall behind;
- Web-based learning requires participants to at least have some technical skills and knowledge of computer programs; and
- Over emphasising social interaction within web-based learning environments, may in effect nullify the authoritarian role of the educator or subject matter expert (Firdyiwek, 1999; Hiltz, 1995).

With the background on virtual environments, distance learning and web-based learning, the following section will examine asynchronous learning environments as an example of a specific web-based learning mode, in more depth.

2.4.3 Asynchronous Learning

'Asynchronous' and 'Synchronous' are terms associated with web-based education and distance learning and refer to the specific mode in which communication takes place within these environments. Asynchronous and synchronous modes of communication do not refer to a specific tool or medium, but rather to the time dimension of communication. To further clarify the meaning and the relationship between the terms, please refer to figure 2.3 for an exposition of the relevant terminology.

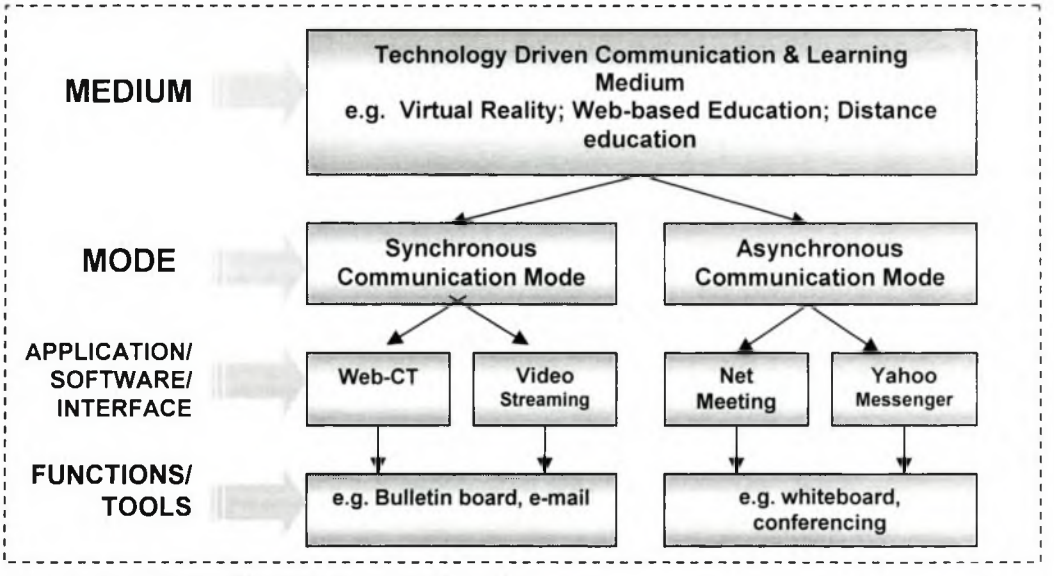

Figure 2.3 Exposition of Relevant Terms

Asynchronous learning can be defined as "...making remote learning resources such as instructors, fellow students, text, and software, accessible at any time and place trough electronic access, without the requirement to be online at the same time" (Colgate, 1999, p.1).

When the student and lecturer come together at the same time, the teaching/learning process can be described as "synchronous". When the teaching/learning process takes place at any time, as the definition reflects, the process can be described as asynchronous. Both these processes can be accomplished in a place-dependent or place-independent manner (Rochester Institute of Technology, 2000).

The following table provides a summarised comparison between asynchronous and synchronous learning, for contextual clarification purposes.

Table 2.1 Comparison between Asynchronous and Synchronous Communication

Asynchronous: **Definition:** Teaching/ learning process takes place at anytime	**Synchronous:** **Definition:** course instructor and students come together at the same time
Advantages: ▪ Do not need to disrupt critical parts of live; ▪ Collaborative or group learning is more easily accomplished when group members do not need to mesh schedules; ▪ More active participation encouraged through computer conferencing; ▪ Fit course work into their own schedules that works best for them; ▪ Some student communicate best in asynchronous mode; ▪ Sharing of work may be more easily accomplished; ▪ Learning styles and disabilities easier accommodated; self pacing learning is facilitated.	**Advantages:** ▪ Most people have experience with this mode – more comfortable; ▪ Students can see each other's eyes, facial expression, body language; ▪ Students participate in activities under the direction of the instructor; ▪ Immediate feedback; ▪ Audio and or visual media delivery is not limited by current computer technology.
Disadvantages: ▪ Visual and aural cues are reduced or absent; ▪ Requires self-direction and self-motivation; ▪ Students need instructor assistance to feel a part of a 'course community' in this mode; ▪ Providing laboratory and studio experiences for students may be more challenging; ▪ Feedback to questions and comments is delayed; ▪ Estrangement.	**Disadvantages:** ▪ Must gather in the same place and time; ▪ Leave responsibilities to attend classes; ▪ Students may choose to be passive, although present.
Where and When: ▪ Anytime, anywhere access; ▪ Sometimes incorporates synchronous activities and elements.	**Where and When:** ▪ Feel of class depends upon technology used.
The experience: ▪ Courses emphasise collaboration and communication; ▪ Students and instructor connected via e-mail and online discussions.	**The experience:** ▪ Feel of class depends upon technology used; ▪ Real time interaction between interaction between instructor, onsite and remote students.
Tests: ▪ Alternatives such as writing assignments, open-book exams, and problem-solving often used in-lieu of traditional exams.	**Tests:** ▪ Off- site proctors sometimes utilised.
Faculty-Student interaction outside class: ▪ Office hours offered via e-mail, phone or fax; ▪ On-line discussions.	**Faculty-Student interaction outside class:** ▪ Office hours offered via e-mail, phone or fax.
Student interaction outside class: ▪ Joint projects developed through use of collaborative software; ▪ E-mail, chat groups, ListServ for on-line discussions.	**Student interaction outside class:** ▪ Group study; ▪ ListServ or chat groups for online discussions.
Types of Delivery Systems: ▪ Videotape, Broadcast/ Cable TV, Streaming (A&V) Audiocassette, CD-ROM/ Multimedia, Integrated Course Delivery Packages.	**Types of Delivery Systems:** ▪ Broadcast/Cable TV, Satellite, ITFS, Videoconferencing, Audio conferencing, Audio graphics, Streaming (A& V).
Choose asynchronous activities when: ▪ Learners are from a wide span of time zones and countries; ▪ Learners have inflexible or unpredictable work schedules; ▪ Learners cannot wait for a class to form; ▪ Learners have unique individual needs.	**Choose synchronous activities when:** ▪ Learners need to discuss issues with other learners at length; ▪ Learners need the motivation of scheduled events reinforced by peer pressure; ▪ Most learners share the same needs and have the same questions.

(Extracted from CSUS, undated, pp.1-5; Horton, 2000, p.57; Rochester Institute of technology, 2000, pp.4-6)

Figure 2.4 depicts the possible combinations of time and place. Figure 2.4 further illustrates that the technology used may differ between the two modes of teaching/learning.

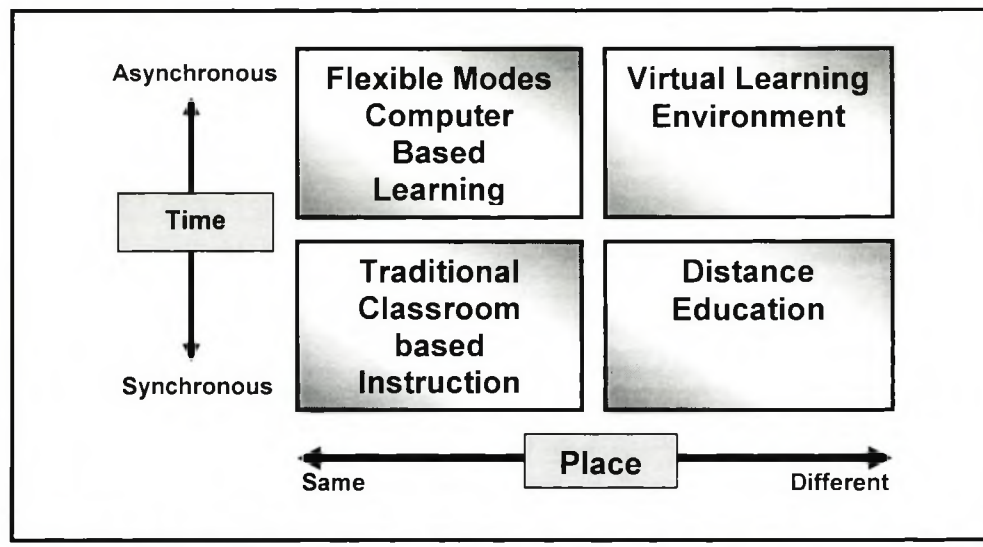

Figure 2.4 Asynchronous vs. Synchronous: Combinations of Time and Place (Hedberg, Brown & Arrighi, 1997, p.48)

Any given course need not be either asynchronous or synchronous, but might be a combination of the two processes. The ideal design mode of teaching will depend to a great extent on the demographics and characteristics of the population, as well as on other factors pertaining to learning and communication (Rochester Institute of technology, 2000).

(a) Traditional classroom vs. asynchronous learning environments

The most significant difference between traditional classrooms and asynchronous leaning environments is that the traditional classroom makes use of a 'same place; same time' principle, where as the virtual classroom uses a 'more flexible time and place independent' principle.

A second important difference between the two learning environments is that, in the case of the traditional classroom, most interaction takes place by speaking and listening which may be supplemented by writing and reading. In the asynchronous learning environment, interaction takes place in the form of typing and reading from a computer terminal, which

can be supplemented by printed materials and occasional face-to-face meetings.

When contrasting asynchronous learning environments with the traditional classroom on selected factors, (see table 2.2) it becomes clear that asynchronous learning environments offer more advantages.

Table 2.2 Asynchronous Learning Environments vs. Traditional Classrooms

TRADITIONAL CLASSROOM	ASYNCHRONOUS LEARNING ENVIRONMENTS
Speaking and listening; one person at a time. Mostly the teacher talks and the students (may) listen.	Typing and reading; Multilogues in which students actively participate as co- learners.
Entire class must move at the same speed.	Self –pacing.
Socialising inappropriate.	Socialising mixed with "serious" exchanges.
Mostly individual assignments.	Mostly group exercises and assignments.
Students must take notes.	Complete transcript automatically saved and reviewed.
Computer resources generally not available to each student in the classroom.	Computer resources an integral part of the facility.
Set time and place.	Anytime, anyplace.

(Hiltz, 1995, p. 17)

(b) Advantages of asynchronous learning environments

The following list represents the key main advantages of asynchronous learning:

- Remote students need not relocate or travel to a given campus, disrupting critical parts of their lives such as family life or employment;
- Collaborative or group learning can be more easily accomplished since group members' wont need to incorporate their schedule in order to accomplish a certain goal;
- Asynchronous computer conferencing encourages more active participation;
- Students have the freedom to decide when they want to study and how much time they spend on studying according to their individual schedules. They do not depend on the time of the lecturer neither on

the time of the lecture. Students can, for example, re-read articles as well as skipping ones they are already familiar with;

- Some students communicate best in an asynchronous mode;
- Electronic communication allows for sharing of work, for example, the sharing of drafts;
- Asynchronous learning can easily accommodate different learning styles and disabilities; and
- Asynchronous communication has the potential for permanently storing conversations and comments made during a particular communication session (Liberation, 2000; Rochester Institute of technology, 2000).

Elaboration of the advantages brings to light the true value of asynchronous learning. A virtual asynchronous school is open 24 hours a day, 7 days a week, and is not restricted to a few hours a week. Asynchronous learning provide each individual student with the time they need with the lecturer and other participants, offering opportunities for active participation and enabling every student to have a voice. Learners do not need to compete for airtime like in face-to-face, audio or video–conferences. While working in asynchronous mode, the learners are not pressured to respond within a certain time frame, this gives them the opportunity to reflect, formulate and compose responses thoughtfully. This, in turn, leads to better quality of interaction and participation. Proceeding from the previous argument, researchers found that the different levels of skills and confidence of students brought to the traditional classroom might hinder class participation. Asynchronous learning eliminates this problem by providing time to reflect, this in turn levels the playing field when students are less intimidated by more able or assertive students.

Asynchronous learning also allows many people to contribute to discussions and dialogues, leading to a deepened understanding of complex topics. Students become able to view other participant's work, motivating them to some extent to produce more ambitious work. Students thus become both a user of information and a resource for information, making the overall experience richer (Colgate, 1999;

Doherty, 1998; Funaro & Montell, 1999; Jaffee, undated; Liberation, 2000).

Asynchronous learning seems to be a powerful learning tool not only from a theorist point of view, but also from a student's point of view.

A study conducted at Drexel University in 1995 produced the following data (Doherty, 1998):

- 90% of students felt they had more access to the instructor than in "conventional" course delivery;
- 85% would take another asynchronous learning course;
- 80% did not miss class lectures;
- 75% felt they had more communication with fellow students than in conventional courses; and
- 75% felt they learnt more in the asynchronous learning course that they expected to learn in a conventional course.

(c) Disadvantages of asynchronous learning environments

The following provides a summary of the major disadvantages of asynchronous learning environments:

- Asynchronous environments mainly use text-based communication tools which lack mechanisms for making social differentiation. Social status cues as well as physical cues such as gender are reduced or absent;
- Limited reading and writing skills may reduce communication effectiveness;
- This mode requires self-direction and self-motivation to attend to the course work;
- Students need instructor assistance to feel a part of a "course community" in this mode;
- Providing laboratory and studio experiences for students may be more challenging;
- Hardware and software requirements and related skills may limit access for some students;
- Feedback to questions and comments is delayed; and

- Learners find it difficult to feel the presence of their colleagues in an asynchronous environment; furthermore, learners are not always in a position to meet peers physically, which contributes to a feeling of isolation (Liberation, 2000; Rochester Institute of Technology, 2000).

Besides the disadvantages of asynchronous communication that educators need to consider before adopting an asynchronous mode, educators should also examine relevant learning theories to avoid later disappointment.

2.4.4 Learning Principles

Within any asynchronous education program the following learning principles should be promoted and adhered to as far as possible, in order to improve the effectiveness of the distance learning and web-based education program.

(a) Collaborative Learning

Collaboration can be defined as "...the act of participants working as a group to strive towards a common purpose or to achieve a common goal. Implicit in group interaction is multi-way communications and mutual awareness among collaborating group members" (Reiss, 1996, p.2).

Both the teacher and the learner should become active participants in the learning process within the distance learning context. Students are theoretically in part, held responsible for the education of their fellow students. With collaborative learning, knowledge is not merely something that is delivered to students, but rather emerges from active dialogue. In many instances, traditional classrooms hinder learner collaboration. Traditional classrooms make use mainly of one-to-many communication. Asynchronous learning environments, on the other hand, provide the opportunity for many–to–many communications. Discussion groups encourage learners to work together on solving problems. In order to accomplish a universal goal, learners have to verbalise their ideas and present them to their peers. The process of verbalising strengthens the ideas because learners have to re-think their ideas to be able to formulate them in words. Discussions between students contribute towards

elimination of the anxiety many students feel when faced with a one-on-one discussion with the lecturer.

Collaborative learning tasks can help promote a move from superficial to more intense and deeper learning experiences. Collaborative learning provides students with a space of their own where they can learn from each other, publish their work to a larger audience, share their thinking with each other and comment on each other's thinking. Collaborative learning provides real rewards that stems from the feedback they receive from peers and other participants (Brooks, 1997; Eustace, 1994; Funaro & Montell, 1999; Jaffee, undated; Liberation, 2000).

(b) Learner Control

Learner control is the degree to which a learner can direct his/her own learning experience. Learner control is an essential aspect of effective learning. Theorists propose that each learner will know what is best for his or her own learning and will act on that knowledge accordingly. Within web-based learning, learners with various learning styles should thus be able to control the path and pace of instruction, and be able to pursue their preferred method of communication. Learner control enables students to become more autonomous, ask more questions, and participate in more conceptually based information exchanges (Dede, 1996; Doherty, 1998; Horton, 2000).

Transformative pedagogy states that the learner should play a part in controlling his/her own learning. The more the learner controls the elements of instruction the more rewarding the instructional experience will be, leading to intrinsic motivation (Dede, 1996; Doherty, 1998; Horton, 2000).

Learner control does not eliminate the value of an instructor; the instructor should still fulfil his/her role as a couch and observer placing him/her in a position to provide feedback, reminders and role models, while at the same time allowing the learner to lead the process. Learner control is especially useful in asynchronous learning–anytime, anyplace, for anyone – since asynchronous learning environments provides some degree of

control over depth of study, range on content and the time spent on learning (Dede, 1996; Doherty, 1998; Horton, 2000).

(c) Constructivist Learning Principles

Constructivist learning principles build on the assumption that students should at all times be encouraged and given the opportunity to express their knowledge and skills by creating and exhibiting a meaningful product. Learning and development is a social and collaborative activity that cannot be 'taught' in the traditional sense of the word. According to constructivist principles, it is up to the student to construct his or her own understanding in his or her own mind. In constructivism, learners are viewed as creating personal mental models of subject matter and relationships through active manipulation of relevant material. Theorists propose that Constructivist principles should be incorporated in the design of any asynchronous learning environment. Learning should take place in a meaningful context; designers should thus provide complex learning environments that incorporate authentic activity, and social negotiation as an integral part of the learning process. Learners should also be able to view materials from multiple perspectives (Kim & Soo-Song, undated; Moshell & Hughes, 1996; Sharpe, 2001).

(d) Pedagogical

A primary pedagogical concern regarding asynchronous learning is the separation of student and teacher. Traditionally learning is viewed as a social process requiring intensive interaction between student and lecturer/teacher. Asynchronous learning networks may remedy some of these concerns since they permit interaction, feedback, and facilitation needed for effective learning. The available technology should thus be utilised to its full potential in order to bridge the physical gap between participants (Jaffee, undated).

Further pedagogical concerns regarding asynchronous learning environments are as follows:

- The medium used for learning often drives the methodology and creates constraints on instruction which increase with the reliance on technology;
- Several pedagogical methodologies should be incorporated in the learning environment in order to break down these constraints;
- Learning environments may also impact the learner negatively, in the sense that they may feel isolated and unconnected;
- Developing strategies that empowers the learner, and encouraging them to interact, can overcome this limitation; and
- Student and learners in asynchronous learning environments may often feel overwhelmed as a result of the multiple media used, and information overload. Assistance should thus be incorporated in the course work in order to overcome this "lost in hyperspace" phenomenon (Hill, 1997).

(e) Self-Directed Learning

Society is placing increasing emphasis on lifelong learning, and the need to continually improve one's skills in accessing, processing, and transforming information into new knowledge. This, in turn, pressures educational institutions to adopt a philosophy of self-directed learning. It is thus important to incorporate this notion in the design of web-based education systems, which allows students to teach themselves while the lecturer becomes a resource for learning (Brooks, 1997; Romiszowski, 1997).

(f) Mediation

Mediation is an important factor within any learning environment. Mediation allows intervention between the student and subject matter. It guides the learning process toward a specific outcome, and helps the student to connect a body of knowledge with his/her own cognitive framework. Asynchronous learning networks don't necessarily allow lecturers to situate reading material, ideas and concepts within a general theoretical framework, as a result of the absence of a lecture mode. Lecturers can, however, mediate the learning process in other ways, such

as posing and framing questions about the course material that requires students to apply the knowledge to a familiar context (Jaffee, undated).

(g) Interactivity

Interactivity should form the foundation of any asynchronous learning environment. Learning is essentially viewed as a social process that requires interaction for the purpose of expression, validation, and the development of the self as a knowledgeable learner. To ensure successful, effective learning, learners within an asynchronous learning environment needs to be connected to some medium, with the ability to provide feedback and encouragement, in order to maintain their interest, attentiveness and commitment. Courses should thus be structured in such a way that they maximise the opportunities for interaction between the teacher and student, among students, and between students and the learning environment (Jaffee, undated).

2.4.5 Communication within asynchronous learning environments

Communication within asynchronous environments can either be text-based or based on multi-media settings. The following discussion will focus on the advantages and disadvantages of text-based and audio/video based communication.

Asynchronous, text-based interaction has immense potential for the full, analytic, thoughtful, and productive development of knowledge. It has the benefit of an ongoing transcript for review and a variety of information manipulation tools for searching and organising to enhance and support the communication (Higgings, 1997).

Text-based communication may enhance the value of the communication process, in that students reflect more carefully when they have to articulate their arguments into written speech. Text-based communication can be stored more easily than audio and video communication material. Online courses may produce a lot of material, making search mechanisms necessary. Text-based material allows for better and easier use of search mechanisms than do audio and video material. Contrasting with traditional classrooms, comments made by

students as well as drawings on the blackboard, can be captured and stored for later review. On the other hand, some learners may not feel comfortable with the fact that their comments will be stored in a database. Text-based communication has the advantage of composure, a luxury denied or at least restricted by face–to-face verbal communication (Liberation, 2000; Masterson, 1999).

The lack of typing skills might pose a threat to the advantages of text-based communication. The main disadvantage of text-based communication is however, the significant lack of non-verbal communication mechanisms. In text-based systems non-verbal cues are lost to the participants making it impossible to, for instance, indicate confusion by means of facial expression, or nodding one's head to indicate understanding (Masterson, 1999).

Adding audio or video to asynchronous communication add a new dimension of possibility for participants to express themselves more completely, counteracting most of the problems faced during purely text-based communication. When using audio or video communication methods, participants will be able to completely express their emotions using their voice and facial expressions, providing a more personal feeling that is difficult to accomplish with text only communication. One major advantage of using video and audio is the improvement in efficiency due to more rapid creation of messages. On the other hand, audio and video may lead to a decrease in the efficiency of message consumption, due to the fact that the average user can read text more quickly than the rate at which it is spoken. Incorporating audio and video also reduces eyestrain commonly encountered when reading through a long document (Turner & Ross, 1999).

2.4.6 Key considerations for the implementation of software applications

Given the fact that technological advancements made various applications available, educational institutions are currently faced with the gruelling task of deciding which of the various applications would be best suited for implementation in their specific educational environment. Besides the obvious human-factors and usability considerations, that will be described in subsequent paragraphs, the list to follows (Wooley, 1996) provides key considerations that will ultimately influence the educational institutions' decision to implement a certain software application.

Key Considerations for the implementation of software applications:

- Price;
- Operating System Support;
- Compatibility with Other Environments;
- Administrative Capabilities;
- Browser Support; and
- Customisability.

Elaborating on the above mentioned list, the following general issues may also play a role in the decision-making process (Hill, 1997).

- **Technological:** A major concern for distance educational systems is the availability of hardware and software. Without access to the necessary hardware and software products, interaction in a Web environment is not possible. This relates directly to concerns regarding costs, especially if participants need to purchase new equipment in order to interact;
- **Organisational:** Organisational issues pertain to the preparation of the distance learning course. Distance learning programs differ greatly from traditional classroom programs and need special attention. It may take the facilitator of the program months to prepare and finalise. As new issues come into play, the preparation phase may become even more difficult;
- **Institutional:** Organisational policies regarding distance learning may or may not hinder the development of distance learning programs. Creators and facilitators should investigate the impact such policies might have on the development of programs; and
- **Ethical:** Ethical issues regarding admission, intake and retention of students, course administration, learner/facilitator interaction, and program, course, and learner evaluation, should be considered.

2.5 CONCLUSION

The preceding chapter specifically focused on virtual learning environments, distance education and web-based education, all of which provides institutions for tertiary education with a unique opportunity to realise their future vision, namely, supplying the growing population with effective, flexible learning environments.

The discussion and theories on distance learning and web-based education shows that technological advancements has made various applications or interfaces available, providing institutions for tertiary education with unique opportunities to re-evaluate the resources available to them and to improve their learning outcomes (Kumari, 2001).

It is anticipated that the technology imbedded in distance learning and web-based education will enhance learning and re-conceptualise the course environments to extent beyond the normal processes that occur in the traditional classroom. The extent to which the web-based and distance education systems will enhance the education, communication and information sharing processes will, however, be influenced by the perceived usability, the attitude towards, and the need for the above mentioned media.

The following chapter will describe in varying degrees of detail, certain aspects, concepts and elements pertaining to the usability testing of asynchronous Web-based and distance learning and communication media.

CHAPTER THREE
REVIEW OF LITERATURE: USABILITY CONCEPTS

3.1 INTRODUCTION

With the purpose of enhancing and improving the education, communication and information sharing processes, within the University of Stellenbosch, the research proposes to quantify and test the usability of the supporting systems imbedded in asynchronous distance learning and web-based environments. The main objectives of the research states that empirical tests will be conducted in order to evaluate the usability of the various asynchronous computer based communication media. This chapter will provide a theoretical framework for the usability evaluations conducted during the research process, by describing relevant concepts pertaining to usability, including the contextual basis of usability, the definition of usability, and a description of the usability criteria and evaluation methods.

3.2 USABILITY IN CONTEXT

Before turning to individual concepts and definitions it is important to set the stage for usability testing by defining the context of usability and the relationship between usability and its parent discipline.

The study of usability is but one of the technical areas within the field of Human-Computer Interaction, better known as HCI. The discipline of HCI deals with all aspects of the relationship and interaction between humans and computers, which in turn, forms a major part of the larger subject, termed Human-System Interaction (HSI). Human-System Interaction forms the applied side of usability's parent discipline, namely Ergonomics or Human Factors (Shackel & Richardson, 1991). Figure 3.1 presents a visual representation of the relationship between the various elements as described above.

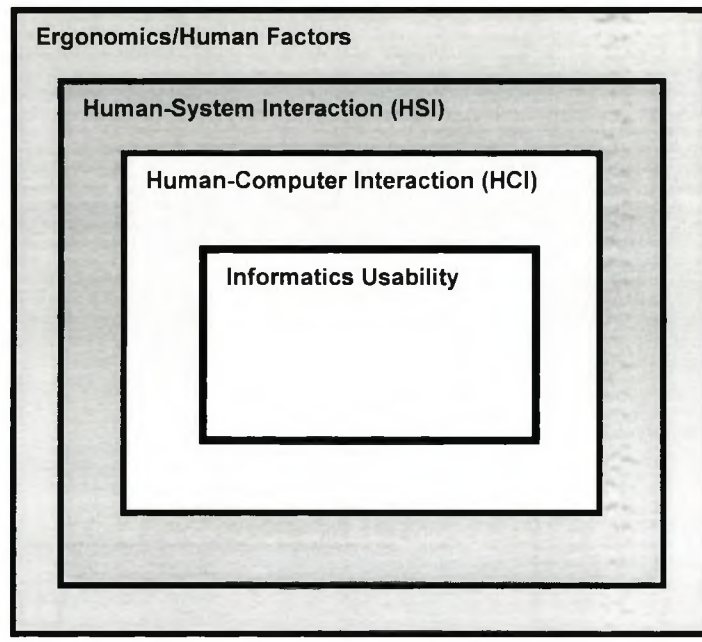

Figure 3.1 Usability and its Associated Disciplines
(Shackel & Richardson, 1991, p.2)

3.2.1 Ergonomics

The discipline of ergonomics came about due to design and operational problems of various work systems which developed in parallel with the technological advancements. According to Kalawsky, Bee and Nee (1998), most design problems emerged because people find technology seductive while their understanding of human performance and capabilities are underdeveloped. It is suggested that research should focus less on enabling technology and more on understanding human interaction with systems. Ergonomics is mainly concerned with the design of systems with which people carry out their work, with the sole purpose of counteracting design and operational problems. All work systems consist of a human component and a machine component embedded in a local environment. The ability of people to do their jobs effectively and efficiently is not only influenced by the job content but also by the physical design of the work system. Ergonomics aims to ensure that the human needs for safe and efficient working environments are met during the design of the work system. Since ergonomics are concerned with the human needs and welfare, it is essential to study the characteristics of the people involved in any human-computer interaction situation, in order to apply this knowledge to the design of the system (Bridger, 1995).

The growth of cognitive psychology has underscored the importance of problem solving, information analysis, and procedural skills as critical research topics. The application of cognitive interpretations to the field of ergonomics, brought about a new discipline called cognitive ergonomics. Cognitive ergonomics investigates the relationship between information sources (usually their content and design) and users' characteristic ways of thinking. Cognitive ergonomics comes into play where the task under study primarily involves mental rather than physical efforts. One will resort to cognitive ergonomics in situations where cognitive events are used to explain how a stimulus is expected to influence behaviour (Bridger, 1995; Carrol, Mack & Kellogg, 1988).

3.2.2 Human-System Interaction

According to Shackel and Richardson (1991, p.5) Human-System Interaction is "...concerned with methods, media and mechanisms for enhancing cooperation between people and systems in an interactive organisational environment". Human-System Interaction also studies the elements influencing the effectiveness and acceptability of systems according to the user; these elements include the humans, the organisation, the tasks, the machines, and the environment.

3.2.3 Human-Computer Interaction

In its simplest terms, Human-Computer Interaction (HCI) can be defined as the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings. A more elaborate definition describes HCI as a discipline mainly concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them (Hewett, Beacker, Card, Carey, Gasen, Mantei, Perlman, Strong & Verplank, 2002; Victoria Point Multimedia, 2000).

The study of HCI will be affected by the various forces shaping the nature of computing. These forces will inevitably affect the relationship and interaction between humans and computer systems, and will thus place greater emphasis on creating user-friendly, effective and efficient computer systems. These forces include:

- Decreasing hardware costs leading to larger memories and faster systems;
- Miniaturisation of hardware leading to portability;
- Reduction in power requirements leading to portability;
- New display technologies leading to the packaging of computational devices in new forms;
- Specialised hardware leading to new functions;
- Increased developments of network communication and distributed computing;
- Increasingly widespread use of computers, especially by people who are outside of the computing profession;
- Increasing innovation in input techniques; and
- Wider social concerns to improve access to computers for currently disadvantaged groups (Hewett et al., 2002).

(a) The content of human-computer interaction (HCI)

In order to fully understand the extent of the study field of HCI, it is vital to understand the various interrelated aspects of HCI. Figure 3.1 and previous paragraphs explained the relationship between HCI and its parent discipline, Ergonomics. The following figure visually represents the five interrelated aspects of HCI: (N) the nature of HCI, (U) the use and content of computers, (H) human characteristics, (C) computer system and interface architecture, and (D) the development process.

Computer systems exist within a larger social, organisational and work milieu with various application areas for the use of computer systems. Aspects of human-machine fit and adaptations such as technical and work aspects should be considered before introducing computers to the working environment. Human factor engineers should also take into account the various human characteristics that influence HCI, such as information processing, communication and the physical characteristics of potential users. On the computer side, a variety of technologies have been developed for supporting interaction with humans. Lastly, human factor engineers should consider the development process, which includes the design for HCI, the various techniques for implementing the design, evaluation techniques and various designs for study (Hewett et al., 2002).

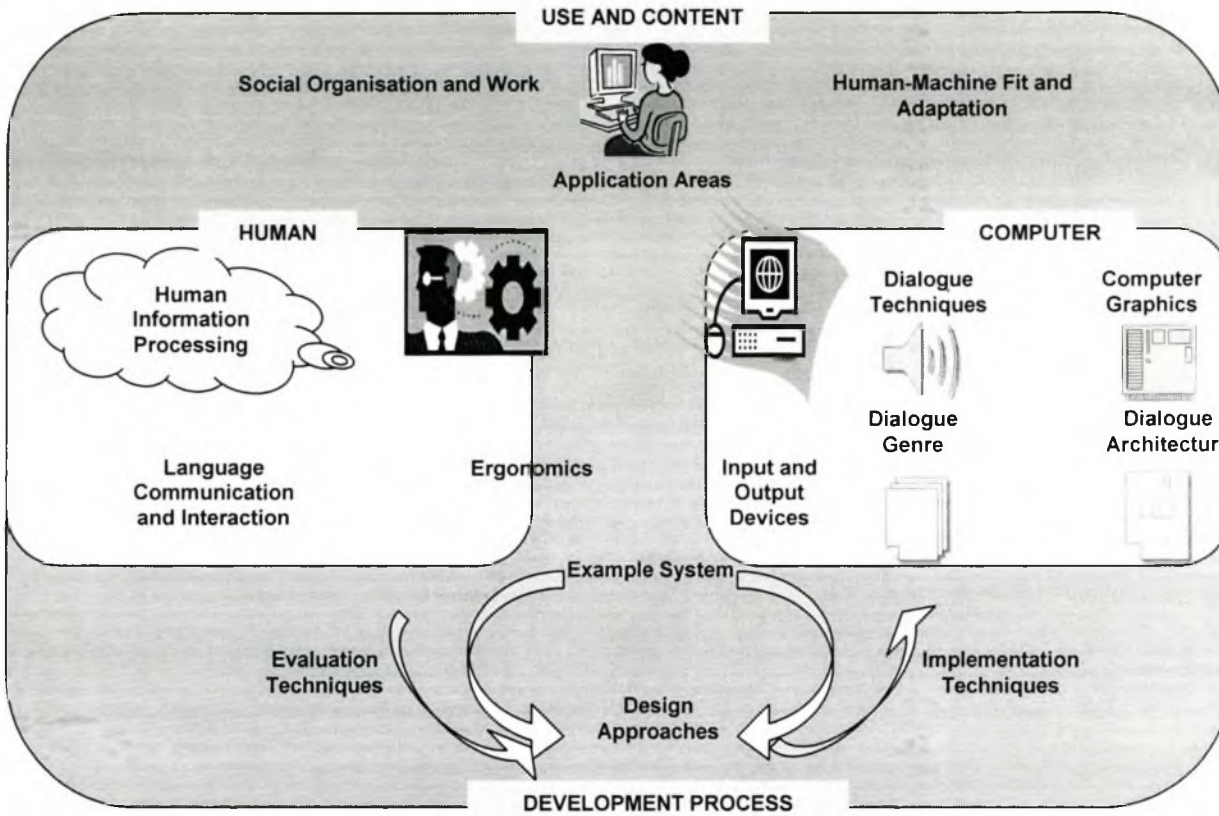

Figure 3.2 Human-Computer Interaction

(Hewett et al., 2002, p. 8)

To conclude HCI, imbedded in the discipline of ergonomics inevitable aims at understanding the user in terms of interaction and cognition.

(b) Prerequisites for uptake of new technology

The principle of HCI builds on the assumptions that an interaction exists or will exist between a user and a computer/system component. HCI aims at predicting and diagnosing design problems before users experience the system, insuring that when future interaction takes place, that interaction will be successful, and will ultimately lead to full acceptance of the system. Problems pertaining to the design and usability of a system are unfortunately not the only factor determining acceptance of a system. Various other factors exist that threatens the acceptance of a system, such as a Computer Based Training System.

The Technology Acceptance Model (TAM), depicted in figure 3.3, illustrates the key factors that determine user acceptance and actual

usage of technology to a large degree. As the model indicates, user acceptance of technology in it simplest sense, is determined mainly by two factors: perceived usefulness and perceived ease of use. These factors not only impact on the behavioural intentions to use a system, but also the actual use of the system. Perceived usefulness and perceived ease of use will have a profound effect on the users' attitude towards using the system in question. Behavioural intentions to use a system are describes as a function of the users' attitude and the systems usefulness, and as such predict actual use. Researchers also suggest that behavioural intentions are the strongest predictor of actual use (Grossberg, Struwig & Tlabela, 1999).

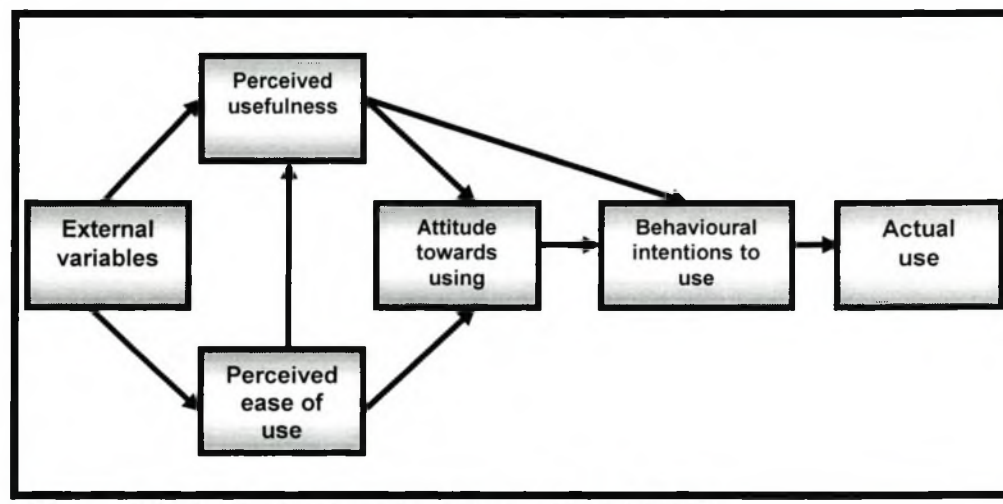

Figure 3.3 The Technology Acceptance Model (TAM)

(Grossberg et al., 1999, p.88)

The model clearly shows that a study of usability factors and the evaluation thereof should play a major role in determining the eventual acceptance and actual usage of a system.

The factors indicated by the above mentioned model, may in a sense be the main factors determining acceptance, but is by no means the only factors impacting acceptance and actual use. Developers should also take note of factors such as:

- System availability;
- System accessibility;
- System affordability;
- System awareness; and

- System appropriateness (Ekberg & Roe, 2001).

Mackie and Wylie (1988) include these and other factors in a more elaborate model of technological acceptance. The innovation acceptance model will be explained briefly.

The acceptance process for computer innovation can be described as a mental process that users engage in. This process starts of with the user's initial knowledge of a specific innovation, and ends in an eventual decision to adopt or reject its use. Various factors that influence the process and the final outcome of the acceptance model have been identified (Mackie & Wylie 1988).

- **Initial Awareness**: Various formal and informal channels and media create an initial awareness of innovation. It is important that the initial communications regarding the product be accurate and reasonably comprehensive. Early resistance to the product may be the result of employing haphazard methods for the creation of initial awareness;
- **Need for Improvement:** The specific work experience will impact the user's perceived need for the innovation. Regardless of how successful the initial awareness process was, it is unlikely that users will accept an innovative product if they do not perceive a need for the improvement. The user must perceive a need, it is not enough for developers to identify a need they think the users are unaware of;
- **Level of Interest:** Users should exhibit a level of interest if the innovation is to be accepted. The user's level of interest is a function of his/her perceived need for the innovation and his/her awareness of the purpose for the innovation;
- **Information Acquisition:** Users with sufficient awareness, and perceived need for an innovation will likely seek additional information regarding the innovation. The degree of information seeking will be affected by the ease with which users can obtain additional information, and the intensity of their perceived need for the innovation;

- **Perceived Features and Perceived Need:** The additional information that a user received, will result in either a favourable or unfavourable reaction to the features of the specific innovation;
- **Experience with Similar Developments:** Users are prone to base their evaluation of a new product, on their experience with what they perceive to be similar developments. This comparison between innovations and previous products will once again lead to a favourable of unfavourable reaction to the innovative product;
- **User Participation in Design:** Certain highly qualified users may have a self perception of their expertise, and will be biased toward innovations that were created without their involvement;
- **Personal risk:** Innovations often carry a degree of subjective risk to the potential users. To counteract this, information regarding the innovation should be made readily available to the potential user, in order to give him the opportunity to accurately access his risk in implementing the innovation;
- **Availability of Support:** Acceptance of a product can be influenced by the availability of proper documentation, maintenance support, and training;
- **Organisational Climate:** Some organisations are more receptive to innovations than others. The organisations feelings towards innovations, inevitable spills over to various levels in the organisation, and has the potential of influencing the receptiveness of individual within the organisation; and
- **The Role of Authority:** Authority decisions are those forced upon the user to adopt or reject an innovation by someone in a position of higher authority.

Figure 3.4 depicts the various elements and their relationship with one another.

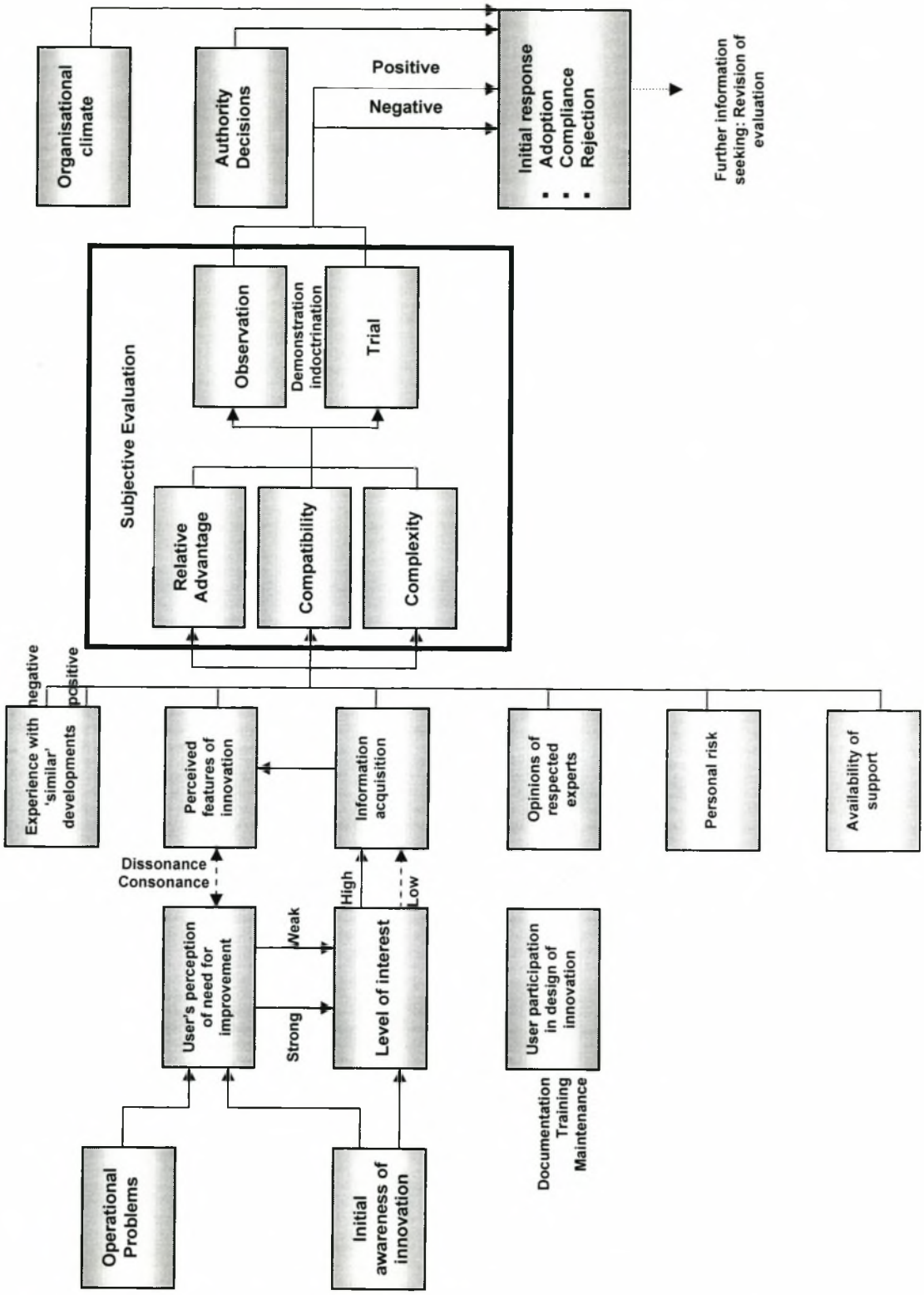

Figure 3.4 A Model of the Innovation Acceptance Process

(Mackie & Wylie, 1988, p.1084)

The above discussion clearly demonstrates that, apart from ensuring user-friendliness and usability, institutions for tertiary education should take note of the various extraneous factors that might hinder the successful integration of asynchronous learning and information sharing environments, into the current educational domain for the purpose of enhancing learning and information sharing within the educational institutions.

3.3 THE RATIONALE BEHIND USABILITY ENGINEERING

The result of changes in the technological arena is that the user population is less homogenous; many new users bring different needs to be satisfied and are no longer willing to put up with difficult or uncomfortable interfaces. Potential new users are increasingly exercising their right to choose and will only use computers if they are appropriate, useful and usable (Shackel & Richardson, 1991). According to Shackel and Richardson (1991), the market has become much more selective, partly through experiences of poor usability.

High usability is thus desirable and human factors elements have become paramount to the design and evaluation of software applications. Human Factors evaluation and usability testing will indicate the sources of design and operational problems, that in turn will help designers to create systems that will in time, alleviate or eliminate the sensory, perceptual, and cognitive problems resulting from using current, less user-friendly systems. Usability engineering and evaluation ensures high usability by incorporating human factors elements before the design, during the design, and after field installation of a software product (Nemire, 1994; Nielsen, 1992).

3.4 DEFINITION OF USABILITY

Poulson (1998, p.3) describes usability as a "...attribute of the way that a person interacts with a product," this implicates that usability cannot be assessed independently from usage. Usability is thus essentially a question of perception, which makes it a difficult concept to adequately define, especially when keeping in mind that various aspects of a product contributes to how it is perceived by any individual person.

There are numerous definitions of usability. Opaluch and Tsao (1993) propose that usability is the degree to which a system is easy to use, easy to learn, and optimised from the end-user's perspective.

ISO 9241:11 defines usability as:

> "The extent to which a product can be used by specified users, to achieve specified goals, with effectiveness, efficiency and satisfaction, in a specified context of use" (cited in Gulliksen, Harker & Steger, 2001, p.156).

Shackel (1991, p.24) suggests that the usability of a system or equipment is:

> "The capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios."

The problem with defining usability is evident in the fact that there is no broadly recognised, single definition for usability that would be acceptable to all professionals in the usability community. It is, however, generally accepted among authors that an operational definition of usability should include one or more of the following performance measures, (a) usefulness, (b) effectiveness, (c) learnability, and (d) attitude. The advantage of such an operational definition of usability is that it defines usability to be a quantifiable and measurable concept and that it emphasises the non-functional demands of usability that are essential for the final interpretation of the concept (Gulliksen et al., 2001; Ruben, 1994).

In order to further clarify the meaning of usability, a distinction should be made between usability and accessibility. Some confusion regarding these two concepts exists in literature, which portrays these concepts as interchangeable. According to Engelen (2001), something is accessible if it can be reached, in terms of HCI, accessibility can be defined as a set of properties that are built into the product. These properties enable people within the widest range of abilities and circumstances, as is commercially practical, to access and use it. A system can thus be said to be accessible if the user *can* perform the various functions contained within it, on the other hand, as indicated in the definitions stated above, usability refers to the ease, effectiveness and efficiency with which the user can perform those functions.

3.5 USABILITY PERFORMANCE MEASURES

According to the International Standards Organisation (cited in Corporate Solutions Consulting, undated, p.2), a "...system can be said to be usable when specified users, in specified circumstances, with specified goals, can use it with effectiveness, efficiency and satisfaction". Usability attributes/performance measures are set to describe the users of the system, the situations under which they will use the system, the goals that they will be trying to accomplish, and the levels of performance that they must be able to achieve for the system to be acceptable.

The following definitions as set out by JH Associates (2000) directly links with the definition of usability, and should thus be clarified in order to better grasp the full concept and scope of usability and the measures thereof.

- **Context of use:** The users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used;
- **Work system:** A system consisting of users, equipment, tasks and a physical and social environment, for the purpose of achieving particular goals;
- **User:** The person who interacts with the product;
- **Goal:** An intended outcome;
- **Task:** The activities required to achieve a goal. These activities can be physical or cognitive. Job responsibilities can determine goals and tasks;
- **Product:** The part of the equipment (hardware, software and materials) for which usability is to be specified or evaluated; and
- **Measure:** The value resulting from measurement and the process used to obtain that value.

Performance measures or attributes of usability provides quantifiable means of determining the usability of any given system or product. Through the use of performance measures, designers can measure the success of a system primarily by the end result of the users' interaction with the system. Performance measures or attributes of usability helps designers answer certain questions pertaining to the usability of the system, such as:

- "How well do users achieve the set goals?" (effectiveness);
- "How much of the goal do users achieve per minute?" (efficiency); and
- "How much of the process is productive in achieving the goal?" (productivity) (Macleod, Bowden & Bevan, 1997).

The most frequently used usability performance measures cited in literature, are not surprisingly the usability measures included in the operational definition of usability, mentioned above. Referring back, it was stated that an operational definition of usability should include one or more of the following performance measures, (a) usefulness, (b) effectiveness, (c) learnability, (d) attitude. Each of these measures will be described individually.

3.5.1 Usefulness

The usefulness of a system or product indicates the degree to which a product enables a user to achieve his or her goals. Usefulness measures may also be used to assess and predict the user's motivation to actually use the system. If a specific user perceives the usefulness of the system to be low, the user will also have low motivation to use the product. Usefulness can be considered as one of the most important usability performance measures, due to the fact that all other measures becomes irrelevant if the users feels unmotivated to use the system and inevitable avoids the system all together (Ruben, 1994).

3.5.2 Effectiveness (ease of use)

Effectiveness can be quantified in terms of factors such as speed of performance and error rate. The effectiveness, with which users employ a specific system to carry out specific tasks, refers to how correctly and completely task goals are achieved in context. The effectiveness can further be defined as a function of two components, the quantity of the task attempted by the users, and the quality of the goals they achieve. A system is said to be effective when a required percentage of the specified target range of users can accomplish the required range of tasks, at better than some required level of performance (e.g. in terms of speed and errors), within some required proportion of the range of usage environments. The overall effectiveness of a specified system can be expressed by the following formula (Macleod et al., 1997; Ruben, 1994; Shackel, 1991):

Effectiveness = *f* (quantity, quality)

3.5.3 Efficiency

Efficiency is an indicator of expertise, and is always related to some measure of cost and performance. A value for the task effectiveness achieved by a user can be obtained by measuring the quantity and quality components of usability independently, and then applying the following formula (Macleod et al., 1997):

$$\text{Task effectiveness} = \frac{(\text{quantity} \times \text{quality})}{100}\ \%$$

3.5.4 Learnability

Learnability has to do with the user's ability to operate the system to some defined level of competence after some predetermined amount and period of training. It can also refer to the ability of infrequent users to relearn the system after periods of inactivity. Users will require less training if the systems are easy to learn and match the way in which they approach their tasks, less training in turn would lead to a reduction in the overall cost of the product. Learnability can be measured in terms of the time spent on user training, from the commissioning and start of the user training. Learnability measures should be based upon some specified amount of training and user support, and should be measured within some specified relearning time for intermittent users (Corporate Solutions Consulting, undated; Ruben, 1994; Shackel, 1991).

3.5.5 Attitude/User Satisfaction

Attitude refers to the user's perceptions, feelings, and opinions of the system. Attitude measures variables such as the user's level of tiredness, discomfort, frustration and personal effort. Attitude measures can be used to predict whether continued and enhanced usage of the system will take place. Attitude will also predict user performance of the system, since users are more likely to perform well on a product that meets their needs and provides satisfaction than one that does not (Ruben, 1994; Shackel, 1991).

3.5.6 Additional performance measures

The following set of performance measures, are used less frequently in usability studies, but the mere fact that they have been used in numerous previous usability studies, with successful results, shows that their inclusion in a usability evaluation has merits.

(a) Memorability

Memorability refers to the amount of training and time required for users to return to peak levels of performance, after absences in the use of the system (Corporate Solutions Consulting, undated).

(b) Productivity

In the most common sense productivity refers to the speeds with which users are able to carry out their required tasks while using specific computer systems. Productivity also refers to the proportion of time spent not having problems. User productivity can be expressed in terms of the following formula (Corporate Solutions Consulting, undated; Macleod et al., 1997):

$$\text{User productivity} = \frac{\text{Productive time}}{\text{Task time}} \times 100\%$$

(c) Flexibility

A system is said to be flexibility if it allows some degree of adaptation in various tasks and/or environments beyond those first specified. Systems should preferably be able to adapt to users' needs. The adaptation can be made by either the interface itself, or the users' customisation of the interface (Lin, Choong & Salvendy, 1997; Shackel, 1991).

(d) Error Rate

If systems are less prone to human error it can drastically reduce reconciliation costs. Error rate can be expressed as the total time spent

overcoming problems, searching unproductively through a system, and seeking help. These problem-related measures are valuable sources of diagnostic data about specific areas of design failure and provide pointers to the causes of these problems (Corporate Solutions Consulting, undated; Macleod et al., 1997).

(e) Compatibility

Users of a system will respond to certain stimuli while in interaction with the system. Systems should at all times allow users to respond naturally to stimuli. Compatibility thus refers to the phenomenon that the subject's responses are faster and more accurate for the pairings of stimulus sets and response sets that corresponded naturally than for those sets that do not correspond naturally (Lin et al., 1997).

It should be noted that the performance measures as defined above are not necessarily correlated with each other, although some measures might be correlated to some degree. A system can, for instance, be satisfying to use but not necessarily be efficient to use, or vice versa (Macleod et al, 1997).

3.5.7 Causes of unreliable performance measurements

While implementing the usability performance measures, various potential methodological pitfalls may arise, which can have a negative impact on the user performance measures and result in unreliable measures. Usability evaluators should take care as not to fall prey to these pitfalls (Macleod et al., 1997):

- During usability testing, to much emphasis may be placed on user characteristics, training and tasks, while neglecting equally important aspects, such as the technical context (computer environment network etc.) and organisational context (motivation, interruptions, access to help etc.). Usability evaluators should take care to match the context of the evaluation with the 'context of use' in all important respects;
- Assuming that a specific task was completed successfully, evaluators often use completion time as an efficiency metric. This can be very misleading since task output is frequently incomplete, inaccurate and may contain errors. To overcome this barrier, it is important to measure effectiveness (accuracy and completeness) as well as task time; and

- Due to varying importance of errors, simply counting the amount of errors made during a specific task may be misleading. One option to counteract this problem is to allocate weights to errors, or to simply measure accuracy and completeness of goals achieved.

3.5.8 Individual characteristics and its effects on performance

During usability evaluations, evaluators and designers should account for individual differences which may affect the usability performance measures. These individual characteristics may explain to a large degree, the variance of usability performance measures obtained during usability testing.

The following individual characteristics should be taken under consideration (Egan, 1998):

- **Experience:** One should never under-estimate the variability in HCI that occurs in natural settings where users with different amounts of experience are working side by side. Differences in experience leads to significant differences in the way the task and system is understood and organised, which in turn correlates with measures such as error rate and time taken to complete a specific task. The user's level of experience can thus be used to explain variance in error rate and time taken to complete the task;
- **Technical Aptitude:** Users with a natural technical aptitude would find it easier to grasp the system concepts than users with low levels of technical aptitude. As with differences in experience, error rate and time taken to complete a task can be attributed to differences in technical aptitude;
- **Age:** In situations where age varies significantly across the user population, and experiential variables are controlled, age can be used as a powerful predictor of how much difficulty users will have learning to use a complex, computer system; and
- **Domain Specific Knowledge:** Studies show that users who have acquired extensive knowledge and skill related to a job will perform more effectively when using a computer system within the specific job setting. It should be noted that domain specific knowledge begins to predict performance only after users have acquired some experience with the computer system.

3.6 USABILITY EVALUATION METHODS

Earlier evaluation studies were mainly based on an experimental approach and were highly influenced by techniques developed in applied psychology. Most evaluators, however, moved towards a less formal approach to evaluation in order to avoid problems encountered during laboratory trials.

Laboratory trials are an important, but also limited, means of assessing systems. On the one hand, laboratory trials are very effective if a comparison of various design options is required, on the other hand, it does not allow effective generalisations about design features taken in isolation. Laboratory trials mostly evaluate a select sample of activities that are possible with the complete system, the sample of users may be less representative of the wider population of possible users, and only certain aspects of use will be evaluated during trials. Lastly, laboratory trials make it extremely difficult to assess whether or not performance would improve over time, since trials are typically performed over a short period of time (Poulson, 1998).

Cost effectiveness justifies the use of a less formal approach to usability testing. Less formal approaches can identify most of the problems with a system, while at the same time using resources more efficiently, since fewer participants are required to conduct tests. No attempts are usually made to control conditions of use, and to take objective performance measures. Informal approaches place less importance on having end users taking part in evaluation trials (Poulson, 1998).

Although the less formal approach is more cost effective it is not advisable to exclude more comprehensive or rigorous evaluation activities.

Besides the two approaches to usability testing, various usability evaluation methods exist, each with its own merits and uses. These evaluation methods can be divided into three broad categories, namely: Testing Methods, Inspection Methods and Inquiry Methods. The various methods can be grouped as either being low cost methods, medium cost methods, or high cost methods.

To determine the specific cost of conducting a usability evaluation method, the following should be considered:

- Personnel required: number of users, usability experts, and software developers;
- Time required for data collection and analysis; and

- Need for coordination – that is, whether the method requires the participants to be present at the same time (University of Maryland, undated).

Table 3.1 provides a summary of the available methods, plotting cost against the type of usability evaluation method. This summary clearly shows that most of the testing methods are of high cost while most of the inquiry methods are of medium cost.

Table 3.1 Type of Method vs. Cost of Method

	Low Cost	Medium Cost	High Cost
Testing		Remote Testing	Coaching Method Co-discovery learning Retrospective testing Shadowing method Teaching method Thinking aloud method Question asking protocol Performance measurement
Inspection	Heuristics Evaluation	Cognitive Walkthroughs Feature Inspection	Pluralistic Walkthrough
Inquiry		Field observation Interviews Logging actual use Proactive field study Questionnaires	Focus groups

(Adapted from University of Maryland, undated, pp.3-5)

3.6.1 Testing Methods

During testing methods, users perform typical tasks using either the completed system or a prototype of the system. Evaluators will then use the results in order to evaluate how the user interface supports the users to do their tasks. Testing methods may be used during the design, test and deployment phases of system development and includes the following methods (Lin et al., 1997; University of Maryland, undated):

- Coaching Method;
- Co-discovery Learning;
- Performance Measurement;
- Remote Testing;
- Retrospective Testing;
- Shadowing Method;

- Teaching Method; and
- Thinking Aloud Protocol

3.6.2 Inspection Methods

During inspection methods, usability specialist will typically examine usability related aspects of a user interface. Typical inspection methods include the following (University of Maryland, undated):

- Cognitive Walkthroughs;
- Feature Inspection;
- Heuristics Evaluation;
- Pluralistic Walkthrough; and
- Scenario-based Checklists

3.6.3 Inquiry Methods

During inquiry methods, evaluators will obtain information about the users' likes, dislikes, needs and understanding of the system by talking to them or observing them in real work settings. Inquiry methods include the following (University of Maryland, undated):

- Field Observation;
- Focus Groups;
- Interviews;
- Logging actual use;
- Proactive Field Study; and
- Questionnaires

Another commonly used usability evaluation method is the use of a usability laboratory.

3.6.4 Usability Laboratories

Testing a specific product in a well designed usability laboratory can improve quality, ensure clearer documentation, and reduce the number of development problems, decrease maintenance costs and yield higher productivity. A number

of companies are currently employing usability laboratories in order to test the usability of their products.

The discussion on usability laboratories will focus on one specific organisation, as it provides an excellent example of the elements and processes within a well designed usability laboratory. The usability lab (ULab) at the Online Computer Library Center (OCLC) was established in July 1990 and has since been used to test over 120 products with more than 500 users. During usability testing, the HCI team implements the following four basic components of usability testing:

- Identify, watch and listen to users while they use the specific product;
- Record user behaviour;
- Analyse the data; and
- Report the results (OCLC, 2002).

The OCLC usability laboratory consists of three rooms: an evaluation room, a control room and an observation room (See figure 3.5).

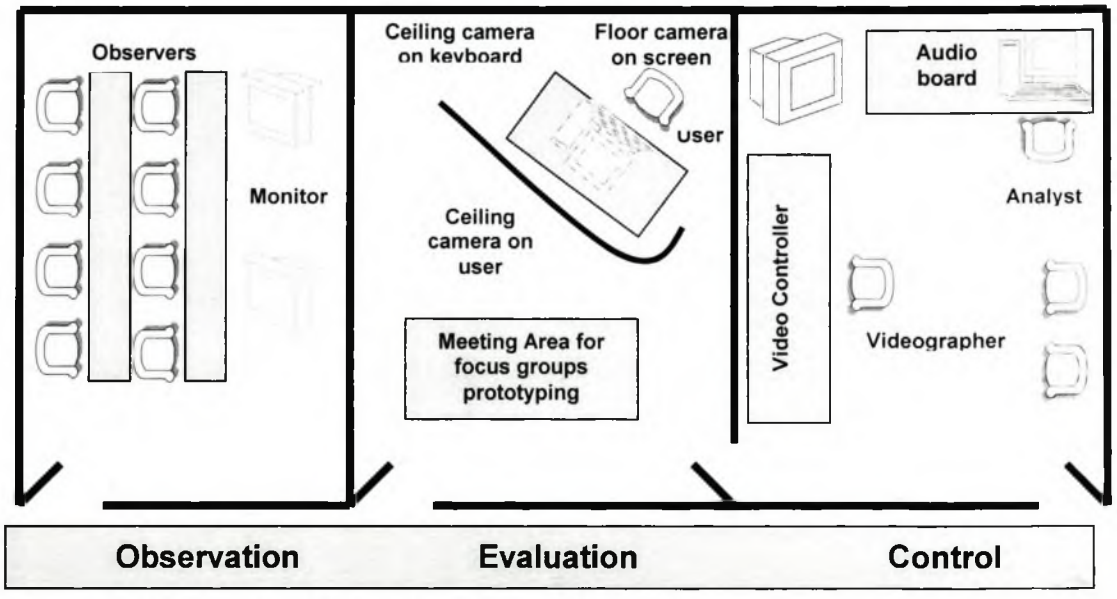

Figure 3.5 The Usability Laboratory at OCLC

(Murphy, 2002, p.2)

In the evaluation room, the user sits at a workstation designed to help make the user feel as comfortable as possible. As indicated in the figure, three remote-controlled cameras are positioned outside the user's line of vision to capture the computer screen, the user, the keyboard and mouse. The control room is used to operate the remote-controlled cameras and log events during the test as they

watch and listen to the user. In the observation room, members of the product team may view the proceedings on television monitors (Murphy, 2002).

Ruben (1994) describes different testing setups/environments, ranging from simple low-cost setups to more expensive and sophisticated testing environments. The usability lab at OCLC clearly shows an example of a more sophisticated and expensive testing environment. These types of environments may not be as attractive to a start-up testing enterprise, as more inexpensive setups, such as the one described by figure 3.6.

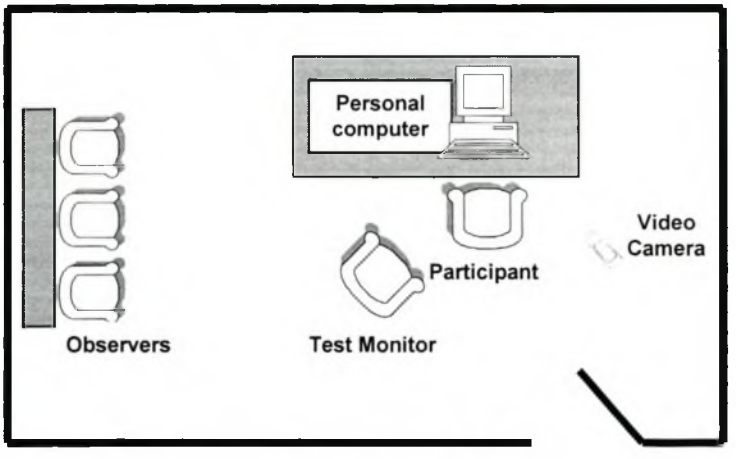

Figure 3.6 Simple Single-Room Setup

(Ruben, 1994, p.51)

The single-room setup, as depicted in figure 3.6, is the most basic type of testing setup, both in terms of resources and the amount of space required. The advantages of this type of testing setup are that:

- The test monitor has an excellent sense of what is going on with the participant;
- During early phase exploratory tests, where much interaction is desired to interrogate the participant during the test, this position accentuates a sense of teamwork; and
- For difficult test, where the participant has to struggle with the material, it enables you to encourage and overcome the participant's self-consciousness.

Single room testing setups has disadvantages as well, namely:

- The test monitor's behaviour can affect the behaviour of the participant;
- There is very limited space for observers.

Table 3.2 provides a summary of the major advantages and disadvantages of the most frequently used usability evaluation methods.

Table 3.2 Summary of Advantages and Disadvantages of Different Usability Evaluation Methods.

Method Name	Advantages	Disadvantages
Laboratory testing	▪ Identify serious problems. ▪ Identify recurring problems. ▪ Avoid low-priority problems. ▪ Some degree of objectivity.	▪ Require expertise. ▪ High cost. ▪ Need large number of users. ▪ Miss consistency problems.
Thinking aloud	▪ Pinpoints user misconceptions. ▪ Low cost.	▪ Unnatural to users. ▪ Hard for expert users.
Formal modelling	▪ Quantitative analysis. ▪ Give unexpected insight. ▪ Some degree of objectivity.	▪ Extremely complex. ▪ Require expertise. ▪ Tend to focus on one dimension.
Guidelines/checklists	▪ Identify general problems. ▪ Identify recurring problems. ▪ Can be used by non-specialist. ▪ Applicable at all design stages.	▪ Miss some severe problems. ▪ Might be misapplied. ▪ Difficult to follow.
Heuristics evaluation	▪ Identify many problems. ▪ Identify more serious problems. ▪ Low cost. ▪ Predict further evaluation needs.	▪ Require expertise. ▪ Require several evaluators. ▪ Some degree of subjectivity.

(Lin et al., 1997, p.269)

Various factors such as the objective and purpose of the evaluation, as well as, time and budgetary constraints will influence the choice of usability evaluation methods to be used. After careful consideration of the advantages and disadvantages of the various usability evaluation methods, the researcher decided to combine elements of inspection methods and laboratory test in the research design. Inspection methods provides the researcher with the opportunity to focus on the feature set of the communication and information sharing systems by analysing certain features in terms of set usability criteria. Laboratory test allows the researcher to compliment subjective measurements obtained from the inspection methods, with valuable and indispensable objective measurements with regard to the usability of the communication and information sharing systems.

In conclusion, an effective usability evaluation method should be able to express specific problems, and the evidence for them, in ways that would motivate developers to change certain aspects of the system. Some usability evaluation methods has the ability to make

design suggestions, while others simple identify the problem leaving development teams to conceive of the change. Even less effective usability evaluation methods, may exhibit a degree of persuasive power, if the evidence produced by the method capitalises on the developers' knowledge and process, which makes it easy for them to incorporate into their design (John & Marks, 1997).

Usability testing methods and usability performance measures should not only be used for evaluation purposes of existing software applications of interfaces. These criteria and tests should also be used during the design of software in order to drive the design to meet pre-defined and agreed objectives and levels of performance (Corporate Solutions Consulting, undated). The previous section introduces various usability testing techniques that can be implemented during various stages of the system development. The developers' main objective should thus be to take full advantage of the performance measures and testing methods available to him/her. This objective can be obtained by means of using a user-centered approach during the planning and design phases of product development.

3.7 USER CENTERED DESIGN (UCD)

> "Building usability into a system requires more than knowledge of what is good. It requires more than an empirical method for discovering problems and solutions... It even requires more than money and time. Building usability into a product requires an explicit engineering process." (Macleod et al., 1997, p.278)

Tertiary educational institutions are progressing towards the introduction of user-friendly, effective and efficient virtual environments for the enhancement of learning, communication and information sharing within the educational domain.

It is not only the task of the engineers and the technical personal to ensure the usability of communication and information sharing systems. The responsibility lies, to a large extent, with the educational developers, HCI specialist and with ergonomics and usability experts, who should work in collaboration with the design team in an effort to ensure the user-friendliness, effectiveness and efficiency of new technology based systems introduced to enhance the learning and information sharing processes within the educational institutions.

The following section aims at providing a knowledge base regarding the design principles that tertiary educational institutions should investigate in future research attempts, aimed at the creation of an integrated virtual environment with the potential of enhancing information sharing, learning and communication.

Ruben (1994, p.10) accurately describes User Centered Design (UCD) as the "...recent term coined to describe an approach that has been around for decades under different names, such as human factors engineering, ergonomics, and, more recently, usability engineering". These two terms can thus be used interchangeably, for the purpose of this paper, the term user-centered design will, however, be used throughout the discussion.

UCD is a well defined process that places emphasis on early and continuous involvement of users in the design process. UCD is performed as part of the system development process, which uses an array of user-centered tools and methods in order to create the most usable and effective communication and information sharing system possible within the limits of available time and resources (Ramey, 1991 & Baseline, 2000). UCD also incorporates the application of knowledge about the user's physical, perceptual and cognitive capabilities into the design of new and usable tools, systems and tasks. This process thus leads to easy-to-use products or services with important end-user benefits, such as reduced learning time, enhanced educational and communication productivity, enhanced learning, and fewer operating errors (Baseline, 2000; Nemire, 1994; Opaluch & Tsao, 1993).

Figure 3.7 User-Centered Design

(Ruben, 1994, p.11)

In summary, UCD aims at creating computer systems that adheres to the usability performance measures, and in essence will enhance educational effectiveness and efficiency. Figure 3.7 depicts the basic philosophy of UCD that places the user at center focus of the process, where all the design elements are derived form the user's viewpoint.

3.7.1 Models of User-Centered Design

The discussion will now turn to specific models of UCD.

(a) Nielsen's usability engineering model

Nielsen (1992) presents a more elaborative model (Refer to figure 3.8), incorporating all the stages mentioned above. Only certain steps in this model will be explained briefly.

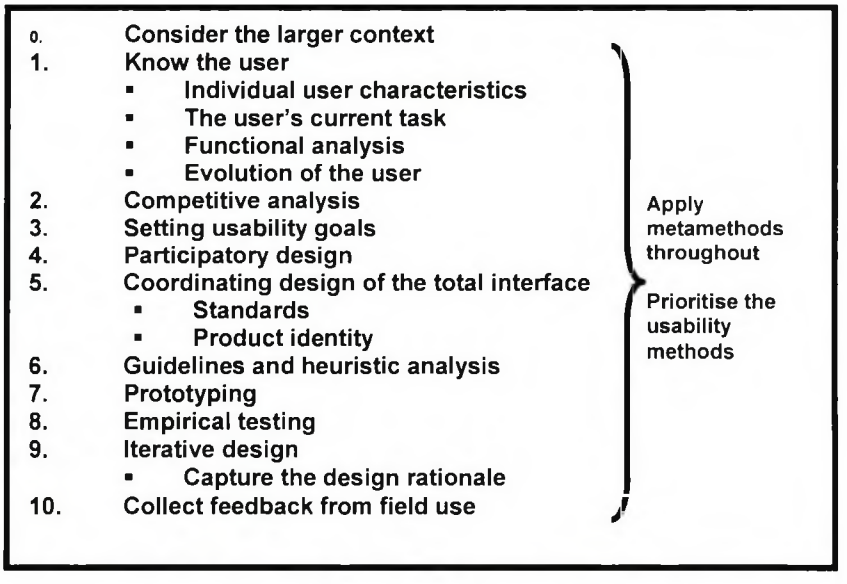

Figure 3.8: Elements of the Usability Engineering Model as presented by Nielsen

(Nielsen, 1992, p. 13)

- **Know the user:** This involves identifying the end user and determining the features and usability criteria important to the end-user. Careful consideration should be taken of individual user differences and variability in tasks, designers should also fully appreciate the context in which the product will be used. It is suggested that a project team should be assembled that includes

engineering, marketing, human factors professionals and end-users. Developers should also keep in mind that users often include installers, maintainers, system administrators, and other support staff, in addition to the people who sit a the keyboard. The concept of "user" should be defined to include everyone whose work is affected by the product (Nielsen, 1992; Opaluch & Tsao 1993; Poulson, 1998);

- **Competitive Analysis:** For most products in the design phase, competing products already exists. Designers should use these competing products as a special kind of 'prototype' for their own products. By analysing existing products according to established usability guidelines, designers will be able to identify weaknesses in competitors, and are thus in a unique position to solve or avoid such problems in their own future offerings. Designers will also be able to establish how well the competing products' functionality and interaction techniques support the kinds of tasks they expect the planned new product to support (Nielsen, 1992; Opaluch & Tsao 1993);
- **Setting usability goals:** The five main usability characteristics should be prioritised based on the analysis of the end-users and their unique tasks. These usability characteristics include, but are not limited to:
  - Learnability;
  - Efficiency;
  - Error rate;
  - Satisfaction;
  - Ease of use; and
  - Effectiveness (Nielsen, 1992).
- **Participatory design:** It is imperative to include end-users in the design phase of the product, and not only during the pre-design phases. Including end-users throughout the design phase will ensure the identification of potential mismatches between the users' actual task and the developers' model of the task (Nielsen, 1992);
- **Coordinated design:** Consistency is one of the most important usability characteristics, and should apply across the different media that form the total user interface. Coordinating the various aspects included in a single interface is of cardinal importance and ensures

the establishment of interface standards and product identity, which in turn leads to consistency within the interface (Nielsen, 1992); and

- **Prototyping:** Prototypes can either be working models or early representations of a system. Poulson (1998, p.9) views prototyping as an "...effective medium of communication between end user and designer that provides a concrete forum for exchange which has benefits over more abstract discussions." Figure 3.9 illustrates the rapid prototyping process that includes repeated cycles of redesigning and evaluation of a prototype by end-users.

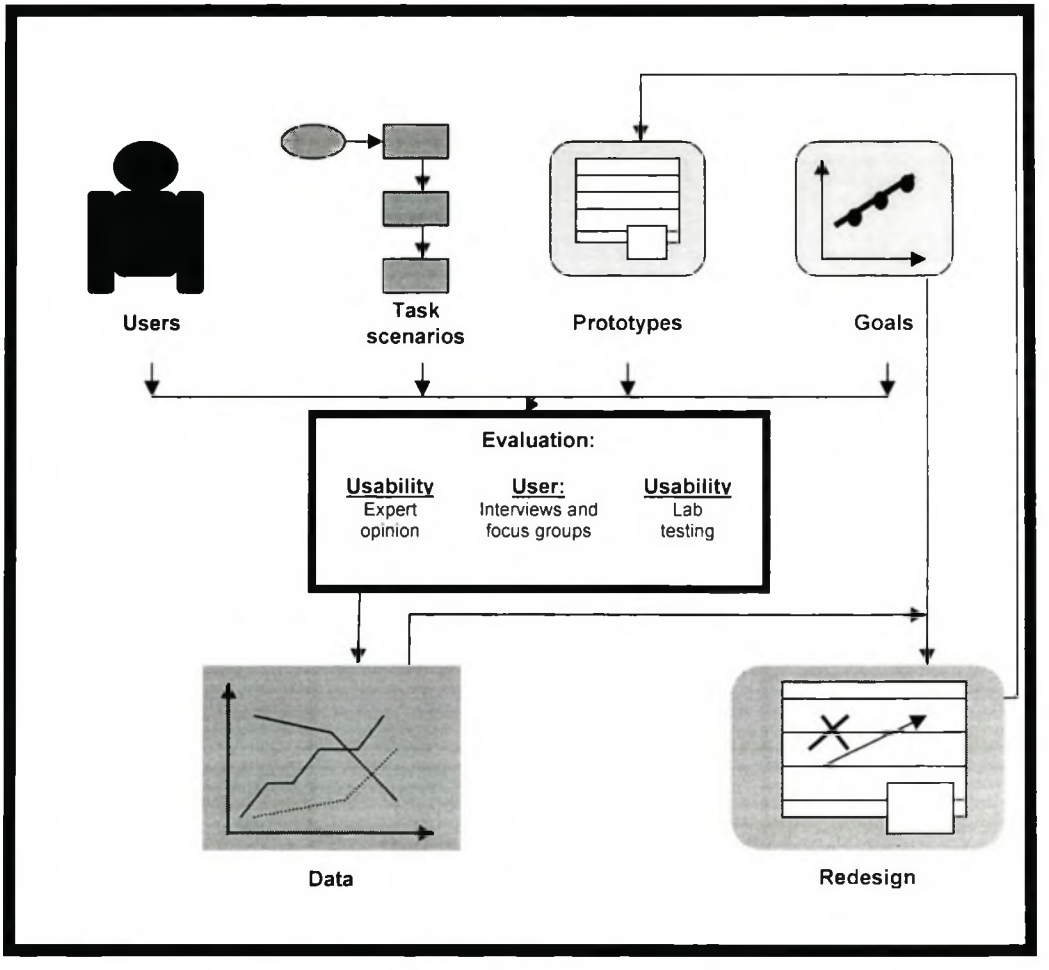

Figure 3.9: Overview of Rapid-Prototyping Methodology

(Opaluch & Tsao, 1993, p.81)

(b) Product development life cycle

The following model represents yet another phased approach to user-centered design. Table 3.3 provides a detailed description of the various human factors activities that need to occur during each phase.

Table 3.3 Hewlett Packard's Human Factors Activities during the Life Cycle

	Phase 1 **Needs Analysis**	**Phase 2** **Requirements Specification**
Objectives	Identify need for product by studying user, task, and work environment characteristics.	Specify requirements product must satisfy to meet user needs.
Human Factors Activities	Identify and characterise target user population. Identify and analyse user tasks. Identify users' physical and organisational environment. Identify usability problems on similar or existing products. Identify users' product feature list.	Identify ergonomic or market-based requirements. Define and develop product usability and acceptance goals. Define criteria for measuring usability and acceptance. Develop product localisation plan. Develop usability testing schedule.
Human Factors Methods	Case Studies/ customer visits. Survey. Focus group. Task analysis. User Diaries. Conceptual Modelling. Rapid Prototyping.	Literature review of: ▪ Previous product usability specifications; ▪ Human factors standards; ▪ Market research standards; ▪ Market research data; and ▪ Competitive research data
Human Factors Collaboration	Assist Marketing in the identification and investigation of users and their needs.	Provide Marketing with information regarding product requirements that will satisfy user needs.
	Provide R&D with information on users/ tasks and helps to scope the design, development, and test processes.	Work together with R&D to specify usability requirements, goals, and acceptance criteria.
	Assist Quality in the analysis of competitor products.	Work together with Quality to determine usability metrics for the products.
	Provide Learning Products with information on users/ tasks and help scope the design, development, and test processes.	Work with Learning Products to identify support materials that will facilitate learning and effective use of the product.

Table 3.3*(Continued)*

	Phase 3 Conceptual Design	Phase 4 Prototype, Development, and Test
Objectives	Develop product specifications to meet previously identified usability requirements and performance objectives.	Test product with target user population performing representative tasks to ensure a usable/ functional product.
Human Factors Activities	Develop product interface requirements. Define mental models describing system form the user's perspective. Determine allocation of functions between user and system. Integrate Human factors data, principles, and guidelines. Test conceptual Models.	Provide technical support in the development of product prototypes. Review production prototypes for ergonomic compliance. Provide feedback (including design recommendations) to designers based on results of usability test.
Human Factors Methods	Incorporate previous usability test data, corporate human factors specifications and human factors literature and standards. Observe/interview target users. Audio/Video taping. Structured walk-through (conceptual testing).	Usability test of: ▪ Simulations or mock-ups; ▪ Early prototypes; and ▪ Production prototypes; Early versions of Learning Products.
Human Factors Collaboration		Gets assistance from Marketing to define target user population and identify representative tasks for usability testing?
	Work with R&D to explore the usability implications of proposed designs. R&D creates conceptual models for structured walk through.	Obtain HW and SW prototypes and technical support from R&D for usability testing.
	Help Learning Products to integrate support materials into the development process.	Obtain product setup guides, on board documentation or online help messages/screens from Learning Products for usability testing.

Table 3.3 *(Continued)*

	Phase 5 **Product Evaluation**
Objectives	Verify that the product meets previously identified customer needs. Gather information for future product development.
Human Factors Activities	Review final production specifications to ensure agreed upon usability recommendations have been satisfactory implemented into the product design. Conduct on-site customer evaluations to determine product usability and how effectively the product meets user needs and expectations. Provide Marketing with usability advantages of the product. Analyse field data for next generation products.
Human Factors Methods	Beta-Site customer evaluations. Analyse Beta-Site data for future product specifications.
Human Factors Collaboration	Work with Marketing to collect field data regarding product usability in order to support the marketing, sales, and support of the product.
	Work with R&D to coordinate Beta-Site field testing. Obtain production HW and/or SW from R&D and provide updates for field evaluation. Obtain updated HW and SW as necessary/feasible from R&D and provide updates for field evaluation.
	Assist Quality in monitoring Beta-Site test data relative to previously set product usability metrics.
	Assist Learning Products in conducting Beta-Site customer evaluation. Obtain updated support materials are necessary/ feasible from Learning Products and provide updates for field evaluations.

(Ruben, 1994, pp.15-17)

3.8 TOWARD THE DEVELOPMENT OF A MODEL FOR THE CREATION OF AN INTEGRATED VIRTUAL LEARNING AND INFORMATION SHARING ENVIRONMENT

Taking previously discussed concepts and theories into account the following model was developed to indicate the delicate relationship between the various concepts and to illustrate how these concepts influence the ultimate outputs generated by the communication and information sharing and learning processes of the various role-players.

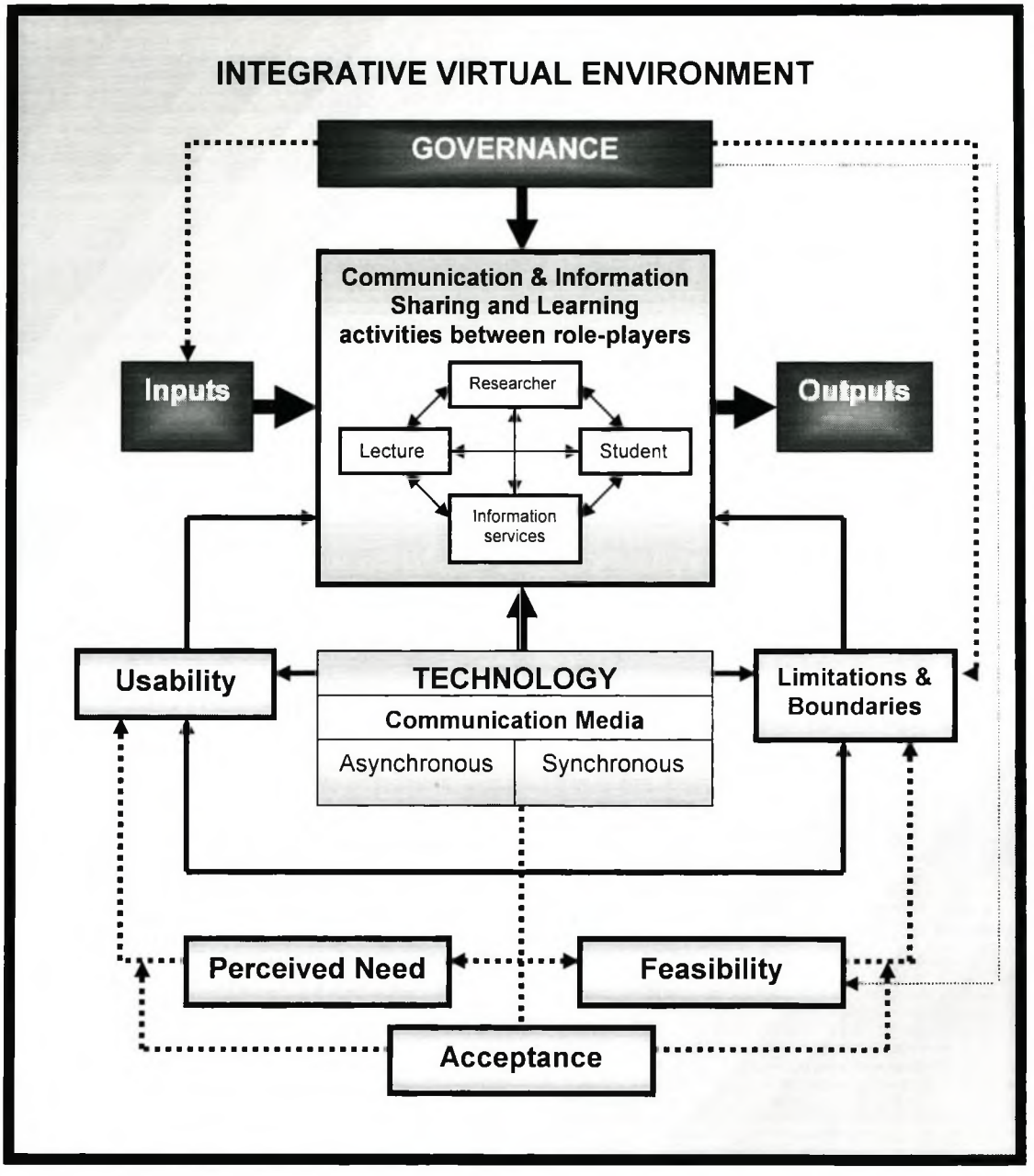

Figure 3.10: Interaction between concepts

The model is centered on a process of communication and information sharing and learning between role-players within an Integrative Virtual Environment. This process describes the ideal situation where various role-players can communicate and share information in modes of communication that best suite their individual characteristics and abilities, leading to enhanced learning outcomes.

The process further describes a situation of flexible learning within the integrative virtual environment which represents the educational arena after transformation has taken place.

The model illustrates that with sufficient inputs, the process will lead to certain outputs contributing to enhanced learning and communication processes.

Outputs generated by the process in terms of learning and education may include the following:

- Promotion of life long learning skills;
- Promotion of incidental learning principles;
- Breakdown of formality and the equalisation of status; and
- Increased motivation to learn.

Outputs in terms of the researching capabilities of the university may include the following:

- Acceleration of research providing the University with a new found international competitive edge and increased market intelligence; and
- Potential widening and deepening of research.

Outputs in terms of the information sharing capabilities of the university may include the following:

- Increased knowledge sharing and transfer of education;
- Enriched, renewed and revised information and knowledge sources; and
- Improvements in the effectiveness of communication.

Outputs in terms of the marketing potential of the university may include the following:

- Increased Marketing opportunities for the University; and
- Improved networking abilities.

The process itself may include the following activities:

- Sharing of experience base between role-players;
- Exchange of perspectives/insights and questions;
- Peer motivation to learn and communicate; and
- Facilitation of group work.

The process will be controlled by the governance of the relevant educational institution and the society. The governance will also influence the inputs allowed into the communication and information sharing process. The rules and regulations of governing body will contribute to the limitations and boundaries of the technology, in the sense that they may limit the access and implementation of certain technological solutions.

Limitations may be identified in terms of the following:

- Cost vs. benefit (ROI);
- Limited availability;
- Fire wall issues;
- Limited Bandwidth space;
- Registration issues and ease of access;
- Property rights regulations;
- Security issues;
- Market readiness;
- Maintenance; and
- Management issues.

Rules and regulations will also affect the perceived feasibility of implementing certain technological solutions

The technological solutions used within the virtual environment will inevitable influence the quality and effectiveness of the communication and information sharing processes, indirectly influencing the quality of the outputs generated by the process.

The technological solutions can either be asynchronous or synchronous communication media. Each of the media forms has their own technological and financial limitations and boundaries. Decisions regarding the implementation of certain technological solutions will further be influenced by the perceived feasibility of implementation, the role-players perceived need for implementation, the overall acceptance of the technological solutions and the usability of the technological solutions. Each of these factors on its own will affect the quality, effectiveness and efficiency of the communication and information sharing process and will thus also indirectly influence the outputs generated by the process.

Most important is the influence of usability on the outputs of the communication and information sharing process. It is assumed that usability will contribute to more effective knowledge management which will lead to enhanced learning. High levels of usability can in effect create a positive and less frustrating learning that enables the exploration of student's natural curiosity contributing to the promotion of enhanced learning.

The model assumes a direct multi-directional relationship between usability criteria and the limitations and boundaries of the technological solutions. Decreases in usability will

add to the limitations while perceived and real limitations will decrease the usability measures of the technological solutions.

Perceived need, feasibility and acceptance will not only influence certain usability criteria such as satisfaction and effectiveness but will also influence the limitations of the media. Low acceptance, feasibility and perceived needs of the role-players can be regarded as true boundaries that need to be overcome.

The following process model suggests topics for future research and the steps to be taken in the creation of a truly integrative virtual learning and information sharing environment.

The first step in the process would be to investigate the present systems available and in use at the University. These systems would include traditional classroom settings, distance education programs, and web-based asynchronous and synchronous communication media. It is important to investigate all available systems due to the fact that every system may show relevance and value for specific situations.

Systems, which are currently operational, should be investigated in terms of their advantages, limitations and boundaries, level of acceptance, the perceived need of the current users and the feasibility of their use. The investigation should also determine whether user needs are relevant and realistic and whether these needs can be satisfied. The acceptance study should pay special attention to stakeholders who might exert power over the choice of available technology.

An investigation of these concepts will lead to valuable information about the elements and principles that should be included into the design of the future system, and what elements and principles should be excluded from the design of a future system.

These elements and principles should then be integrated into the design of the future system together with learning theories, governance issues, usability issues, an analysis of the population their tasks and needs, HCI issues and theories and lastly human factors and cognitive ergonomics issues and principles. The integration of all relevant issues, theories and principles would then lead to the initial design of the future system, based on a UCD principle.

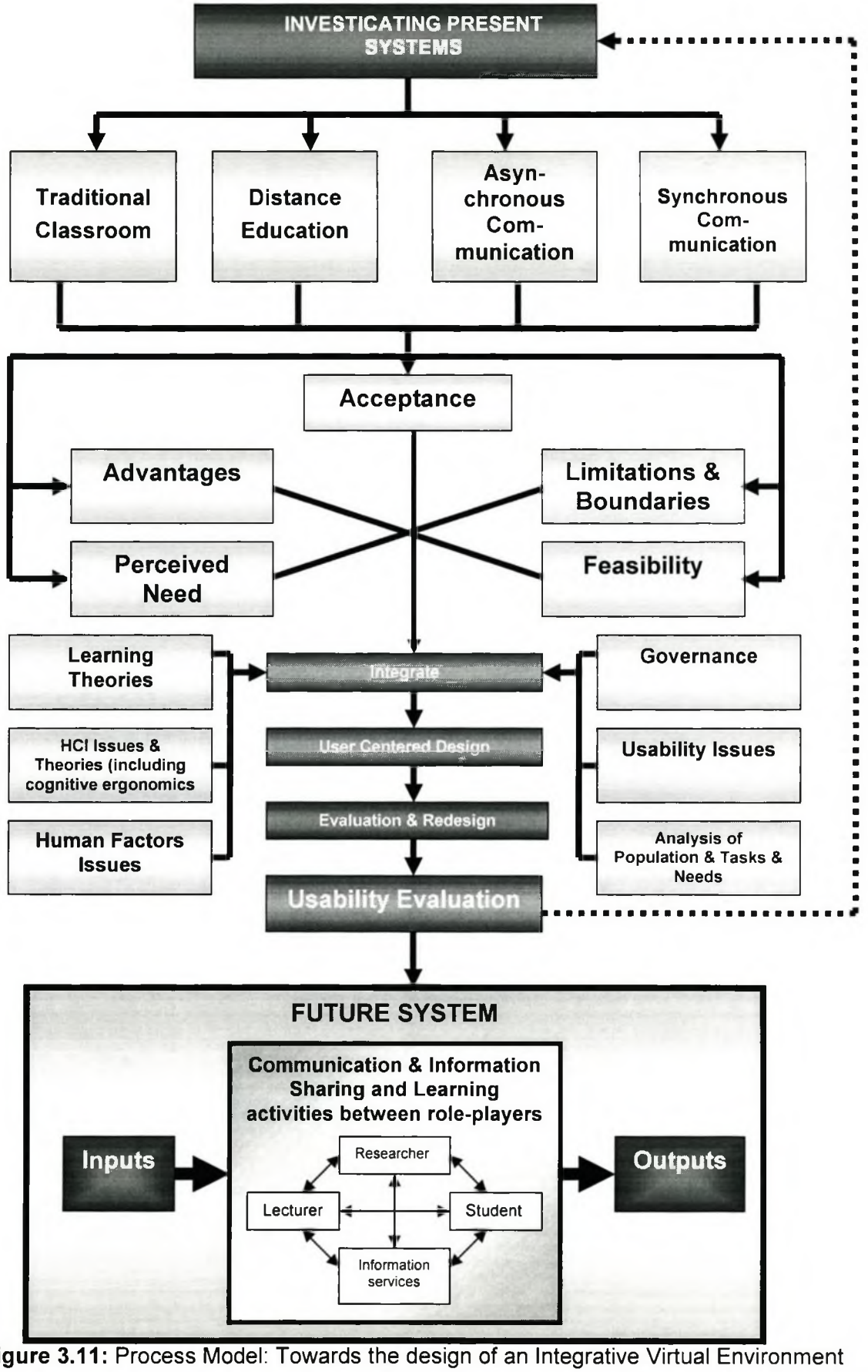

Figure 3.11: Process Model: Towards the design of an Integrative Virtual Environment

After the completion of the initial design phase, heuristics evaluations and other usability methods should be employed to investigate the usability of the system, and problem areas in the design of the system.

The next step would be to redesign or modify/upgrade the system, followed by yet another usability testing phase and a second redesign phase.

This model provides a guideline for future research. The elements described are in no way exhaustive or exclusive, and developers may identify further issues to be included in the design process. The design of an truly user friendly Integrative Virtual Environment for the effective communication and information sharing between role-players, can be a tedious exercise and can typically be considered as a focus topic for future research. Thorough research should accompany each and every step in the process if the process is to yield successful results.

3.9 CONCLUSION

Chapter 2 focused on theories and concepts relevant to virtual environments, distance education and web-based learning and highlighted the fact that the educational arena are in a process of rapid change and at this stage educational institutions can not afford to passively sit by and still maintain their competitive advantage.

The preceding models suggest that the implementation and adaptation of new technology within the educational domain, aimed at enhancing learning, communication and information sharing, brings to light issues pertaining to HCI, and more specifically in terms of usability evaluations.

The usability concepts and issues discussed in this chapter, in collaboration with the theories and concepts with regard to web-based education and distance learning, formed the basis of the usability evaluations of the communication and learning systems currently in operation within the University of Stellenbosch. Subsequent chapters will specifically focus on the usability evaluations conducted at the University of Stellenbosch, the findings of these evaluations and the conclusions reached.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 INTRODUCTION

It is anticipated that the communication media that support the asynchronous communication mode will enhance education and information sharing between role-players. The degree to which the communication media add value to the education and information-sharing process will, however, be influenced by the usability of the media and the role-players' perceived need for the specific media.

In Chapter 3 a theoretical framework was set for the successful usability evaluation of information sharing and communication media. This framework forms the basis of the usability questionnaire and the laboratory tests conducted during the study. Essentially the aim of the usability questionnaire and the laboratory tests is to investigate the status quo of communication media within the scope of this study.

The purpose of this chapter is to provide a broad overview of the research problem, the objectives of the study and the descriptive existential hypotheses that were set for the usability evaluation. This chapter will also discuss the research design and specific methodology employed for the research.

4.2 BACKGROUND

As defined in Chapter 1 paragraph 1.4, the usability study is focused on the asynchronous communication media which are either feasible to be used in the future or which are currently in use at the University of Stellenbosch. The usability study shall primarily focus on the World Wide Web Course Tool (WebCT) and Microsoft Producer for PowerPoint. The following section explains the rationale for selecting of the specific media to be included in the usability study and also provides a description of the specific media.

WebCT is but one example of available course management systems within the scope of online course delivery software products, while Microsoft Producer for PowerPoint is but one example of Video Streaming software. WebCT and Microsoft Producer for PowerPoint formed the focus of the usability study for reasons as set below:

- The first phase of the Virtual Information Space creation process, focuses on current software applications available to the University of Stellenbosch;
- Decisions regarding the appropriate software to be tested were made in cooperation with the Information Technology Department and other stakeholders. Both software applications provided potential cost effective solutions, with limited start up costs; and
- Decisions were further based on the specific needs of the E-Campus Initiative.

Additional reasons for focusing on WebCT:

- WebCT is currently available on campus to lecturers and students alike;
- A large portion of the student and lecturer population currently use WebCT, which indicates that the software application has been accepted on campus;
- Satisfied users can be employed to promote the wide scale use of the software application, cutting on further promotional activities and expenses;
- The University-Educational Department (Uni-Ed) evaluated and compared WebCT to other products such as Blackboard at the end of 1988 in collaboration with the University of Potchefstroom and the University of Pretoria. These evaluations identified WebCT as a user friendly system that allowing lecturers to do their own development work (A.D Van der Merwe, personal communication, 17 October 2002). No formal usability study was, however conducted;
- Evaluations further identified WebCT as the most flexible and diverse of the tested software applications. The University of Stellenbosch consists of ten faculties with various departments and disciplines and requires a flexible system to accommodate various needs (A.D Van der Merwe, personal communication, 17 October 2002); and
- Registered users can change the server settings allowing them to work online on their courses without paying for the time they spend on the web. This makes it a very attractive option especially for students with limited resources.

Additional reasons for focusing on Microsoft Producer for PowerPoint:

- Video Streaming is an excellent example of asynchronous enabled communication software, which provides a unique opportunity to address the learning principles discussed in Chapter 2;
- Video Streaming has been identified as a possible complimentary multimedia, communication web-based system to facilitate the education and the educational processes;

- Microsoft Producer is a free add-on to PowerPoint 2002 which eliminates start up costs making it an attractive alternative for students and lecturers alike;
- Microsoft Producer incorporates various media forms, such as video, audio and PowerPoint. The incorporation of various media increases the richness and attractiveness of the educational process; and
- Microsoft Producer utilises PowerPoint 2002, a software program known to many lecturers and students, decreasing the need for extensive training.

4.2.1 World-Wide-Web Course Tool (WebCT)

WebCT was originally developed in 1995 by the University of British Columbia as a project to build a web-based classroom for a third-year computer science course, and has since become well known as a low cost, asynchronous delivery and course management system, for the creation and maintenance of password protected learning environments. WebCT is in essence an environment that enables educators with various levels of technical expertise and knowledge of course management systems, to create sophisticated web-based courses by integrating an array of tools and features imbedded in WebCT (Goldberg, Salari & Swoboda, 1996; Jackson, 2002; McCormack & Jones, 1998).

WebCT can further be described in terms of the following points:

(a) WebCT as a learning management system

Learning Management Systems form one functional category of a vast array of software tools used in web-based learning. Learning Management Systems (LMS) generally provide the learners with an integrated view of all their active coursework and assignments in a syllabus format, spanning multiple courses and provides comprehensive assessment methods and goal tracking tools. Within the learning management systems category there exist at least three subsets of tools (Jackson, 2002):

- **Course Management System (CMS):** Course Management systems facilitate the web-delivery and management of instructor led courses. These systems are most popular for traditional higher

education institutions and include examples such as Blackboard and WebCT;

- **Enterprise Learning Management:** Enterprise learning management systems provide teams of developers with a platform for content organisation and delivery for a variety of content types. These systems are mostly used within large corporate training departments; and
- **Learning Content Management Systems:** Learning content management systems are systems with the capabilities of a knowledge management database system and integrated authoring tools. These systems are most frequently used on corporate intranets.

(b) WebCT compared to blackboard:

The following table provides a summarised comparison between WebCT and Blackboard, two of the most dominant and well known web course management systems available to higher education institutions.

Table 4.1 Comparison between WebCT and Blackboard

	WebCT 3.1	Blackboard 5.0
Product type	Web Course management system for the creation and maintenance of password protected online educational environments.	
Language	Neither product was developed exclusively for language classes, but for just about any subject.	
Hardware/ Software requirements	Java-enabled Internet connection and a designated area on a server running WebCT or Blackboard. Both companies also offer hosting of courses on their servers.	
Supplemental software requirements	Netscape Communicator 4.x or Internet Explorer 5 is the preferred browsers. If media files are to be incorporated into the course, the appropriate plug-ins (for example Real Player, Windows Media Player, Quicktime Player) needs to be installed on student computers.	
Price	WebCT can be downloaded for free for evaluation purposes, but a license needs to be purchased as soon as student accounts are created. Prices are determined by the number of student users and are calculated for one year. Faculty support is at extra cost.	Blackboard offers free evaluation courses. Prices are calculated per server and are based on the level (course or portal manager) and level of support.
Communication Tools	Discussion (threaded, asynchronous). Mail (internal, asynchronous). Chat (synchronous, text only). Whiteboard (synchronous, primarily visual, but text possible). Assignments/Drop-box (file exchange). Calendar.	Discussion board (threaded, asynchronous). E-mail (external, asynchronous). Virtual Classroom (synchronous, text and images). Digital Drop-box (file exchange). Calendar.

Table 4.1 Comparison between WebCT and Blackboard *(Continued)*

	WebCT 3.1	Blackboard 5.0
Course Content tools	Single page. Unlimited number of Content Modules. Student Annotations. Glossary. Learning goals. References. Audio (created independently of WebCT). Video (created independently of WebCT). Self-test questions. Index. Search. Links to communication tools. Image database.	3 Content areas organised in folders and files.
Exercises and Assessment tools	Self-test (not reported to instructor). Multiple choice or true / false only quizzes (full reports and statistics for instructor). Surveys (anonymous). Student homepages. Student presentations.	Quizzes (full reports and statistics for instructor). Survey (anonymous). Settings = *Randomisation*. Student homepage. Student presentation. Group areas.
Course and Student Management tools	myWebCT. Manage students. Track Students/Pages. My Progress (student progress report). My Records (student grade Report).	myBlackboard/My institution. Online grade-book. Course statistics. Check Grade (student grade report).

(Siekmann, undated, pp.1-2)

(c) Advantages of WebCT:

WebCT has incorporated a variety of tools, designed to address the needs of the entire educational enterprise – from administrators serving the needs of a broader student demographic, to students and faculties looking for ways to enhance teaching and learning. Studies with regard to WebCT have proven WebCT to be an innovative solution for educational institutions, enabling them to (Division of Distance & Distributed Learning, undated; WebCT, undated):

- Attract and retain students and faculty;
- Expand campus boundaries;
- Drive graduation rates;
- Continually improve course and degree program quality; and
- Integrate good teaching principles by: a) encouraging lecturer to student interaction; b) encouraging student to student interaction; c) promoting active learning; d) communicating high expectations; e) facilitating time on task; f) providing rich, rapid feedback; and g) respecting diverse learning.

The teaching principles mentioned above can be achieved by incorporating various tools in the web-based course. Table 4.2 depicts the various tools available, the principles they incorporate and the learning styles they support.

Table 4.2 WebCT Tools and the Teaching Principles and Learning Styles they Support

WebCT Tool	Teaching Principles the tool facilitates	Learning Styles the tool supports
Discussions	▪ Lecturer to student interaction; ▪ Student to student interaction; ▪ Rich, rapid feedback; ▪ Promotes active learning.	▪ Verbal learners; ▪ Social learners; ▪ Textual learners.
Organise page	▪ Diverse learning; ▪ Communicates high expectations.	▪ Learners to content interactivity; ▪ Facilitate directed instruction; ▪ Provides global picture; ▪ Advanced organiser; ▪ Linear learner.
Mail	▪ Lecturer to student interaction; ▪ Student to student interaction.	
Video	▪ Diverse learning.	▪ Visual learners; ▪ Demonstration of techniques.
Annotations	▪ Active learning.	▪ Detailed oriented learners.
Image Database	▪ Lecturer to student interaction; ▪ Student to student interaction; ▪ Active learning.	▪ Visual learners.
Resume Course	▪ Time on task.	▪ Sequential learners.
Quiz	▪ Rich, rapid feedback; ▪ Communicate high expectations; ▪ Time on task; ▪ Lecturer to student interaction; ▪ Active learning.	▪ Can direct student learning through selective release.
Self Test	▪ Rich, rapid feedback; ▪ Communicates high expectations; ▪ Diverse learning.	▪ Self paced learners.
Audio	▪ Respects diverse learning; ▪ Rich, rapid feedback.	▪ Auditory learners.
Bookmark	▪ Time on task.	▪ Sequential learners. ▪ Self-paced learners;
Calendar	▪ Time on task.	▪ Concrete sequential learners. ▪ Advanced organiser;
Assignments	▪ Rich, rapid feedback; ▪ Lecturer to student interaction; ▪ Time on task.	
Glossary	▪ Time on task; ▪ Rich, rapid feedback.	
Homepage	▪ Student to student interaction; ▪ Respects diverse learning.	
Link	▪ Time on task (helps students reach needed materials quickly); ▪ Active learning.	▪ Various learning styles.
Presentation	▪ Lecturer to student interaction; ▪ Student to student interaction; ▪ Diverse & Active learning; ▪ Rich, rapid feedback.	▪ Collaborators; ▪ Constructivists; ▪ Visual learners.
Progress	▪ Rich, rapid feedback; ▪ Respects diverse learning; ▪ Lecturer to student interaction.	
Search	▪ Time on task.	
Goals	▪ Communicates high expectations; ▪ Lecturer to student interaction; ▪ Time on task.	
References	▪ Respects diverse learning; ▪ Active learning; ▪ Communicates high expectations.	

(Division of Distance and Distributed Learning, undated, pp.1-7)

WebCT offers various role-players the opportunity to capitalise on the advantages of technology-enabled education with the potential of transforming their educational experience and the potential of opening a new world of opportunities. Table 4.3 provides a summary of the major advantages experienced by various role-players employing WebCT as a web course management system.

Table 4.3 Transforming the Educational Experience

	Capability	Impact	Value
Administrators	▪ Positively expands academic capacity; ▪ Increase student performance tracking.	▪ Increased student retention; ▪ New revenue streams; ▪ Improved expense management.	▪ Rapid ROI.
Lecturer	▪ Increase course management; ▪ Increase content management; ▪ Increase in the availability of assessment tools.	▪ Decrease in preparation time; ▪ Improved content availability; ▪ Improved content sharing.	▪ Increased productivity.
Students	▪ Increased personalisation; ▪ Increased academic support.	▪ Increased course completion; ▪ Improved grades.	▪ Improved learning.
IT Professionals	▪ Increased Scalability; ▪ Increased standards based architecture.	▪ Campus-wide deployment; ▪ Improved integration.	▪ Increased Efficiency.

(WebCT, undated, p.1)

(d) Disadvantages of WebCT:

Through the years users and developers have encountered various problems while working with the system. Fortunately these problems are relatively minor in nature and demonstrated no significant negative effect on the overall usefulness of the system. These problems may be of importance only in certain circumstances and does not affect all of the role-players involved. McCormack and Jones (1998) identified the following disadvantages pertaining to the use of WebCT:

- **Compulsory accounts:** WebCT is an 'access controlled and student tracking' based system and requires all participants to have a valid WebCT account, adding to the effort involved in setting up a web-based course;

- **Account sharing:** Team members responsible for creating a specific classroom with WebCT are required to share the same account. This causes some problems with regard to the effective management and integration of various course components;
- **Browser limitations:** Incompatibilities between web-browsers can cause certain problems pertaining to the use of WebCT. These problems arise due to the fact that WebCT uses browser functionality that Netscape and Microsoft browsers implement differently;
- **Interface problems:** Individuals with no experience with graphical user interfaces and Web forms may find the interface cumbersome at first glance, especially when considering the use of frames, JavaScript and the general class design interface;
- **Closed communication tool:** The e-mail and bulleting-board tools imbedded in WebCT, can only be accessed from within WebCT and cannot interact with e-mail and other Internet communication systems; and
- **All online:** Students may find the fact that a WebCT class must take place online discouraging keeping in mind that certain individuals pay for Internet access based on the time that they are connected.

(e) Description of WebCT's asynchronous tools:

The following list provides a short description of the most popular and most widely used asynchronous tools embedded within WebCT (Division of Distance & Distributed Learning, undated; Goldberg, Salari & Swoboda, 1996).

- **Goals tool:** Using the goals tool, lecturers can communicate their expectations regarding the course content to students;
- **Compile tool:** Students are able to compile pages from a path and create their own custom study guide;
- **Page annotations facility:** This tool allows students to create private annotations to specific pages or notes;
- **Mail tool:** Provides the necessary private mail between students and lecturers in the course;

- **Image database tool:** The image database houses images that instructor has created, downloaded, or where copyright is not a problem. WebCT automatically provides a page that allows students to search for images based on the name or keywords;
- **Quiz tool:** The quiz tool provides timed quizzes to students on dates specified by the lecturer. These quizzes can include graphics, charts, tables, links to other websites, streaming media, video and audio media;
- **Student Self-Evaluation tool:** Unlike the quiz tool, the self-evaluation tool provides the student with a multiple choice questionnaire they can use to evaluate their own level of knowledge. This tool can be added to any page of notes;
- **Calendar tool:** The calendar tool can be used to outline on each day the activities a student should be completing and to direct students to course resources;
- **Index tool:** Lecturers can create and index to cross reference key terms and concepts to the detail content within the course. After course author defined the words that should appear in the index, WebCT will automatically create an index which points to the relevant pages that contain specific words;
- **Assignments tool:** The assignment tool allows lecturers to describe, create and distribute written assignments, to students such as papers, essays, and formal lab reports in detail. Assignments can be linked to the Homepage or can be linked to quizzes and self tests;
- **Glossary tool:** Lecturers or course-designers can create a searchable glossary of terms. WebCT automatically adds links from the notes to the glossary entries;
- **External Reference Tool:** This tool can be used to link external references of any kind to the course content within WebCT;
- **Course Bulleting Board:** The course bulleting board can be seen as a discussion forum that creates a unique opportunity for course participants to communicate with one another by means of messages posted on the bulletin board. The course bulleting board can be used to make announcements, ask and/or answer questions posted by various role-players;

- **Student Homepages:** Student homepages enables students to create a personalised page within the course that provides personal and biographical information about the student that he/she wishes to share with other participants;
- **Student Presentations:** The student Presentation tool enables individual students, or students working as a team, to create and upload their own presentation, to be viewed and evaluated by other participants; and
- **Resume Course:** This tool enables the student to resume studying content pages where they left off.

(f) WebCT within the University of Stellenbosch:

WebCT was first implemented at the University of Stellenbosch at the beginning of 1999. With no noticeable problems its popularity has increased drastically ever since. A large and diverse group of lecturers are currently taking advantage of WebCT to communicate with students and assess student progress. Recent statistics (2002) shows that approximately 534 WebCT modules are currently running on the local (Stellenbosch Campus) WebCT server, with approximately 14650 students registered for modules on the local server. At present a further 105 modules are currently running on the Tygerberg Campus server, with approximately 1635 students registered for these modules. The development server houses a further 698 modules in the process of development (A.D Van der Merwe, personal communication, 17 October 2002).

The following list represents the most popular applications of WebCT at the University of Stellenbosch (US, undated):

- Distribution of study materials;
- Communication between lecturers and their assistants;
- Communication between lecturers and their students;
- Student to student communication;
- Monitoring of class attendance;
- Formative assessment of students; and
- Summative assessment of students.

4.2.2 Video Streaming Media: Microsoft Producer for PowerPoint 2002

Current web browsers and servers have enabled users to download and play back high-quality audio and video files from the internet by supporting full-file transfers and document retrieval. Although this is a relatively simple process, full-file transfer often implies very long, unacceptable transfer times and playback latency. Video Streaming offers a possible solution to this problem by allowing video and audio files to be streamed across the internet from the server to the client (Hunter, Witana & Antoniades, 1997).

Video Streaming involves the real time or on demand distribution and transfer of audio, video and multimedia on the internet, so that it is received as a continuous real-time stream. With streaming media the recipient has the choice of either downloading the file on their hard-drive or directly viewing it without downloading it on a PC. Viewing files directly ensures that no physical file is left behind on the recipient's PC. The process will also be faster in contrast to options where the recipient has to download the file before they can open and view it (Sharp's Audio-Visual, undated).

(a) Description of Microsoft Producer 1.1

Microsoft Producer for PowerPoint 2002 is an add-in for Microsoft PowerPoint 2002 that enables the creation of engaging and effective rich-media presentations for viewing on demand in a Web browser (Microsoft, 2002). Microsoft Producer enables the learner to pause and rewind the lecture in order to take notes and clarify certain points. This function increases learner control by allowing students to achieve their personal goals through their own individual learning methods and timeframes. The dynamic visual inputs provided by Microsoft Producer, makes this a powerful educational tool for bridging the gap between theory and practice. Visual demonstrations incorporating the experience and expertise of the educator are more likely to be remembered than simple written instructions. It is suggested by literature that the audio qualities of streaming media provided by Microsoft Producer has the potential of enhances the understanding of educational material because sound does not interfere with the visual aspects of the video (Zenios, 2002)

Microsoft Producer offers a variety of tools and features that allows users to:

- Capture, Import, and Organise a wide variety of media elements;
- Synchronize Media Elements; and
- Publish and share presentations anywhere (Microsoft, 2002).

The above mentioned features can be utilised to create cost-effective lectures delivered any time and on any desktop. Microsoft Producer can create high-impact rich media presentations and deliver on-demand broadcasts for educational purposes. Microsoft Producer can enable better access to existing video libraries within educational institutions (Microsoft, 2001)

(b) Description of minimum system requirements

Producer requires the following:

- A 400-Megahertz (MHz) processor, such as Intel Pentium or an Advanced Micro Devices processor;
- 2 Gigabytes (GB) of free hard disk space for capturing digital video content;
- 128 Megabytes of RAM;
- A video capture device and an audio capture device;
- A sound card;
- Microsoft PowerPoint 2002;
- Microsoft Internet Explorer 5.0 or later;
- Microsoft Windows XP Professional, Windows XP Home Edition, or Windows 2000 Professional; and
- Office XP application suite (Microsoft, 2001, 2002).

4.3 THE RESEARCH PROBLEM

The primary aim of the study is to conduct descriptive research in order to quantify and test the usability of asynchronous communication media and learning environments through empirical research methods. The study further sets the goal to examine and determine the role-players' perceived need for the specific communication media, namely WebCT and Microsoft Producer. The following research questions as stated below were addressed during the research process:

1. What are the limitations and benefits of the specific software in terms of usability criteria?
2. Does a specific need exist for the particular communication media, namely WebCT and Microsoft Producer, and functions within the certain software applications?

4.4 RESEARCH HYPOTHESES

The research objectives stated in Chapter 1, paragraph 1.4 and the research problem stated earlier, as well as the literature review in Chapter 3 set the foundation for the formulation of specific existential research hypotheses to be tested during the usability study and needs analysis phase. The formulated hypotheses provide provisional statements regarding the expectations of the researcher in terms of the potential research findings. The hypotheses are as follows:

Hypothesis one

A positive attitude exists regarding the general usefulness/utility of the software applications.

Hypothesis two

A positive attitude exists that the software application will lead to improved effectiveness.

Hypothesis three

A positive attitude exists that the software application will lead to improved efficiency.

Hypothesis four

A positive attitude exists regarding the reliability of the software applications.

Hypothesis five

A positive attitude exists regarding the general ease of use of the software applications.

Hypothesis six

A positive attitude exists regarding the consistency of the software applications.

Hypothesis seven

A positive attitude exists regarding the error management capabilities of the software applications.

Hypothesis eight

A positive attitude exists regarding the compatibility of the software applications.

Hypothesis nine

A positive attitude exists regarding the learnability of the software applications.

Hypothesis ten

Generally the participants will feel highly satisfied with the software applications.

Hypothesis eleven

Acceptable error rates for the application exist.

Hypothesis twelve

The participant's general reaction towards the software applications will be positive

Hypothesis thirteen

60% of the sample population will be able to complete the tasks set out in the task protocol sheet successfully.

Hypothesis fourteen

60% of the sample population will be able to complete the tasks set out in the task protocol sheet within the time limit.

Hypothesis fifteen

50% of the sample population will be able to complete the tasks set out in the task protocol sheet without any errors.

Benchmarks for hypotheses thirteen to fifteen were determined subjectively due to the lack of adequate existing benchmarks. Benchmarks are based on the researcher's experience with the software applications, conversations with subject experts, expert evaluations and from literature of previous studies.

4.5 RESEARCH METHODOLOGY

A scientific approach to research allows researchers to obtain behavioural facts with the greatest rigor by means of systematic observation and the recording of events. The scientific approach is thus a special systematised form of all reflective thinking and inquiry. The scientific approach can also be referred to as an empirical approach to research, where empirical refers to the process of direct observation (Furlong, Lovelace & Lovelace, 2002; Kerlinger, 1992).

According to Babbie (1995) research within any science serves three main purposes: exploration, description (what, who, when, where, how), or explanation (knowing why the event occurs or identifying the causal factors of the event).

- **Exploration:** Exploratory research creates a beginning of familiarity with a specific subject or topic and can be used in situations where the subject of study itself is relatively new. A researcher would typically use exploratory studies if he/she needs to satisfy a specific curiosity and has a desire for better understanding. Exploratory research can also be used to test the feasibility of undertaking a more extensive future study, or to develop new methods to be employed in any subsequent study;
- **Descriptive:** Descriptive studies aims at describing specific situations and events. During descriptive studies the researcher will typically observe a specific situation and then describe what was observed, using scientific descriptions through the use of specific set hypothesis; and
- **Explanation:** The last general purpose of scientific research is to explain certain phenomena. Thus the researcher will try to answer the "why" question of research.

This particular study can be seen as mainly descriptive in nature, with certain elements of an exploratory study. The whole concept of integrative virtual environments, and subsequently the process surrounding the creation of these environments, is a new developmental area for South African Educational Institutions.

4.6 SPECIFIC RESEARCH DESIGN

A research design as defined by Kerlinger (1992, p.279) is "...the plan and structure of investigation so conceived as to obtain answers to research questions". The research

design should thus be seen as the overall program or procedures followed by the researcher to conduct the research, and can include a description of methods used and steps taken from initial problem formulation to the final analysis of the data.

The research design should enable researchers to answer research questions as validly, objectively, accurately, and economically as possible. Figure 4.1 provides a broad overview of the process and steps taken to complete this specific research.

The research was conducted at the University of Stellenbosch and focused on the application of WebCT and Producer for PowerPoint within the on-campus educational environment. Sampling procedures focused primarily, but not exclusively, on role-players involved in post-graduate educational activities.

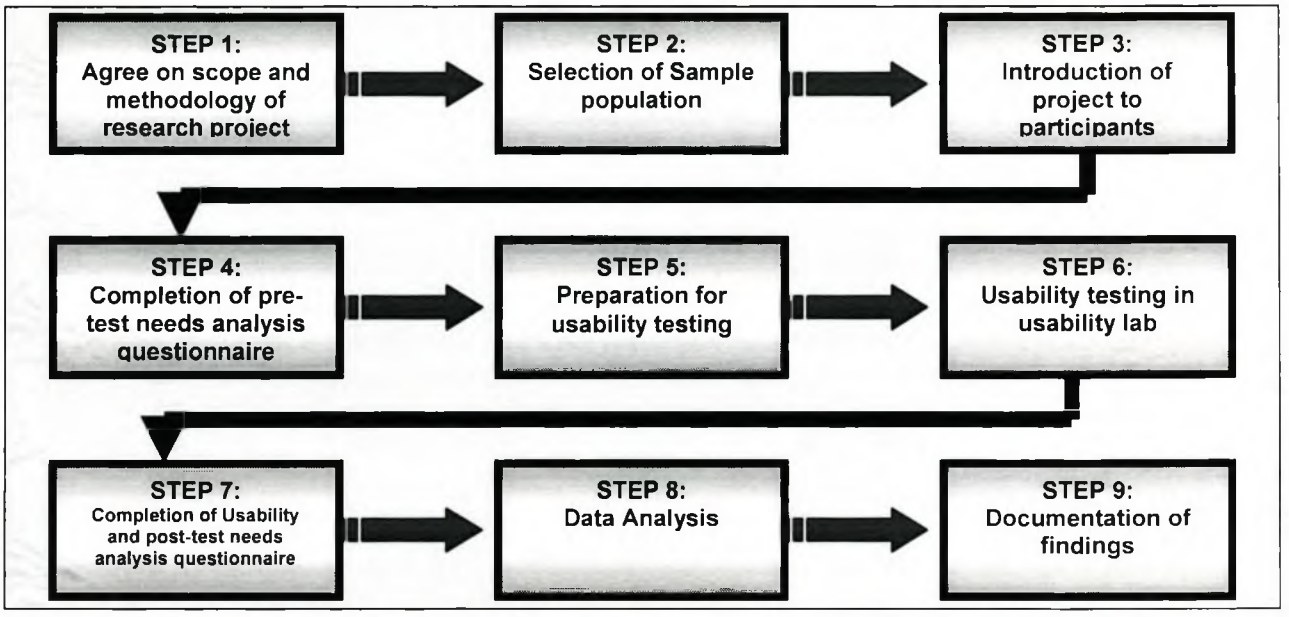

Figure 4.1 Research Process

Various research methods for conducting descriptive research exist, each with its own strengths and weaknesses. Although certain concepts are more appropriately studied by some methods than by others, an effective research design should include more than one of the following research designs in order to take full advantage of their different strengths. These designs include experiments, survey research, field research, content analysis, existing data research, comparative research and evaluation research (Babbie, 1995).

After careful consideration of the purpose and objectives of the study, as well as a realistic assessment of the time and budgetary constraints, the researcher decided to

combine usability inspection methods, the use of a usability laboratory and survey research in the research design of the particular study. The combination of research methods ensures that both subjective and objective measures were obtained.

4.6.1 Survey Research

Survey research represents the most frequently used mode of observation in the social sciences, whereby researchers would typically select a sample of respondents and administer a standardised questionnaire to them. Although survey research can effectively be used for descriptive, exploratory and explanatory purposes, it is not the most effective design for addressing causal direction. Survey research was chosen for this particular design due to its excellent ability to measure attitudes and orientations within a specific population sample. Besides effectively measuring attitudes and orientations, survey research may also be used to measure attitudes, preferences, beliefs, predictions, facts and past behavioural experiences (Babbie, 1995; Schwab, 1999; Weisberg, Krosnick & Bowen, 1996).

The following points highlight the major strengths and weaknesses of survey research.

(a) Strengths

- Useful in describing the characteristics of a large population;
- Surveys are flexible. Many questions may be asked on a given topic, providing considerable flexibility in the analysis of the research;
- A standardised questionnaire requires the researcher to ask exactly the same questions to all subjects and impute the same intent to all respondents giving a particular response; and
- Surveys can effectively measure the prevalence of attitudes, beliefs and behaviours. Researchers can assess changes over time, evaluate the differences between groups and propose causal relationships (Babbie, 1995; Weisberg et al., 1996).

(b) Weaknesses

- Survey research can seldom deal with the content of social life. A survey researcher rarely develops a feel for the total life situation in which respondents are thinking and acting;
- In certain ways, survey research can be regarded as inflexible. Studies involving direct observation can be modified with ease, whereas survey research requires the initial study design to remain unchanged throughout the process; and
- Survey research is generally weak on validity but strong on reliability (Babbie, 1995).

Survey research was considered the most appropriate method of research for this study despite its inflexibility and weak validity. Survey research methods provided the researcher with the opportunity to effectively measure the user populations' attitudes and beliefs with regard to the usability of WebCT and Microsoft Producer. The fact that a standardised questionnaire was used decreased the possibility of biasing the evaluation of WebCT and Microsoft Producer.

As was mentioned earlier, survey research involves the administration of a questionnaire to measure attitudes, opinions and orientations. There exist three major methods for the administration of questionnaires: self-administered questionnaires, interview surveys and telephone surveys (Babbie, 1995). As the questionnaires used in this study were self-administered questionnaires this method will be discussed briefly.

When using self-administered questionnaires, respondents are responsible for completing the questionnaire themselves. These questionnaires can be distributed to a number of respondents gathered at the same place and time, or questionnaires can be distributed using mail or electronic methods. Using self-administered questionnaires has two major advantages. Self-administered questionnaires are generally cheaper and quicker than face-to-face interview surveys. Respondents can sometimes feel reluctant to report controversial or deviant attitudes or behaviours in interviews but are usually willing to respond to an anonymous self-administered questionnaire (Babbie, 1995).

4.6.2 Usability inspection methods and laboratory tests

As described in Chapter 3 paragraph 3.6.2, usability inspection methods may be used to obtain information about usability related aspects of a user interface, by focusing on the specific features of the software application. In combination with survey research and usability inspection methods, the use of laboratory settings provides some degree of objectivity by creating a unique opportunity to observe aspects such as the success rate and error rate of the users. This is the chosen methodology for this particular study.

4.7 DESCRIPTION OF THE SAMPLE

A sample is in essence a special subset of a population observed in order to make inferences about the nature of the total population itself. Various sampling techniques can be used to determine the sample population to be used during the research process. These techniques can be either divided in non-probability or probability sampling methods. Probability sampling represents the most accurate method by making use of precise scientific techniques in one or more of its stages, such as random sampling. Probability sampling allows researchers to make relatively few observations and generalise from those observations to a much wider population. Probability sampling however is not always the most feasible method. Certain situational constraints may prohibit the use of probability sampling, in these situations non-probability sampling techniques are often the most appropriate. Although not based on random selection, these methods have their own logic and can provide useful samples for social inquiry (Babbie, 1995; Kerlinger, 1992; Weisberg et al. 1996).

Examples of probability sampling include the following: simple random sample, systematic selection procedure, stratified sample, cluster sample and multistage area sample. Examples of non-probability sampling include the following: reliance on available subjects, purposive or judgmental sampling, snowball sampling, convenience sample and quota sampling (Babbie, 1995; Kerlinger, 1992; Weisberg et al. 1996). Due to the nature of the study and the budgetary constraints imbedded in the study, non-probability sampling was used to determine the sample population.

4.7.1 Non-probability sampling

During convenience sampling, the researcher would typically survey people who can be reached and contacted with relative ease. Although convenience sampling procedures can be classified as a relative weak form of sampling, it is also the most frequently used sampling method and has its own merits when used with reasonable knowledge and care. This type of sampling method may in some instances, where no source of bias exists, generate valid results that are representative of the larger population. However, convenience sampling can also generate results that are not representative of the population. Although convenience sampling may yield valuable insights, researchers should take care as not to over generalise the data obtained from this sampling method. The representativeness of a convenience sample can be validated if the results of a single study are confirmed with new samples and by different researchers in different places (Babbie, 1995; Kerlinger, 1992; Weisberg et al. 1996).

4.7.2 Sample size

For achieving statistically valid results, small sample sizes lack the statistical power to identify significant differences between study groups. However, Ruben (1994) makes the assumption that for the purpose of usability testing a minimum of 10 to 12 participants should be sufficient. For the purpose of conducting less formal usability test, research has shown that four to five participants will expose 80 percent of the usability deficiencies of a product, and that this 80 percent will represent most of the major usability problems imbedded in the system. Important usability problems are more likely to be found with fewer subjects than are less important problems which can be overlooked by a relatively small sample. Using a relative small sample will thus identify most of the major usability problems but only some proportion of the less important problems (Virzi, 1992).

An original sample of 86 participants was selected during the initial pre-test needs analysis phase. Due to unforeseen circumstances and time constraints on the part of the participants, 36 participants could not partake in the final usability evaluations. The final sample for the usability evaluations were thus limited to only 50 participants. The researcher decided to include the responses obtained from the 36 participants mentioned above, in the statistical analysis of the pre-test needs analysis questionnaire. In the light of the above mentioned research,

the nature, constraints and objectives of the study a sample size of 50 participants comprising of students, lecturers, researchers and information service providers, seems to be sufficient and capable of producing valid results in terms of the set usability criteria.

4.7.3 Sampling procedure

Lecturers, researchers, students and information service providers were identified as the main strata within the scope of this research. The population group from which the sample was drawn was limited to role-players functioning within the University of Stellenbosch.
Prominent lecturers, researchers and information service providers were identified through lists obtained from various faculties, the research institute of the University and Uni-Ed.

Participating lectures were subsequently asked to identify students within their respective postgraduate courses. Additional student participants were obtained through lists provided by the administration department of the University.

As part of the sampling procedure, participants were invited to partake in the study by means of an official letter inviting them to attend an initial introductory presentation. The main purpose of the presentation was to ensure continued participation during subsequent laboratory tests. Secondly the presentation was utilised as a vehicle for the successful distribution of the pre-test needs analysis questionnaires, unfortunately a small number of participants were unable to attend the scheduled introductory sessions. In order to decrease their disposition with regard to information received during the introductory session, an additional introductory letter containing valuable information were used to introduce the research and ensure their participation. Participants were also invited at a later stage to attend the laboratory tests. The last invitation was personally delivered to each participant to further motivate them and to ensure their attendance. Appendix A contains examples of the various letters and invitations mentioned above.

4.8 MEASUREMENT INSTRUMENTS

4.8.1 Background

Data obtained from measurements during the course of any given study can be said to be either objective or subjective measures. Objective measures are based on the direct use of sensory information from the external world that is "publicly available". During objective measurements, different observers will experience a particular event in the same manner and therefore, give the same measurement. Subjective measures, on the other hand, are based on the personal, internal reactions of the observer. When the meaning of the event is based on the interpretation of the observer, these measures would be subjective in nature (Furlong et al., 2000). During the course of the research process, the questionnaires used, provided subjective measurements while the laboratory sessions provided objective measurements.

During the course of the study three separate questionnaires were administered to address the specific goals of the study and to obtain specific qualitative measures. The questionnaires used included a pre-test needs analysis questionnaire, a post-test needs analysis questionnaire and lastly a usability questionnaire.

Although the development of each of the questionnaires will be discussed individually, the following points concerns all of the questionnaires used.

- **Question Form:** Questions within a measuring instrument can be either closed-ended or open-ended questions. Open-ended questions allow respondents to freely express their thoughts and feelings by allowing them to reply using any format they feel comfortable with. Closed-ended questions on the other hand expect respondent to choose an answer provided within a specific set of response alternatives (Weisberg et al., 1996). After careful consideration, the researcher included both open-ended and closed-ended questions in the usability and needs analysis questionnaires. Closed-ended questions mainly consisted of semantic differential rating scales, where respondents were asked to rate entities on a bipolar scale. Likert Type scales were used to determine the respondent's agreement or disagreement with a number of statements. These scales

were also used to determine the frequency with which participant would use specific functions;

- **Question Wording:** During questionnaire construction, great care was taken regarding the wording of questions as to comply with the general rules presented by literature. These rules are to avoid ambiguous wording, b) avoid writing biased questions, c) never use double-barrelled questions, to avoid double negatives within a question, to be specific, and to keep the respondent in mind (Schwab, 1999; Weisberg et al., 1996);
- **Topic and Question Order:** The topics and questions within each of the questionnaires were designed with consistency in mind. Topics were grouped together as not to confuse the respondent, and each section started with an introductory sentence explaining to the respondent the topic of the next series of questions; and
- **Response Choices:** Although some variety was introduced in later sections of the usability questionnaire, the scales within each questionnaire were used consistently to avoid confusing the participants. Response set arises when respondents do not seriously consider each question but simply answer all the questions either by agreeing or disagreeing (Weisberg et al., 1996). To counteract this problem certain negative statements were included in the usability questionnaire.

4.8.2 Needs analysis questionnaire development

The needs analysis questionnaire utilised during the study was designed by the Virtual Information Space (VIS) Project researchers.

Objective three of the research study as defined in Chapter 1, paragraph 1.4 states that the findings obtained from the usability questionnaire, will be used in conjunction with an examination of the user needs and applicable concepts, to make recommendations to assist in future decisions regarding the value of the integration of these media into the creation of a high value interactive virtual learning environment.

In order to achieve the above mentioned objective a Needs Analysis Questionnaire was designed to determine the perceived needs of the end users in terms of the communication media.

The needs analysis questionnaire consisted of a pre-test (refer to Appendix B) and post-test needs analysis questionnaire (refer to Appendix C). Participants completed the pre-test needs analysis questionnaire a month before the commencement of the usability evaluation. The post-test needs analysis questionnaire was completed directly after the usability evaluation of the application software. Discrepancies between the pre- and post-test needs analysis questionnaire provides answers to questions regarding the influence of training and adequate knowledge on the perceived needs of the participants.

Each questionnaire provided the participant with detailed instructions and explained the purpose of the questionnaire. In cases where the questionnaire was handed out individually, the researcher gave further verbal instructions and explanations, if and where required.

The questionnaire consisted of four scenarios, incorporating the four levels of interaction (See figure 4.2). The inclusion of the four scenarios was considered necessary to determine which function participants would most likely use during their interaction with specific role-players. Certain functions were excluded from later scenarios due to the fact that the original design purpose and objective of the function are not applicable to certain scenarios.

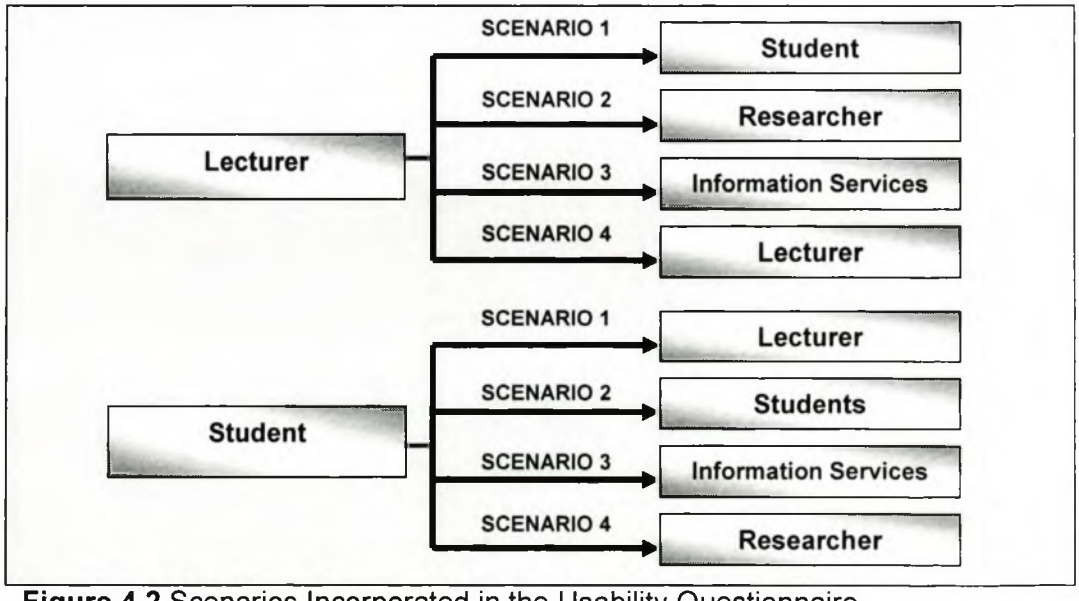

Figure 4.2 Scenarios Incorporated in the Usability Questionnaire

Each question contains a description of the specific function, a frequency scale to indicate the frequency with which participants would use the media, and an additional open-ended sub-question where participants were given the

opportunity to indicate any additional applications they might have for using the specific function. Section B of each scenario provided additional functions for specific media, providing the participants with the opportunity to rate the usefulness of the additional functions according to their own perception of the function.

The purpose and method of communication typically differs among various participant groups. After careful consideration the decision was made to develop a separate questionnaire for student participants, as certain functions are not practical and applicable to their specific purpose (See Appendix B and C).

4.8.3 Usability questionnaire development

The usability questionnaire (refer to Appendix D) forms the subjective measurement of usability. The Virtual Information Space Usability Questionnaire was designed by the VIS Project researchers, after a thorough investigation of the literature concerning usability criteria and the measurement of usability criteria. Several questionnaires were consulted and evaluated. These questionnaires subsequently formed the basis of the finalised usability questionnaire. These questionnaires are:

- Project Legend Concept Evaluation (De Jager, 2002);
- Software Usability Measurement Inventory (SUMI) (HFRG, undated);
- Computer System Usability Questionnaire (Lewis, 1995b);
- After-Scenario Questionnaire (Lewis, 1995a);
- Purdue Usability Testing Questionnaire (Lin, Choong & Salvendy, 1997);
- System Usability Scale Questionnaire (SUS) (Digital Equipment Corporation, 1986);
- Questionnaire for User Interface Satisfaction (Chin, Diehl & Norman, 1988);
- Perceived Usefulness and Ease of Use (Davis, 1989);
- Practical Usability Evaluation Questionnaire (Perlman, 1997);
- USE Questionnaire (Lund, 1998).

The Likert-Type rating scale utilised in the usability questionnaire provided seven response options ranging from 'strongly disagree' to 'strongly agree'. After careful consideration it was concluded that certain statements contained in the questionnaire has the potential to elicit a neutral response. Even numbers of response options were considered impractical as it would have forced

participants to either respond positively or negatively to questions where a neutral response would have been appropriate. When faced with an even number of available responses the respondents might resort to giving random responses between the two middle items (Kirakowski, undated). The odd number of response options thus allows the participant the opportunity to choose the neutral response where applicable.

The usability questionnaire consisted of four separate sections:

(a) Section A

Section A aimed at providing the researcher with specific biographical information regarding the respondents. This section included general questions such as 'gender', 'language' and 'user group'. The biographical section also provided valuable insights into aspects pertaining to the respondents general computer experience, exposure and computer literacy. The last few questions of this section focused specifically on the respondents' previous exposure or usage of the specific software application under investigation;

(b) Section B

Section B focused specifically on the usability issues and criteria of the software applications and which were divided into six dimensions. Various dimensions were utilised to cluster usability criteria into meaningful subsections. Each new criterion tested was accompanied by a general definition of the criteria as to aid the respondents' understanding of the various terms and concepts used throughout the questionnaire;

(c) Section C

Section C contained questions pertaining to the general reaction of the respondents towards the specific software application. This section utilised a semantic differential scale, placing two contrasting responses at opposite poles of a six point rating scale;

(d) Section D

The last section of the questionnaire allowed the respondents the opportunity to express their likes and dislikes about the system using open-ended questions.

Each respondent completed one usability questionnaire for WebCT and one usability questionnaire for Microsoft Producer for PowerPoint. The questionnaires used for the respective software applications were essentially the same except for minor alterations. Although the questions and response options were exactly the same, the questionnaires were individualised by specifically referring to either WebCT of Microsoft Producer. Secondly, question 13 of 'Section A' was altered to include the functions unique to each individual software application. Appendix E highlights the changes made to the usability questionnaire in order to individualise the questionnaire for each of the software applications tested.

It was the goal of the researcher to accommodate participants and to provide a pleasant experience for the participants during the course of the usability testing. Due to the fact that participants were required to complete multiple questionnaires and after careful consideration of the available options, it was decided to present the usability questionnaire and the post-needs analysis questionnaire in electronic format. The general assumption was that bulky hardcopy pen-and-paper questionnaires may decrease participants' motivation and enthusiasm, while on the other hand electronic questionnaires may create the elusion of requiring less effort and thus increasing the participants' motivation. The utilisation of an electronic questionnaire has the added advantage of automatically recording responses in a format compatible with the Statistical Package for Social Science (SPSS).

The electronic questionnaire was created using Borland Builder C++.

4.8.3.1 Reliability

> If a specific questionnaire repeatedly applied to the same subject, consistently produces the same result each time, the questionnaire can be considered to be reliable. It should be noted that reliability does not necessarily ensure accuracy. Reliability refers to two different concepts: internal consistency and consistency across time. Internal consistency refers to whether various statements in a questionnaire actually measure the same construct. Consistency across time on the other hand is concerned with whether the questionnaire will produce the same results if it is applied to the same phenomena after a certain time laps has occurred (Babbie, 1995; Buley, 2000; Furlong et al., 2000).

Various methods exist which can be used to measure the reliability of a questionnaire:

- The most commonly used method is the test-retest reliability measurement. This involves using the questionnaire to measure the exact same individual or object on two separate occasions. If answers vary, the measurement method may, to the extent of that variation be unreliable;
- The second method, namely alternate forms reliability involves the administration of two or more versions of the test. All versions should be equivalent in content and level of difficulty and should yield similar scores; and
- The reliability of a questionnaire can also be assessed by examining the internal consistency. This type of reliability assessment is useful with tests that contain a series of items intended to measure the same attribute.

Theoretically, the minimum figure for reliability is considered to be 0.00 and the maximum is 1.0. Reliability measures should never fall below 0.50 unless a very short questionnaire was used (Kirakowski, undated). Although unreliable measuring instruments may be loaded with errors it should be noted that measurements may still produce valuable insights and results without being reliable.

The usability questionnaire's reliability was measured using Cronbach's coefficient alpha (refer to table 4.4 and 4.5). This statistic provides an indication of the average correlation among all of the items that make up a scale. Cronbach alpha values are quite sensitive to the number of items in the scale. Scales with less than ten items commonly produces low Cronbach values (Pallant, 2001).

Table 4.4 Reliability values for the Microsoft Producer and WebCT Usability Questionnnaire

SCALE	ALPHA VALUE	
	Microsoft Producer	**WebCT**
General Usefulness/Utility	.8537	.7452
Effectiveness	.6897	.7801
Efficiency	.1216	.1169
Reliability	.7603	.6404
Ease of Use	.9048	.8892
Consistency	.6038	.8005
Error Management	.8236	.7456
Compatibility	.8838	.8326
Learnability	.6005	.7017
User Satisfaction	.8746	.8610

The reliability values of all the scales except for the efficiency scale falls above 0.5 which indicates that the Usability Questionnaires can be considered to be a reliable instrument for measuring usability. Although the low Cronbach alpha values for the efficiency scales may necessitate the removal of items that indicated a low item-total correlation, the researcher decided to retain those items in the questionnaire, but interpret results with care.

4.8.3.2 Validity

A questionnaire is valid if it measures what it is supposed to measure. The term validity refers to the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration (Babbie, 1995; Furlong et al., 2000).

There are various forms of validity:

- Face Validity is determined by looking at a measurement procedure to see whether it appears, on face value, to be measuring the variable of interest according to common agreements and individual mental images concerning a particular concept. Face validity is in essence a rather weak assessment of validity since it relies greatly on the subjective judgments of the observer. The quality of face

validity can, however. be improved by making it more systematic by for instance using a selected sample of subject experts to examine the measurement;

- A measure is said to have content validity when the items of the test accurately represent the concept being measured. This approach assumes that the researcher possess a detailed description of the content domain; and
- Criterion validity is based on some external criterion and refers to a questionnaires ability to accurately predict performance on other, independent outcome measures (Babbie, 1995; Furlong et al., 2000; Trochim, undated).

The constraints and descriptive nature of the study permitted only the determination of the face validity of the usability questionnaire. The usability questionnaire was presented to a selected group of subject experts with the purpose of evaluating the perceived face validity of the questionnaire. All subject experts involved in the process reported that the questionnaire appears, on the face of it, to be measuring the variable of interest according to their mental images concerning the particular concept. Precautions were taken to ensure that internal threats to validity were eliminated as far as possible.

4.9 USABILITY LABORATORY TEST

As was mentioned in Chapter 3, paragraph 3.6.4, testing a specific product in a well designed usability laboratory can improve the quality of usability testing, ensure clearer documentation, and reduce the number of developmental problems and yield higher productivity. The main objective for using a laboratory setting as part of the usability evaluation was to create a standardised setting and thus improve the quality and validity of the usability evaluations.

Although it would have been advantageous to use the single-room setup as described in Chapter 3, paragraph 3.6.4, budgetary constraints and a lack of sufficient equipment compelled the researcher to employ more feasible solutions without compromising the virtue of the evaluations. Throughout the setup process the researcher incorporated as much of the principles set out in literature as were feasible under the specific circumstances in order to further enhance the effectiveness of the usability evaluations.

Figure 4.3 provides a graphical representation of the layout of the location used during the usability evaluation of WebCT and Microsoft Producer.

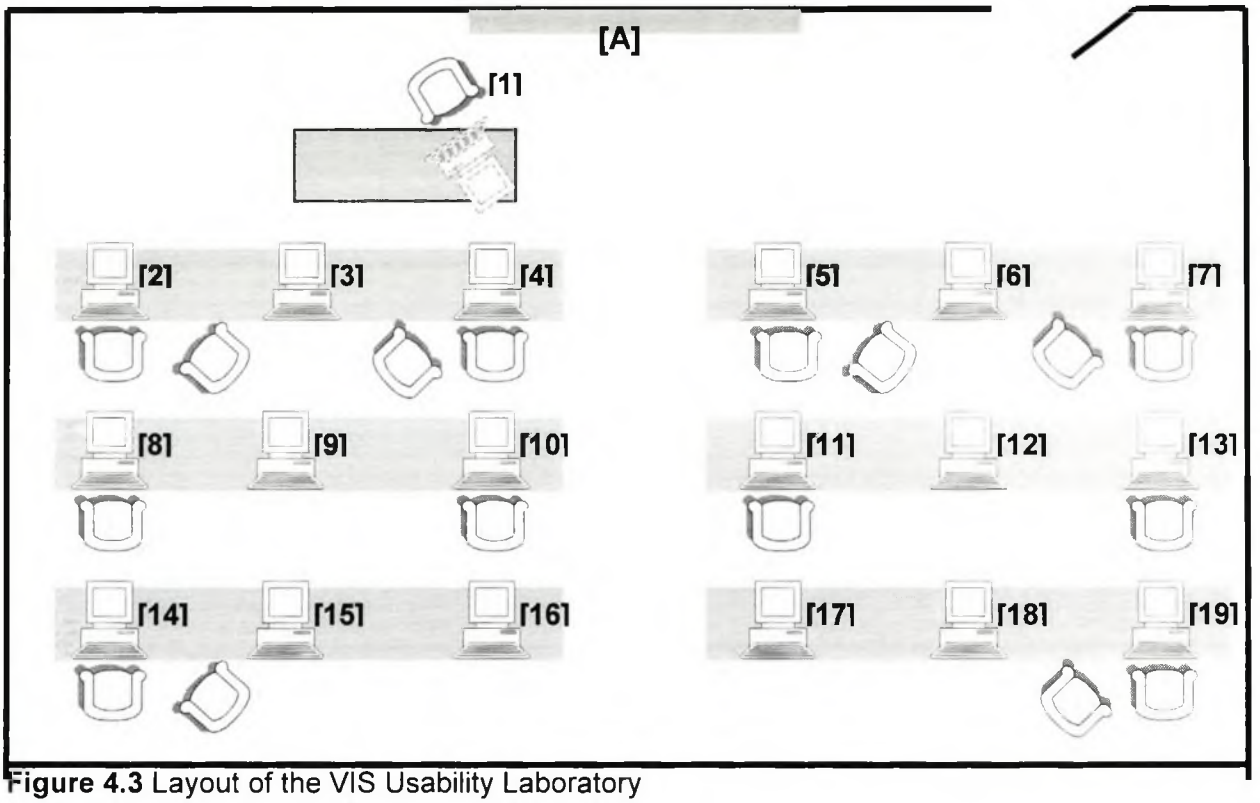

Figure 4.3 Layout of the VIS Usability Laboratory

The researcher was stationed at terminal [1], this terminal was used for training purposes as it allowed actions performed on the terminal to be projected to the projector screen [A]. Participants performed the tasks set out for each of the software applications at terminals [2], [7], [14] and [19], while terminals [3], [6], [9], [12], [15] and [18] served as back-up terminals.

A maximum of four participants were present at any given session. This allowed for a high standard of quality control and eliminated the problem of over-populating the room. The participants were stationed at the corners of the room to allow the participants the opportunity to complete their tasks without disturbances from other participants. One observer/test monitor was stationed next to each of the participants where they could have a clear view of the actions taken by the participant. Terminals [8], [10], [11] and [13] were utilised for the completion of the electronic Usability and Post-test Needs Analysis Questionnaire. After careful consideration the researcher decided to use alternative terminals for the completion of the usability questionnaire. The fact that the participants were not permitted to use the same terminal to complete the questionnaire compelled

them to get up and take a short recess before completing the questionnaire, allowing them the opportunity to reflect on their interaction with the software application. Completing the whole session without interruption had the potential to be tiring, which could lead to decreased concentration and motivation.

Photographs taken during the usability testing sessions as depicted in figure 4.4, demonstrate examples of the terminals and layout of the room.

Figure 4.4 Examples of Terminals and Layout of the Venue

4.9.1 Bias within the usability evaluation

One of the most difficult problems the evaluator has according to Chapanis (1991) is biasing the findings of the usability evaluation. Some important sources of bias are:

- The experimenter or evaluator;
- The instructions to the test subjects;
- The assignment of subjects to experimental conditions; and
- The way data is recorded.

During the specific usability evaluations of WebCT and Producer, the following measures were taken to avoid biasing the results produced by the usability evaluations:

- The researcher developed a session plan that included the order in which activities were to be completed and the time-frames for each activity. Certain rules were also defined in order to standardise the various evaluation sessions. The session plan ensured that each participant worked with the same material in the same way under the same conditions;
- Participants were randomly assigned to computer terminals and observers;
- Each test participant were supplied with a written outline of the session and written standardised instructions for the tasks to be completed; and
- Observers received written instructions and predefined rules.

4.9.2 Pilot testing

A pilot test was performed by a selected group of subject experts prior to the commencement of usability evaluation. The pilot test involved the evaluation of the task logging sheets, the task protocol sheets and the session outline. The pilot test also included a thorough evaluation of the software and hardware to be used during the usability evaluation. Software evaluations included the evaluation of the following software applications:

- Windows 95;
- PowerPoint XP (2002);
- WebCT;
- Microsoft Producer for PowerPoint;
- Electronic VIS Usability Questionnaires; and
- Electronic VIS Post-test Needs Analysis Questionnaire.

Each computer terminal was tested individually to ensure fully operational systems, including the Logitec Web-Camera, keyboard, monitor, floppy drive and the mouse.

4.9.3 User characteristics

During the design of the usability laboratory tests, the following assumptions were made regarding user characteristics and requirements:

- **Product experience:** No particular experience with any of the functions embedded in either WebCT or Producer is assumed;
- **System Knowledge:** None required;

- **Previous Training:** It is assumed that a large proportion of participants will have either no or little previous training; and
- **Computer Experience:** It is assumed that participants would have reasonable knowledge of computers and previous experience with various computer programs.

4.9.4 System requirements

The following minimum system requirements were identified for the successful completion of the usability evaluations:

- 233 MHz Pentium Processor;
- 16 Mb Memory;
- CD Rom drive; and
- 50 Mb harddrive space.

4.9.5 The role of the observers/test monitors

The key responsibility of the observers/monitors was to observe and document results. Observers had to carefully examine each action taken by the participant in order to identify possible errors. Observers had to document the specific errors made by each participant and also document the exact time it took participants to complete a specific task. Data was recorded on an 'Error Rate and Task Logging Sheet' (refer to Appendix F). Secondary to this, the observers' role was to encourage participants and to boost their self confidence by setting them at ease. Observers were not aloud to assist participants by directly showing them the correct course of action.

Participants were placed under the impression that each task should be completed within five minutes. If the participant did not fully complete a specific task within the five minute period, they were allowed a further two minute grace period without their knowledge. Observers, however, had to document the exact step participants were busy with when the five minute period elapsed. Participants were not aloud to continue with the task beyond the seven minute time period. If a participant did not complete the task at this stage (after seven minutes), the observer was required to show the participant the correct steps that would have enabled him/her to successfully complete the task. This was especially important during the Microsoft Producer Evaluations as the success of

subsequent tasks were directly dependent on the successful completion of previous tasks.

Prior to the usability testing, the observers were obliged to attend a training session during which the rules and regulations were stipulated. Observers received written instructions regarding their role. Certain scenarios were explored and the correct reaction to these scenarios was explained to the observers. The reason for the training session was to clarify the observers' role in order to avoid confusion and to eliminate possible observer bias.

4.9.6 Task protocol sheet

The task protocol sheet (refer to Appendix G) is comprised of those tasks that the participants were expected to perform during the usability evaluation. The task protocol sheet only contained tasks that would typically be performed by the various participants in their normal interaction with the system. Due to the fact that the purpose of the study is not to test the participants' level of expertise but to test the usability of the software applications, the tasks set out in the task protocol sheet were designed with the participants' level of expertise in mind. The task protocol sheet contained only simple day-to-day tasks purposefully not to overwhelm the participants.

A single task protocol sheet was designed for all the sample groups involved in the usability evaluation of Producer, while two separate task protocol sheets was designed for the usability evaluation of WebCT. The reason for this was that the typical tasks performed by the participants, who would in normal circumstances take on the role of a course administrator (lecturer, researcher and information service provider), differs from the typical tasks performed by the students. Course administrators would design a specific course using WebCT tools, while students would use a pre-designed course during normal interaction with the system.

The task protocol sheets included the following:

- A brief description of each task;
- The specific content, such as pre-prepared PowerPoint slides that participants would utilise during the course of the laboratory test to complete

the task. The task protocol sheets also included the specific location of content files;

- The materials needed to complete a specific task such as the separate dialogue sheet;
- Important 'hints' intended to help participants complete tasks without providing too much detail; and
- The benchmark timings that established the maximum time limits for the completion of tasks.

4.9.7 Informal software application training

Each testing session started of with an informal training period. The purpose of the training was to generate a degree of familiarity with the software applications to be tested during the usability evaluation. For reasons pertaining to the objectives of the study and due to the time limit of the evaluation sessions, training was focussed only on certain valuable functions of the software and did not incorporate all functions imbedded into the software applications.

Each participant received a training manual (refer to Appendix H) describing in detail the steps necessary to complete specific tasks. Besides the functions discussed during the training, the manuals also contained additional functions. The inclusion of additional functions in the training manual has one specific advantage: participants could work through the training manual at their own pace in order to familiarise themselves with the software applications. This would inevitable alter their perception of the software application and in turn, create a positive reaction, enhanced satisfaction and understanding of the software application.

4.9.8 Outline of evaluation session

The following table describes the course of events for the usability evaluation sessions:

Table 4.5 Outline of Usability Evaluation Session

	EVENT	DESCRIPTION (where applicable)
1	**Participant welcoming and orientation**	▪ Introduce researcher and test observers; ▪ Explain purpose of the laboratory evaluation; ▪ Description of software and hardware to be used during evaluation; ▪ Explain the participants role and provide a brief outline of the session; ▪ Explain the role of the observers; ▪ Explain to participants that they are not being tested; ▪ Ask for any questions.
2	**Handing out test packs to participants**	Test packs included the following: ▪ Outline of Session; ▪ WebCT training manual; ▪ Microsoft Producer training manual; ▪ WebCT task protocol sheet; ▪ Microsoft Producer task protocol sheet; ▪ Dialogue sheet; ▪ Floppy disc containing relevant files.
3	**WebCT informal Training**	Demonstrate three previously determined tasks.
4	**Microsoft Producer informal Training**	Demonstrate three previously determined tasks.
5	**WebCT usability evaluation**	Completion of tasks set out in the task protocol sheet.
6	**Two minute Recess / Break**	Move to new terminal.
7	**Completion of the WebCT usability evaluation questionnaire**	Complete electronically.
8	**Microsoft Producer usability evaluation**	Completion of tasks set out in the task protocol sheet.
9	**Two minute Recess / Break**	Move to new terminal.
10	**Completion of the Microsoft Producer usability evaluation questionnaire**	Complete electronically.
11	**Completion of the post-test needs analysis questionnaire**	Complete electronically.
12	**Participant debriefing**	Thanking participants for their support and participation.

4.10 STATISTICAL ANALYSIS

The results from the various questionnaires used during the study, were analysed using the Statistical Package for Social Science (SPSS, 1990) program. The analysis included the calculations of frequencies, means, modes and standard deviations as well as various correlations between variables. Statistical analysis also included the reversing of negative items within the usability questionnaire.

4.11 CONCLUSION

The study as described in the preceding chapters takes on the form of descriptive research which through the utilisation of survey research, usability inspection methods and laboratory tests aims at describing the status quo of educational and communication systems used within the University of Stellenbosch.

The survey method for descriptive research was used due to its ability supply subjective measures of the user populations' attitudes and perceptions with regard to the usability of WebCT and Microsoft Producer. A usability questionnaire was used to measure the usability criteria of the systems in accordance with formulated hypothesis. These subjective measurements were supplemented with objective measurements obtained through the use of laboratory tests and usability inspection methods.

In Chapter 5, the major research findings obtained from the descriptive research methods are described. The research results were obtained using mainly descriptive statistical methods and will be discussed in accordance with the formulated hypotheses.

CHAPTER FIVE
ANALYSIS AND INTERPRETATION OF RESULTS

5.1 INTRODUCTION

Descriptive research in essence aims at describing specific situations and events. The study in question thus aims at describing the current status-quo of the communication media used within the University of Stellenbosch in terms of measurable usability criteria and perceived user needs.

In order to achieve this aim, the researcher employed survey research techniques as well as laboratory tests, to obtain relevant objective and subjective measures.

The purpose of this chapter is to report the findings of the study in a systematic and logical order. The outline of the chapter will thus follow the original order in which the various questionnaires were presented to the sample group, starting of with a brief review of the biographical dimensions of the sample group. The findings will specifically relate to the existential hypothesis formulated in Chapter 4, paragraph 4.4.

Findings obtained using the Statistical Package for Social Science (SPSS) mainly consist of preliminary descriptive statistics aimed at describing the perceived needs of the user population and the usability of WebCT and Microsoft Producer.

5.2 DESCRIPTIVE STATISTICS CONCERNING THE BIOGRAPHIC PROFILE OF THE SAMPLE

For clarification purposes, figure 5.1 provides a review of the sample population utilised during the various stages of the study, as well as a review of the questionnaires completed during each stage.

Due to the varying task structures of the typical end-user group as was explained in Chapter 4, it was necessary to divide the sample in two separate groups. Group A consisting of lecturers, researchers and information service providers, and Group B consisting of pre-graduate and post-graduate students. Although the design of the questionnaires was essentially the same, the needs analysis questionnaires as well as

the laboratory tests were individualised to suite the characteristics of specific groups, leading to the development of two versions of the same questionnaire.

It was mentioned previously that a total of 36 respondents present during the pre-test needs analysis could not take part in subsequent tests, decreasing the final sample population to only 50 participants.

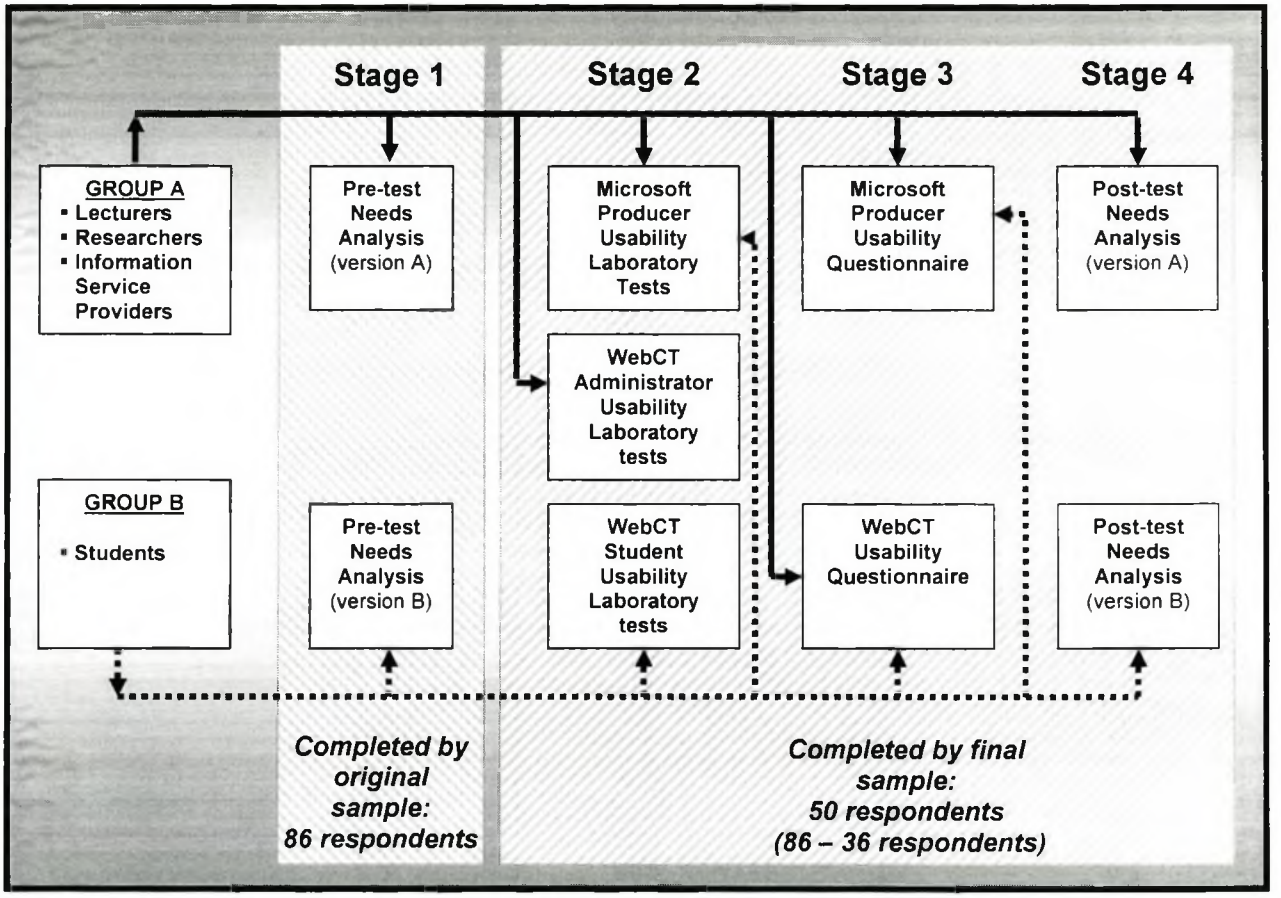

Figure 5.1 Review of Sample and Questionnaires Completed

The biographical questionnaire used to create a preliminary profile of the sample population was presented to respondents as part of the pre-test needs analysis questionnaire. Although the usability questionnaire also contained certain biographical questions, a preliminary analysis of the population sample in terms of their suitability for the study was considered extremely important.

5.2.1 Biographical profile of original sample

The biographical profile of the original sample, comprising of 86 respondents can be summarised as follows (note: all percentages has been rounded to the nearest tenth of a percentage):

- 11% of the sample consisted of fulltime lecturers, 6% consisted of fulltime researchers, 64% consisted of students and 4% consisted of information service providers. The remaining 16% of the sample can be classified as being both a researcher and a lecturer;
- From Figure 5.2 it is evident that the Arts and Economic and Management faculties show the highest frequency of respondents, while other faculties records low frequencies.
- The majority of initial respondents were male (67%), while only 32% were female;
- 79% of respondents claimed Afrikaans to be their first language, English speaking respondents comprised 17% of the sample and 4% claim neither English nor Afrikaans as their first language;
- 50% of the respondents reported that they currently use WebCT, 85% of respondents claim to be using PowerPoint while only 5% of respondents claim to be using Video Streaming software. This shows that PowerPoint can be considered to be the most popular and widely used educational tool, while video streaming is the least popular educational tool. On average PowerPoint represents the educational tool that has been in use for the longest period (mean: 2.5 years) while on average respondents reported that they have been using WebCT for a little more than a year;
- The highest proportion of respondents (31%) spend three to four hours per week on the internet, 25% spend five hours or more on the internet, 24% spend one to two hours per week on the internet, while only 19% of respondents reported that they spend less than one hour per week on the internet. It is thus evident that more than half of the sample spends at least three hours per week on the internet;
- The average respondent have been involved in traditional classroom activities for the past six years and on average spend approximately nine hours per week on these activities. On the other end of the spectrum the average respondent have been utilising web-based and distance education for less than a year, and will on average spend less than one hour per week

on these activities. These data confirm the fact that web-based and distance education is a relatively new concept to educators and learners alike; and

- With specific focus on the student group, figure 5.3 shows the educational level reported by 55 students. From the figure it is evident that the largest proportion of students falls into the post-graduate category.

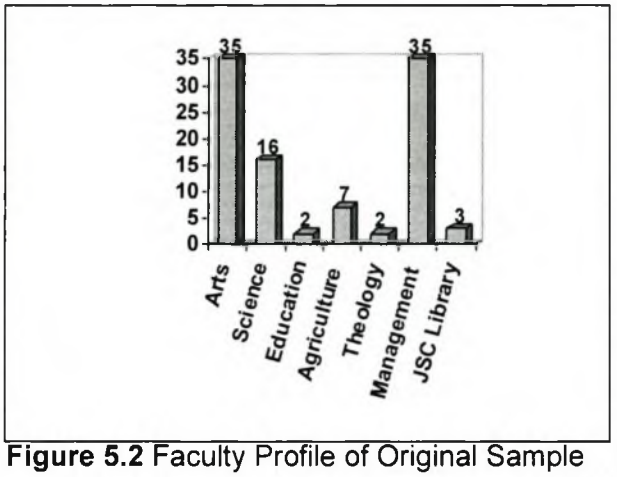

Figure 5.2 Faculty Profile of Original Sample

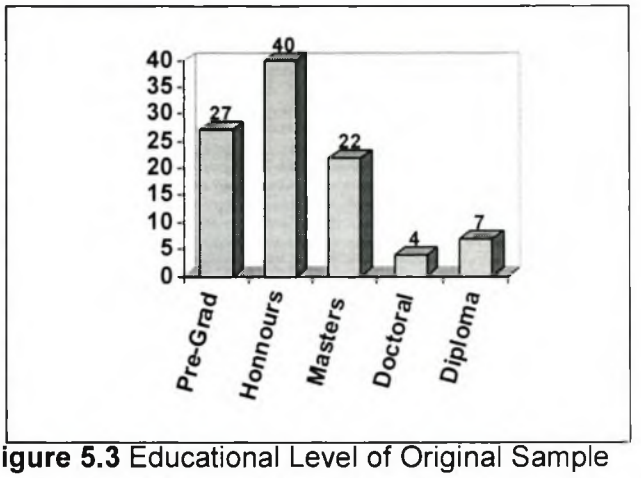

Figure 5.3 Educational Level of Original Sample

5.2.2 Biographical profile of the final sample

The last stages of the study were conducted on a final sample of 50 participants. Although the final sample was taken from the original sample of 86 participants, it was deemed important to once again analyse the profile of the final sample in order to determine what aspects of the profile changed and to what degree the profile of the sample changed. The following figures summarise the most crucial information obtained for the final sample.

Figure 5.4 shows that although the Arts and Economic and Management faculties still hold the highest frequency of respondents, other faculties represented in the original sample were not represented in the final sample.

Figure 5.5 shows that students are the most represented group and the information service providers the least represented group in the final sample as was the case with the original sample.

Figure 5.6 shows that the majority of respondents fell into the honours category of educational level. The only significant change with regard to the educational level of the participants in contrast with the original sample included students

who obtained a doctorate degree. The final sample however depicts a masters degree to be the highest degree obtained by the students.

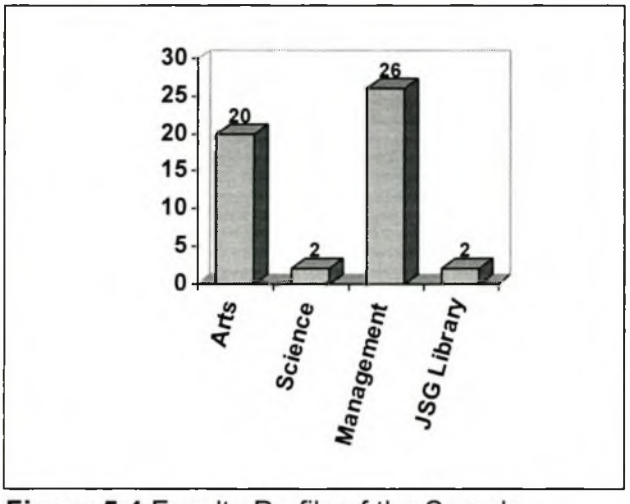

Figure 5.4 Faculty Profile of the Sample Population

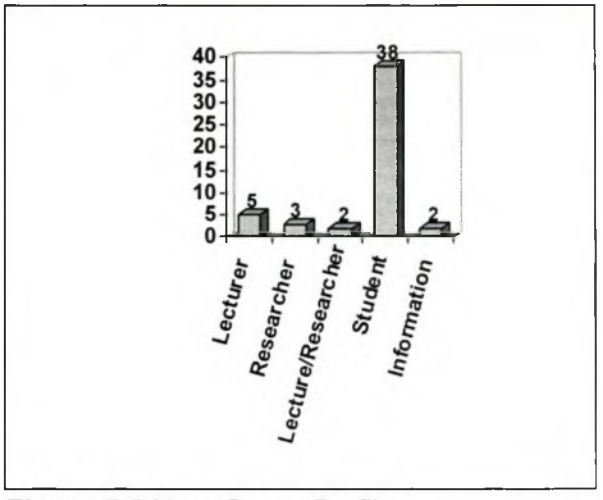

Figure 5.5 User Group Profile

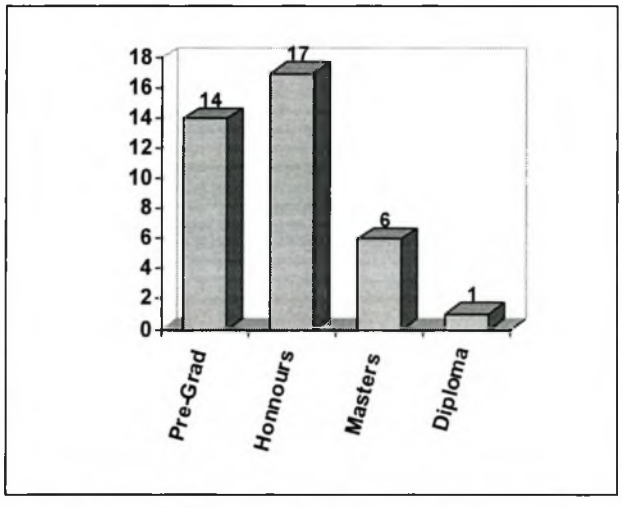

Figure 5.6 Students Educational Level

With regard to the rest of the variables, the final sample seems to be highly representative of the original sample in that no significant difference exists between the statistics analysed for the original sample and statistics analysed for the final sample.

5.2.3 Cross-tabulation analysis performed with regard to the biographical profile

It is interesting to note that students form the user group with the highest percentage of WebCT, PowerPoint and Video Streaming media users (Refer to table 5.1 to 5.3). 83.3% of the students use WebCT as apposed to 0% of

information service providers, 10% of the lecturers and 3.3% of the researchers. Table 5.2 further shows that a limited number of lecturers, researchers and information service providers use PowerPoint. 50% of the participating students and lecturers respectively use Video Streaming as apposed to 0% of the participating researchers and information service providers.

Table 5.1 Cross-Tabulation: 'Do you use WebCT' with User Group

			Lecturer	Researcher	Lecturer/ Researcher	Student	Information Services
Do you use WebCT	**Yes**	Count	3	1	1	25	0
		% within do you use WCT	10%	3.3%	3.3%	83.3%	0%
	No	Count	2	2	1	13	2
		% within do you use WCT	10%	10%	5%	65%	10%

Table 5.2 Cross-Tabulation: 'Do you use PowerPoint' with User Group

			Lecturer	Researcher	Lecturer/ Researcher	Student	Information Services
Do you use Power-Point	**Yes**	Count	4	3	2	35	1
		% within do you use PowerPoint	8.9%	6.7%	4.4%	77.8%	2.2%
	No	Count	1	0	0	3	1
		% within do you use PowerPoint	20%	.0%	.0%	60%	20%

Table 5.3 Cross-Tabulation: 'Do you use Video Streaming' with User Group

			Lecturer	Researcher	Lecturer/ Researcher	Student	Information Services
Do you use Video Streaming	**Yes**	Count	1	0	0	1	0
		% within do you use Video Streaming	50%	.0%	.0%	50%	.0%
	No	Count	4	3	2	37	2
		% within do you use Video Streaming	8.3%	6.3%	4.2%	77.1%	4.2%

5.3 DESCRIPTIVE STATISTICS CONCERNING THE PRE-TEST NEEDS ANALYSIS

The following section provides an exposition of the most important findings obtained from the pre-test needs analysis questionnaire. The data delivered by this questionnaire cannot be considered to be conclusive due to a lack of validity and reliability measurements. The data did, however, provide an overview of the perceptions and knowledge of the participants with regard to the communication media. The questionnaire also provided insight into the perceived frequency with which the participants would use the media if it were readily available to them.

Respondents were asked a series of questions aimed at determining which of the various functions within WebCT and Microsoft Producer they would use frequently if the functions were readably available, and which sub-functions they would consider useful in their daily interaction with various role-players. The main purpose of this questionnaire was to provide insight into the perceived needs of the role-players and thus providing valuable information regarding value of these functions for the development of future systems.

As was mentioned earlier, two versions of this specific questionnaire exist. Responses obtained from the collective lecturer, researcher and information service provider group will thus be explained separately from the responses obtained from the student group.

5.3.1 Responses obtained from the lecturers, researchers and information service providers.

Respondents were asked to consider four scenarios, each describing their interaction with a specific role-player.

(a) Scenario One

Scenario one describes the specific lecturer's, researcher's and information service provider's interaction with students.

- 26% of the respondents indicated that they would probably 'never' use Video Streaming during their interaction with students. Video

Streaming were subsequently identified as the only function where more than 25% of the respondents indicated that they would never use the specific function;

- Most sub-functions were considered to be extremely useful.

(b) Scenario Two

Scenario two describes the specific lecturer's, researcher's and information service provider's interaction with other researchers.

- 26% of the respondents indicated that they would probably 'never' use the glossary function, the image database function and the video streaming during their interaction with students. These functions were subsequently identified as the only functions where more than 25% of the respondents indicated that they would never use the specific function;
- Most sub-functions were either considered to be extremely useful, or elicited a neutral response from most of the respondents.

(c) Scenario Three

Scenario three describes the specific lecturer's, researcher's and information service provider's interaction with other information service providers.

- It is interesting to note that a large percentage of respondents indicated that they would 'never' use the majority functions within WebCT during their interaction with information service providers. The respondents also indicated that they would 'never' use the Video Streaming function during their interaction with information service providers;
- Most sub-functions were considered to be 'not at all useful' for their interaction with information service providers.

(d) Scenario Four

Scenario four describes the specific lecturer's, researcher's and information service provider's interaction with other lecturers.

- The mail function, asynchronous audio and video function, the glossary function and the video streaming function were identified as the only functions where more than 25% of the respondents indicated that they would never use the specific function;
- Most sub-functions elicited a neutral response from most of the respondents.

(e) Conclusions regarding the responses obtained from lecturers, researchers and information service providers

In summary the findings clearly shows that the functions that lecturers, researchers and information service providers would typically utilise in order to communicate and share information would differ from scenario to scenario. They would for instance frequently use the bulletin board during their interaction with other lecturers, researchers and students but they would not necessarily use this specific function during their interaction with the information service providers.

The finding also identifies scenario three as the scenario where least of the functions would be utilised and where most of the sub-functions were perceived to be 'not at all useful'. This indicates that lecturers, researchers and information service providers do not perceive the functions to be of value during their interaction with information service providers.

(f) Summary of open-ended questions

Respondents were allowed the opportunity to air their views with regard to the various functions within the WebCT system. Responding to the open-ended questions was not compulsory and only a few respondents provided comments which can be summarised into a few valuable points.

- The e-mail function can facilitate communication between lecturers and their off campus PhD. and master students;
- The self-test and goals function is more applicable to pre-graduate studies and not of great value to post-graduate studies;
- Post-graduate students can effectively use the presentations function to share their own presentations;
- The asynchronous audio and video function can be used effectively to share information and discuss topics, especially where descriptions becomes cumbersome;
- An extensive subject glossary can be created by cooperating lecturers within a specific department; and
- Video Streaming can be a powerful educational tool in courses that includes music, art and scientific experiments.

5.3.2 Responses obtained from the students

(a) Scenario One

Scenario one describes the students' interaction with lecturers.

- Most sub-functions were perceived to be useful during students' normal interaction with lecturers, with scores ranging from three to five.

(b) Scenario Two

Scenario two describes the students' interaction with fellow students.

- The sub-functions for the glossary function, the bulletin board function and the image database function received favourable reactions, while the sub-functions for the video streaming function received less favourable reactions.

(c) Scenario Three

Scenario three describes the student's interaction with information service providers.

- The presentations function was identified as the only function where more than 25% of the respondents indicated that they would never use the specific function;
- Most sub-functions were considered to be 'very useful' for their interaction with lecturers. The only sub-functions that elicited a neutral response from most of the respondents were the video streaming sub-functions.

(d) Scenario Four

Scenario four describes the students' interaction with researchers.

- Most sub-functions elicited a favourable response from most of the respondents. The video streaming sub-functions were the only sub-functions that elicited a neutral response from most of the respondents.

(e) Conclusions regarding the responses obtained from students

In conclusion the findings show that the frequency with which students would implement certain functions in order to communicate and share information would differ from scenario to scenario. However, the variance between the four scenarios observed for the student population are less conspicuous than the variance between the four scenarios observed for the lecturer, researcher and information service providers.

(f) Summary of open-ended questions

Respondent were allowed the opportunity to air their views with regard to the various functions within the WebCT system. Responding to the open-ended questions was not compulsory and only a few respondents provided comments which can be summarised into a few valuable points.

- Students could benefit from the self test and quiz functions as these functions can compliment their existing study methods;
- Video streaming would be useful in biology courses as it creates an opportunity to visually explain certain phenomena and diseases;

- The calendar and bulletin board function can be used to coordinate group activities.

5.4 DISCREPANCIES BETWEEN THE PRE-TEST AND POST-TEST NEEDS ANALYSIS

In order to determine the discrepancies that might exist between the pre-test and post-test needs analysis, the Wilcoxon Signed Rank Test were used. While 86 respondents were present during the pre-test needs analysis, only 50 of those participants were present during the post-test needs analysis. The pre-test responses, from the 36 respondents who did not complete the post-test needs analysis were excluded from the discrepancy analysis. The following section focuses on the identified discrepancies between the pre-test and post-test needs analysis.

Refer to Appendix I (figure I.1 and I.2) for an overview of the most important findings obtained from the post-test needs analysis questionnaire.

With regard to the lecturer, researcher and information service provider respondents, Table 5.4 presents the significance levels *(2-tailed)* for each of the paired function sets within the various scenarios.

Table 5.4 Wilcoxon Signed Ranks Test Statistics (Administrators)

	Significance level (2-tailed)			
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
RESDS1 - RESDV1	.317			
MAILDS1 - MAILDV1	.059	.157	.564	.102
TESTDS1 - TESTDV1	.564			
GOALDS1 - GOALDV1	.317			
ANNODS1 - ANNODV1	.564	.414	.083	.317
ASVADS1 - ASVADV1	.414	.564	.317	.564
PRESDS1 - PRESDV1	.059	.414	1.000	.564
CALDS1 - CALDV1	.157	.655	.317	.414
QUIZDS1 - QUIZDV1	.705			
GRADDS1 - GRADDV1	1.000			
GLOSDS1 - GLOSDV1	.564	.180	.317	.157
BULDS1 - BULDV1	1.000	1.000	.317	1.000
IMAGDS1 - IMAGDV1	1.000	.564	.564	.180
CONTDS1 - CONTDV1	.180			
VIDSDS1 - VIDSDV1	.564	.157	.317	.083

* $p \leq 0.05$

With regard to the student respondents, Table 5.5 presents significance levels *(2-tailed)* for each of the paired functions within the various scenarios.

Table 5.5 Wilcoxon Signed Ranks Test Statistics: Scenario (Students)

	Significance Levels (2-tailed)			
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
RESSS1 - RESSV1	.480			
MAILSS1 - MAILSV1	.003*	.317	.739	.180
TESTSS1 - TESTSV1	.046			
GOALSS1 - GOALSV1	.705			
ANNOTSS1 - ANNOTSV1	.480	.564	1.000	.194
ASVASS1 - ASVASV1	.102	.655	.157	.655
PRESSS1 - PRESSV1	.564	.564	.581	.058
QUIZSS1 - QUIZSV1	1.000			
GRADESS1 - GRADESV1	1.000			
CALSS1 - CALSV1	.257			
GLOSSS1 - GLOSSV1	.058	.157	.059	.317
BULSS1 - BULSV1	.655	.564	.157	1.000
IMAGSS1 - IMAGSV1	.564	.414	.564	.000*
CONTSS1 - CONTSV1	.317			
VIDSSS1 - VIDSSV1	.000*	.000*	.000*	1.000

* $p \leq 0.05$

To constitute a statistically significant difference between the two sets of scores the significance level should be equal to or less than .05. From the tables it is evident that the respondents did not drastically alter their opinion with regard to the various functions. The tables 5.4 clearly shows that the difference between the lecturers, researchers and information service providers' pre-test and post-test scores were not radical enough to present a significant difference. The pre-test and post-test for the students did, however, present a significant change in the scores for the video streaming function within each of the scenarios (Table 5.5) and the mail and test function in scenario one.

The majority of students indicated during the pre-test needs analysis that they would 'sometimes' use the video streaming function, but indicated during the post-test needs analysis that they would 'frequently' use the video streaming function. The fact that the majority of students did alter their responses suggests that initially they did not fully understand the concept and advantages of video streaming. It can be concluded that the informal training session and the opportunity to interact with the system helped students to envision an array of interaction possibilities created by the video streaming software.

In general, the respondents did not drastically change their perception with regard to the functions after they received training and interacted with the software applications. This would suggest that their initial perceptions can not be contributed to a lack of knowledge or training.

5.5 DESCRIPTIVE STATISTICS CONCERNING USERS' QUALIFICATIONS AND EXPERIENCE IN TERMS OF COMPUTER USAGE

Before turning to a more in depth view of the usability of WebCT and Microsoft Producer, it is important to determine the average users' level of expertise, previous exposure and experience in terms of computer usage. It is assumed that these factors may have an impact on the respondents' assessment of WebCT and Microsoft Producer in terms of the stated usability criteria, and can thus be used to explain variance in the usability data obtained for each of the software applications.

Figure 5.7 shows that 60% of the respondents consider themselves to be computer 'literate' and are skilled to perform only basic operations with the computer. Only 2% of respondents considered themselves to be computer 'literate at expert level' and are skilled in the technical operations and programming of a computer.
The majority of respondents (62%) indicated that they have access to a computer at work and at home. 22% of the respondents claim to have access to computers only at work, while 14% claimed to have access to a computer only at their homes. It is interesting to note that only 2% of respondents indicated that they have no access to computers (See figure 5.8).

It is evident from figure 5.9 that the majority of respondents have more than one year experience with computer systems. Only 2% claimed to have less than one year computer experience.

Figure 5.10 to 5.12 shows that the highest percentage of respondents (72%) uses a computer everyday. The majority of respondents have received less than two hours of formal computer training. Most of the respondents (84 %) reported that they use a computer for both work related and personal activities.

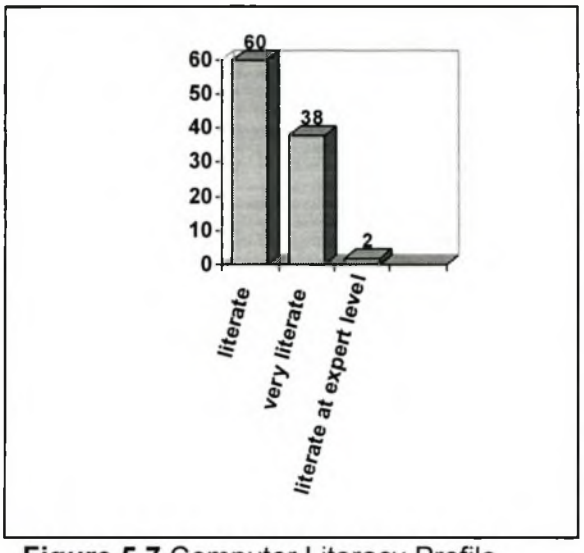

Figure 5.7 Computer Literacy Profile

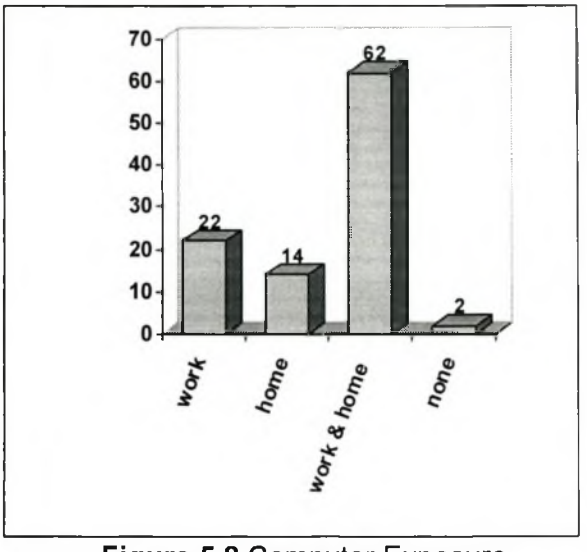

Figure 5.8 Computer Exposure

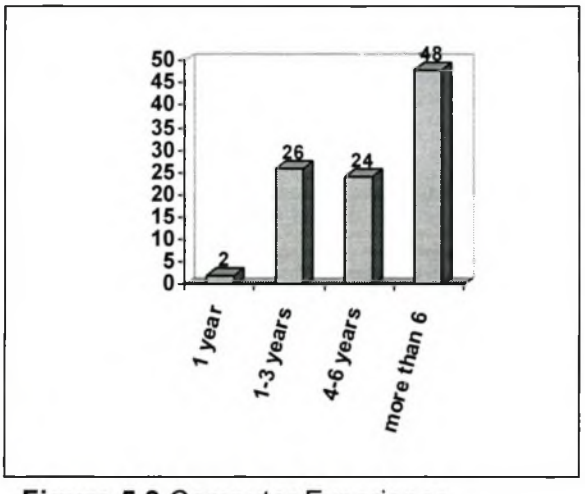

Figure 5.9 Computer Experience

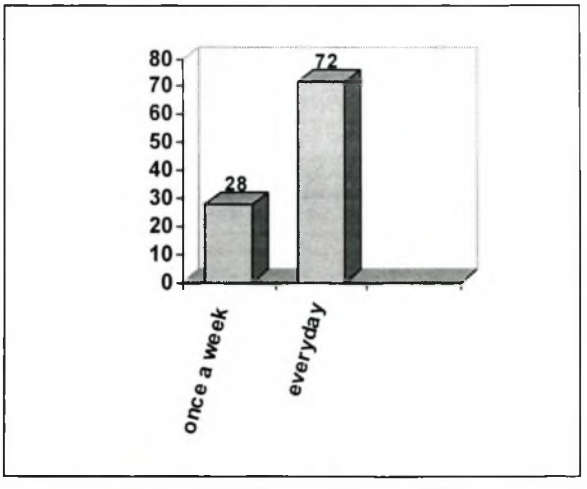

Figure 5.10 Frequency of Use

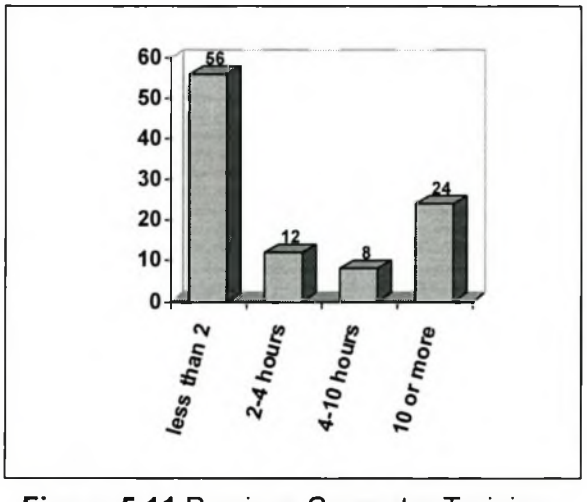

Figure 5.11 Previous Computer Training

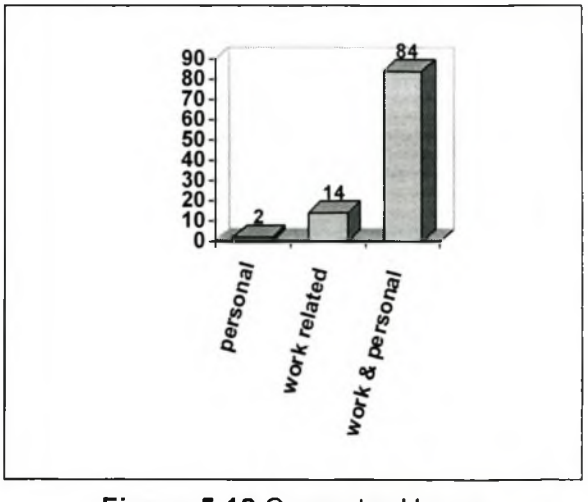

Figure 5.12 Computer Usage

With regard to WebCT the descriptive statistics shows that:

- 38% of respondents claimed their latest exposure to WebCT to be their second exposure. 32% of the respondents claimed that their latest exposure to WebCT was their tenth (or more) exposure;
- All of the respondents (100%) received less than two hours of WebCT training;
- The majority of respondents (58%) claimed that the amount and intensity of the WebCT training they received were insufficient. Only 4% claimed that the amount of training received were more than sufficient and only 6% claimed that the intensity of the training received were more than sufficient;
- The largest percentage of respondents (88%) reported that they did successfully complete all the tasks set out in the experiments;
- The e-mail function and the self-test function were identified as the only functions were more than 50% of the respondents positively indicated that they have previously used the specific function.

With regard to Microsoft Producer the descriptive statistics shows that:

- The majority of respondents (72%) indicated that they have not previously been exposed to Microsoft Producer;
- The highest percentage of respondents (96%) received less than two hours of Microsoft Producer training. 4% of the respondents received no previous training;
- The majority of respondents (56%) claimed that the amount of the Microsoft Producer training they received were insufficient. And 42% of the respondents claimed that the intensity of the Microsoft Producer training they received were insufficient. Only 18% claimed that the amount of training and the intensity of the training they received were more than sufficient;
- The largest percentage of respondents (88%) reported that they did successfully complete all the tasks set out in the experiments;
- None of the listed Microsoft Producer functions were 'never' used previously by the majority of respondents.

5.6 DESCRIPTIVE STATISTICS CONCERNING THE USABILITY OF WEB-CT

The findings for each of the usability criteria tested will be discussed in accordance with the previously formulated existential hypothesis. The criteria tested and included in the discussion are usefulness, effectiveness, efficiency, reliability, ease of use, consistency, error management, compatibility, learnability and user satisfaction. The discussion will

also focus on the error rate, the users' general reaction to the system and the general information obtained from the usability questionnaire.

A frequency table for each of the criteria scales will be presented. Each item within the table refers to a specific question (indicated by the number within the parentheses) in the usability questionnaire. Each item should be read in conjunction with the question it refers to, it should however, be noted that the negative items within the scale were reversed to positive items prior to the statistical analysis of the scale responses.

5.6.1 General Usefulness/Utility of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' categories.

Table 5.6 Frequency table for the Usefulness/Utility of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Usefulness 1 (18)			7	14%	3	6%	3	6%	6	12%	19	38%	12	24%
Usefulness 2 (19)			6	12%	1	2%	4	8%	16	32%	15	30%	8	16%
Usefulness 3 (20)	1	2%					6	12%	7	14%	25	50%	11	22%
Usefulness 4 (21)			1	2%	2	4%	4	8%	20	40%	22	44%	1	2%
Usefulness 5 (22)	1	2%	7	14%	4	8%	16	32%	14	28%	8	16%		
Usefulness 6 (23)			1	2%	2	4%	8	16%	11	22%	19	38%	9	18%
Usefulness 7 (24)	2	4%					2	4%	6	12%	27	54%	13	26%
Usefulness 8 (25)							2	4%	17	34%	25	50%	6	12%
Usefulness 9 (26)			2	4%	3	6%	5	10%	11	22%	23	46%	6	12%
Usefulness 10 (27)			2	4%	2	4%	4	8%	13	26%	21	42%	8	16%
Usefulness 11 (28)			3	6%	3	6%	5	10%	9	18%	15	30%	15	30%
Usefulness 12 (29)	5	10%	2	4%	2	4%	10	20%	7	14%	13	26%	11	22%
Usefulness 13 (30)			1	2%	4	8%	4	8%	4	8%	29	58%	8	16%
Usefulness 14 (31)							2	4%	5	10%	24	48%	19	38%

- 38% of the respondents mostly agreed that the utilisation of WebCT would in effect increase their productivity;
- 32% of respondents slightly agreed while 30% of respondents mostly agreed that WebCT can be considered useful in the execution of their job;
- The majority of respondents mostly agreed that WebCT would be useful while sharing information with various role-players;
- 44% of the respondents mostly agreed that WebCT would enable them to accomplish specific command and control tasks;
- 32% of respondents indicated neutrality with regard to WebCT's ability to aid their decision-making;
- A large percentage of respondents (38%) mostly agreed that using WebCT would make it easier for them to do their job;
- There is strong agreement that WebCT aids and improves communication between role-players;
- 50% of the respondents mostly agreed that using WebCT would in effect enhance their client service/learning/networking/research processes;
- 46% of respondents mostly agreed that WebCT would add value to their learning experience;
- According to the table 42% of the respondents mostly agreed that WebCT would enhance the overall competitiveness of their department. 30% of respondents mostly agreed, and 30% of respondents strongly agreed that the implementation of WebCT would enhance the overall competitiveness of the university as a whole;
- The majority of responses were positive with regard to WebCT's ability to facilitate identity flexibility and anonymity;
- The highest percentage of respondents (58%) mostly agreed that WebCT would facilitate status equalisation; and
- 48% of respondents mostly agreed that WebCT would in effect promote flexible learning.

Hypothesis one, which states that a positive perception exists regarding the general usefulness/utility of WebCT, is accepted due to the fact that the majority of responses concerning the usefulness of WebCT were positive.

5.6.2 General Effectiveness of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' categories.

- The majority of respondents (54%) mostly agreed that they effectively complete their work using WebCT, and WebCT would enhance their information sharing effectiveness;
- 54% of the respondents mostly agreed that they would be able to effectively communicate information using WebCT;
- 32% of the respondents mostly agreed that using WebCT would improve the accuracy of their communication processes; and
- The highest percentage of respondents (52%) mostly agreed that using WebCT would improve the accuracy of information sharing between various role-players.

Table 5.7 Frequency Table for the Effectiveness of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Effectiveness 1 (32)			1	2%			4	8%	14	28%	27	54%	4	8%
Effectiveness 2 (33)			2	4%	2	4%	3	6%	13	26%	27	54%	3	6%
Effectiveness 3 (34)	1	2%	2	4%	3	6%	1	2%	7	14%	27	54%	9	18%
Effectiveness 4 (35)					3	6%	5	10%	12	24%	16	32%	14	28%
Effectiveness 5 (36)			2	4%	2	4%	5	10%	10	20%	26	52%	5	10%

Hypothesis two, which states that a positive perception exist that WebCT will lead to improved effectiveness, is accepted due to the fact that the majority of responses concerning the effectiveness scale of WebCT were positive.

5.6.3 General Efficiency of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' categories.

- A high percentage of respondents (64%) mostly agreed that they would be able to efficiently complete their work using WebCT;
- 44% of the respondents mostly agreed that they would be able to save time using WebCT while sharing information; and

- 26% of the respondents mostly agreed, while 22% of the respondents slightly agreed that the speed of the software application is fast enough.

Table 5.8 Frequency Table for the Efficiency of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Efficiency 1 (37)			2	4%	2	4%	6	12%	16	32%	23	46%	1	2%
Efficiency 2 (38)			3	6%	1	2%	5	10%	9	18%	22	44%	10	20%
Efficiency 3 (39)	4	8%	2	4%	4	8%	11	22%	11	22%	13	26%	5	10%

Hypothesis three, which states that a positive perception exist that WebCT will lead to improved efficiency, is accepted due to the fact that the majority of responses concerning the efficiency scale of WebCT were positive.

5.6.4 The Reliability of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree', 'strongly agree' and 'neutral' response categories.

- A high percentage of respondents (30%) indicated that the system seldom stops or hangs during the execution of their tasks which reflects on the reliability of the system;
- Although 38% of the respondents indicated neutrality, 24% mostly agreed and 12% strongly agreed that if the system stops it would be easy for them to restart it on their own; and
- 22% of the respondents mostly agreed and 26% of the respondents strongly agreed that they would not need the help of someone else to restart the system if it stops.

Table 5.9 Frequency Table for the Reliability of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Reliability 1 (40)	1	2%			9	18%	12	24%	1	2%	12	24%	15	30%
Reliability 2 (41)	1	2%	2	4%	6	12%	19	38%	4	8%	12	24%	6	12%
Reliability 3 (42)			5	10%	2	4%	14	28%	5	10%	11	22%	13	26%

Hypothesis four, which states that a positive perception exists regarding the reliability of WebCT, is accepted due to the fact that the majority of responses concerning the reliability of WebCT fell into positive response categories despite the relatively high percentages of neutral responses.

5.6.5 General Ease of Use of WebCT

The frequency table for the general ease of use of WebCT shows the count and percentage of the responses for each of the items within the general ease of use scale. The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- 30% of the respondents mostly disagreed that WebCT does not require too many steps to perform/complete a specific tasks. It should be noted, however, that 54% of the total responses that were recorded fell within the slightly agree to strongly agree response categories;
- A large percentage of respondents (46%) mostly agreed that it is easy to read the various characters on the screen with regard to WebCT;
- 28% of respondents mostly agreed and 20% of respondents strongly agreed that they were satisfied with the level of ease with which they completed scenarios;
- 28% of respondents slightly agreed that using WebCT were not frustrating;
- 28% of respondents mostly agreed that they were very confident using WebCT;
- A large percentage of respondents (36%) mostly agreed that WebCT were easy to use and user friendly;
- 26% of the respondents strongly agreed that they would not need the support of a technical person to be able to use WebCT;
- 36% of the respondents mostly agreed that WebCT were designed for all levels of users;
- A large percentage of respondents (38%) mostly agreed that WebCT were flexible to interact with; and
- 66% of the respondents agreed on some level that WebCT allowed users to customise windows.

Table 5.10 Frequency Table for General Ease of Use of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Ease of use 1 (43)	1	2%	4	8%	15	30%	3	6%	12	24%	9	18%	6	12%
Ease of use 2 (44)			1	2%	5	10%	3	6%	7	14%	23	46%	11	22%
Ease of use 3 (45)	1	2%	5	10%	5	10%	2	4%	13	26%	14	28%	10	20%
Ease of use 4 (46)			3	6%	6	12%	6	12%	14	28%	13	26%	8	16%
Ease of use 5 (47)			5	10%	8	16%	10	20%	9	18%	14	28%	4	8%
Ease of use 6 (48)	1	2%	2	4%	11	22%	3	6%	8	16%	18	36%	7	14%
Ease of use 7 (49)			4	8%	3	6%	7	14%	11	22%	18	36%	7	14%
Ease of use 8 (50)	3	6%	4	8%	9	18%	4	8%	5	10%	12	24%	13	26%
Ease of use 9 (51)			5	10%	6	12%	5	10%	9	18%	18	36%	7	14%
Ease of use 10 (52)			1	2%	1	2%	9	18%	16	32%	19	38%	4	8%
Ease of use 11 (53)			4	8%	2	4%	16	32%	8	16%	12	24%	8	16%

Hypothesis five, which states that a positive perception exists regarding the general ease of use, is accepted due to the fact that the majority of responses concerning the ease of use of WebCT were positive despite the negative responses received for item 43.

5.6.6 The Consistency of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree' and 'mostly agree' response categories.

- A high percentage of respondents (42%) mostly agreed that they felt in control when they were using WebCT; and
- 30% of respondents mostly agreed that WebCT were consistent and responded to their inputs in the same way each time they used the system.

Table 5.11 Frequency Table for the Consistency of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Consistency 1 (54)			2	4%	9	18%	2	4%	13	26%	21	42%	3	6%
Consistency 2 (55)			1	2%	3	6%	8	16%	14	28%	15	30%	9	18%

Hypothesis six, which states that a positive perception exists regarding the consistency of WebCT, is accepted due to the fact that the majority of responses concerning the consistency of WebCT fell into positive response categories.

5.6.7 The Error Management of WebCT

The frequency table clearly demonstrates that a high percentage of responses fall within the neutral response category.

- 30% of respondents mostly agreed that it would be easy to recover from a mistake they made while using WebCT;
- A large proportion of participants neither agreed nor disagreed with regard to the helpfulness of the on screen help messages, and the ability of the error messages to diagnose the source and cause of a problem;
- The majority of responses (60%) were neutral with regard to the error messages' capability to suggest solutions to the problems; and
- 38% of the respondents neither agreed nor disagreed that it would be easy to find help on the WebCT system.

Table 5.12 Frequency Table for the Error Management Capabilities of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Error management 1 (56)	1	2%	4	8%	7	14%	9	18%	11	22%	15	30%	3	6%
Error management 2 (57)			5	10%	6	12%	19	38%	8	16%	10	20%	2	4%
Error management 3 (58)			6	12%	3	6%	27	54%	9	18%	4	8%	1	2%
Error management 4 (59)	1	2%	8	16%	2	4%	30	60%	5	10%	3	6%	1	2%
Error management 5 (60)	2	4%	5	10%	11	22%	19	38%	3	6%	4	8%	6	12%

Hypothesis seven, which states that a positive perception exists regarding the error management capabilities of WebCT, is rejected due to the fact that a large percentage of responses were neutral and that less than 50% of the total responses for most of the items fell within the positive response categories. Only one item (Error Management 1) can be considered to be positive.

5.6.8 The Compatibility of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- A high percentage (46%) of the respondents slightly agreed that WebCT corresponds with their idea of the way tasks should be executed;
- 34% of the respondents mostly agreed that the results of commands entered into WebCT were similar to other interfaces they have been trained on;
- There was strong agreement (48% mostly agreed) among participants that the menus and icon organisation were logical;
- 42% of the respondents mostly agreed that WebCT uses icons similar to other interfaces they have used or have been trained on;
- 46% of the respondents mostly agreed that command names within WebCT were meaningful and clearly understandable;
- A large percentage of respondents (42%) mostly agreed that the WebCT terminology were in line with standard terminology; and
- The majority of respondents agreed that WebCT did what was expected thus meeting their needs.

Table 5.13 Frequency Table for the Compatibility of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Compatibility 1 (61)			3	6%	4	8%	4	8%	23	46%	15	30%	1	2%
Compatibility 2 (62)	1	2%	3	6%	3	6%	14	28%	10	20%	17	34%	2	4%
Compatibility 3 (63)			1	2%	2	4%	4	8%	11	22%	24	48%	8	16%
Compatibility 4 (64)	1	2%	4	8%	7	14%	4	8%	12	24%	21	42%	1	2%
Compatibility 5 (65)			2	4%	6	12%	3	6%	9	18%	23	46%	7	14%
Compatibility 6 (66)					6	12%	7	14%	10	20%	21	42%	6	12%
Compatibility 7 (67)					4	8%	6	12%	14	28%	23	46%	3	6%

Hypothesis eight, which states that a positive perception exists regarding the compatibility of WebCT, is accepted due to the fact that the majority of responses concerning the compatibility of WebCT were positive.

5.6.9 The Learnability of WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- 34% of the respondents slightly disagreed that there is enough information on the screen when it is needed. It should be noted, however, that 36% of the total responses recorded fell within the slightly agree and mostly agree response categories;
- A total of 70% of the respondents agreed to some degree that most people would be able to learn to use WebCT quickly;
- 42% of the respondents mostly agreed that it was unnecessary to learn a lot of things before they could use WebCT;
- The majority of respondents (50%) mostly agreed that they quickly became skilful with WebCT;
- A large percentage of the respondents (48%) slightly agreed that they seldom wondered if they were using the right command;
- 30% of the respondents slightly agreed, and 30% of the respondents mostly agreed that learning to operate WebCT were easy; and
- 30% of the respondents mostly agreed that it was easy to remember the names and uses of the specific WebCT commands.

Table 5.14 Frequency Table for Learnability of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Learnability 1 (68)			2	4%	17	34%	9	18%	10	20%	8	16%	4	8%
Learnability 2 (69)			2	4%	7	14%	6	12%	11	22%	14	28%	10	20%
Learnability 3 (70)			1	2%	17	34%	1	2%	4	8%	21	42%	6	12%
Learnability 4 (71)			1	2%	6	12%	4	8%	18	36%	15	30%	6	12%
Learnability 5 (72)	3	6%	4	8%	2	4%	8	16%	24	48%	5	10%	4	8%
Learnability 6 (73)	3	6%	2	4%	7	14%	1	2%	15	30%	15	30%	7	14%
Learnability 7 (74)	2	4%	4	8%	6	12%	9	18%	8	16%	15	30%	6	12%

Hypothesis nine, which states that a positive perception exists regarding the learnability of WebCT, is accepted due to the fact that the majority of responses

concerning the learnability of WebCT were positive despite the negative responses received for item 68.

5.6.10 The User Satisfaction Rate for WebCT

The frequency table clearly demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- 38% of the respondents slightly agreed that working with WebCT was satisfying;
- 32% slightly agreed while 32% mostly agreed that they would like to use WebCT frequently;
- A large proportion of respondents (38%) mostly agreed that they did not feel awkward while using WebCT;
- 40% of the respondents slightly agreed that using WebCT was pleasant;
- 34% of the respondents mostly agreed that they were satisfied with the amount of time it took to complete the tasks in the scenario, that WebCT has a very attractive presentation and that they would recommend WebCT to other role-players; and
- A large percentage of respondents (38%) mostly agreed that both regular and occasional users would like WebCT.

Table 5.15 Frequency Table for User Satisfaction of WebCT

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
User Satisfaction 1 (75)					1	2%	10	20%	19	38%	15	30%	5	10%
User Satisfaction 2 (76)					4	8%	6	12%	16	32%	16	32%	8	16%
User Satisfaction 3 (77)			2	4%	7	14%	6	12%	10	20%	19	38%	6	12%
User Satisfaction 4 (78)							10	20%	20	40%	17	34%	3	6%
User Satisfaction 5 (79)							10	20%	13	26%	17	34%	10	20%
User Satisfaction 6 (80)			4	8%	1	2%	5	10%	18	36%	17	34%	5	10%
User Satisfaction 7 (81)	3	6%	2	4%	5	10%			12	24%	17	34%	11	22%
User Satisfaction 8 (82)					4	8%	5	10%	13	26%	19	38%	9	18%

Hypothesis ten, which states that participants feel highly satisfied with WebCT, is accepted due to the fact that the majority of responses concerning the user satisfaction rate of WebCT were positive.

5.6.11 Error Rate with regard to WebCT

The highest percentage of respondents (46%) claimed to have made only one error during the execution of the specific tasks set out in the task protocol sheet. 28% of the respondents claimed to have made no errors during the execution of the tasks set out in the task protocol sheet. A total of 52% of the respondents perceived their error rate to be acceptable, while a total of 24% of the respondents perceived their error rate to be unacceptable. The majority of respondents (50%) disagreed with the statement that they made more errors than the average user. The majority of respondents thus perceived their error rate to be less than the error rate of the average user.

Hypothesis eleven, which states that an acceptable perceived error rate for the application exists, is accepted due to the fact that the majority of responses concerning the user's perceived error rate of WebCT were positive.

5.6.12 General Reaction to WebCT

Section C of the Usability Questionnaire requested respondents to rate their general reaction towards WebCT on a bipolar rating scale with positive attributes listed on the one end and negative attributes listed on the other end of the six point rating scale.

Refer to Appendix I (Figure I.1 to I.5) for frequency charts showing the count and percentage of the responses for each of the items within the general reaction scale. The highest percentage of responses fell on the positive ends of the five bipolar scales.

Hypothesis twelve, which states that a positive general reaction towards WebCT exists, is accepted due to the fact that the majority of responses concerning the user's general reaction of WebCT were positive.

5.6.13 General information regarding WebCT

Section D of the Usability Questionnaire used open-ended questions to extract general information with regard to the respondents' likes and dislikes about the WebCT system. Respondents were required to list the most positive, the most negative aspects and aspects which they would like to alter or add to WebCT.

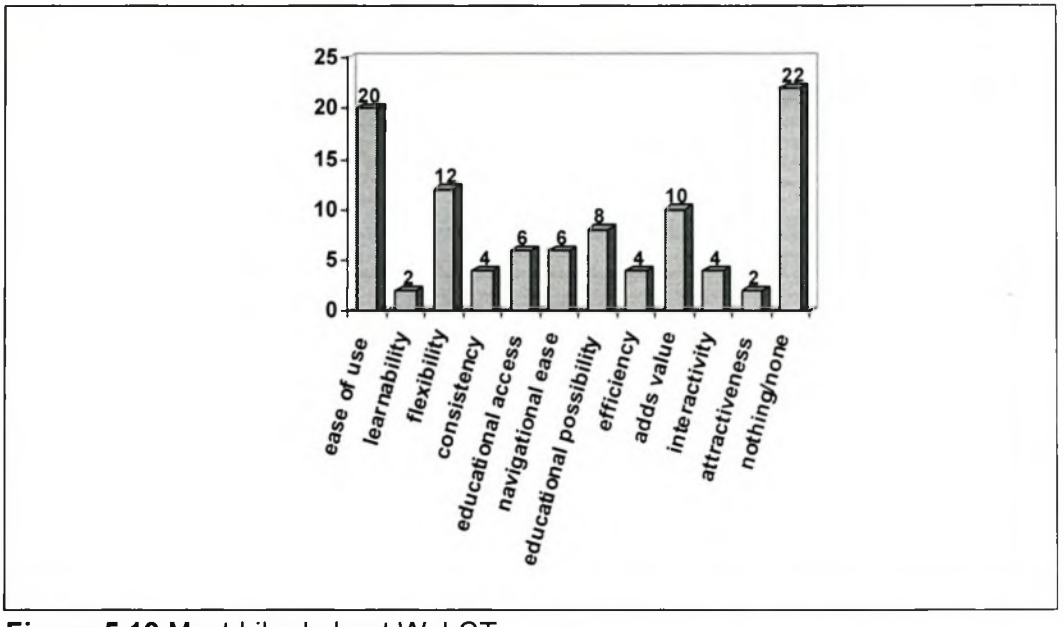

Figure 5.13 Most Liked about WebCT

With reference to figure 5.13 respondents listed the following characteristics that they most liked about WebCT:

- The ease with which they could use WebCT;
- The fact that WebCT is easy to learn;
- The extreme flexibility of WebCT;
- The consistency of WebCT;
- The fact that WebCT makes educational resources accessible to a wider group;
- The navigational ease of WebCT;
- WebCT broadens the educational possibilities;
- Efficiency;
- WebCT adds value to the educational process;
- Interactivity; and
- The attractiveness of the WebCT interface.

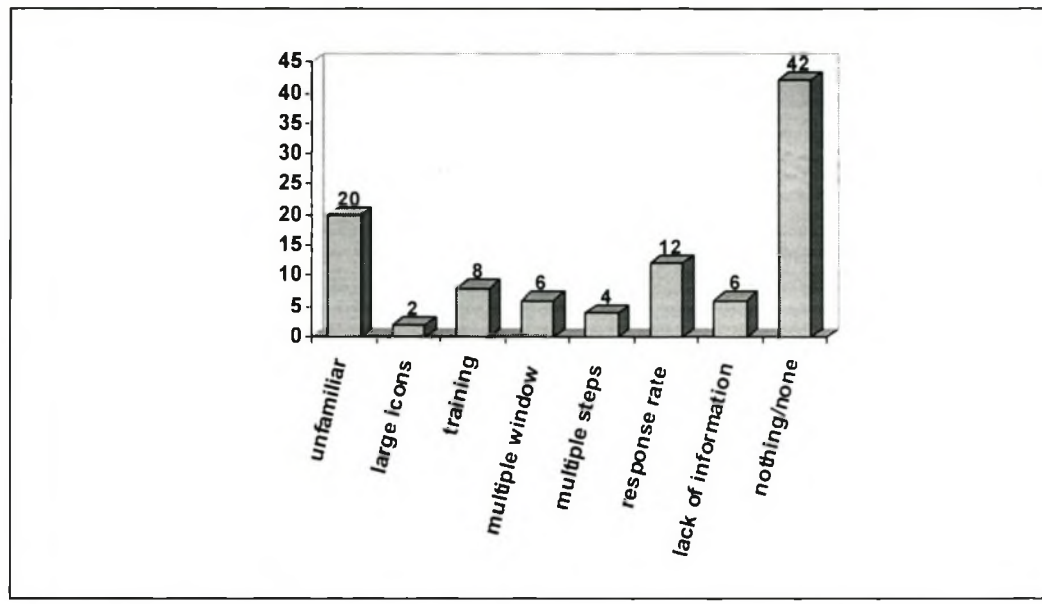

Figure 5.14 Most Disliked Features of WebCT

With reference to figure 5.14 the respondents listed the following features they most disliked about WebCT:

- The original unfamiliarity of the system;
- The large Icons of WebCT;
- The lack of sufficient training;
- Confusion caused by a multiple window design;
- WebCT requires to many steps to complete a specific task;
- The slow response rate; and
- Lack of information.

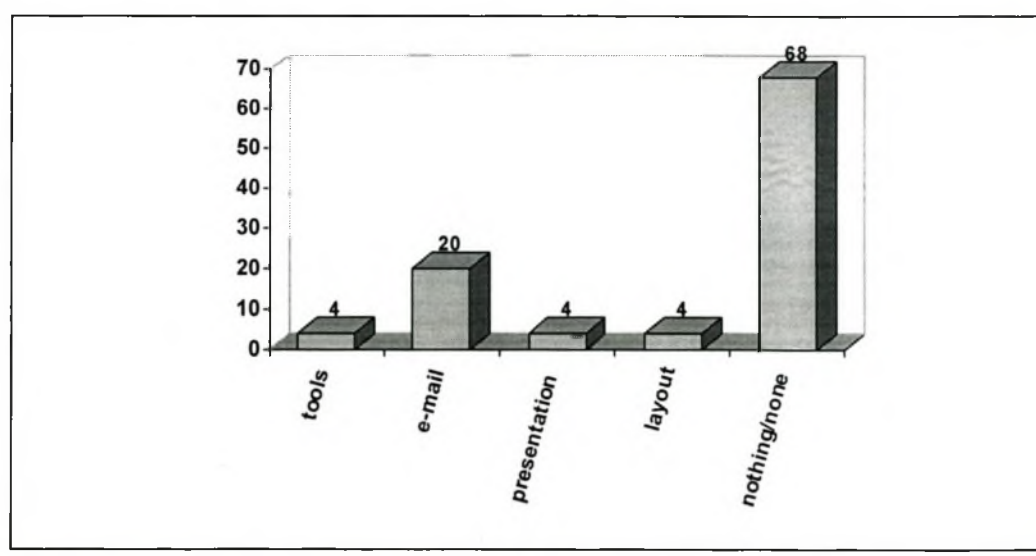

Figure 5.15 Suggestions with Regard to WebCT

With reference to figure 5.15 the respondents listed the following suggestions:

- WebCT should provide more educational tools;
- WebCT should allow e-mail to be accessed from external programs without the need to log on to WebCT;
- The presentation of the interface could be modified to appear more professional; and
- The layout should be more attractive.

5.7 DESCRIPTIVE STATISTICS OBTAINED FROM THE WEB-CT ERROR RATE AND TASK LOGGING SHEET

The error rate and task logging sheets were used to obtain objective measurements with regard to the average error rate of the respondents, average time taken to complete specified tasks and the success rate with which tasks were completed.

The findings for each of the criteria tested will be discussed in accordance with the previously formulated existential hypothesis. The benchmarks set during the formulation of the hypothesis are based on the researchers experience with the software application and on expert evaluations conducted prior to the formal usability study. The expert evaluations involved eight expert users carefully selected from the same population from which the usability testing sample was drawn. Appendix J summarises the biographical profile of the expert user group by means of frequency tables and graphs.

The findings for the student group and lecturer, researcher and information service provider group will be discussed separately due to the varying task structures of the groups as was explained in previous chapters. The lecturer, researcher and information service provider group will subsequently be referred to as the 'administrator' group.

5.7.1 Success Rate

The success rate of the WebCT evaluation can be defined in terms of the total percentage of participants who successfully completed all of the tasks set out in task protocol sheet within the set time limit. The execution of a task was considered to be successful if the participant were able to fully complete the task within the seven minute (5 minutes & 2 minute grace period) time limit despite the amount of errors made.

(a) Success rate for students

82% of the student group successfully completed al three tasks set out in the task protocol sheet. 97% of the respondents successfully completed task one, 90% successfully completed task two and 87% of the respondents successfully completed task three.

(b) Success rate for administrators

83% of the administrators successfully completed all three tasks set out in the task protocol sheet. 92% of the respondents successfully completed task one, 100% successfully completed task two and 92% of the respondents successfully completed task three.

Hypothesis thirteen, which states that 60% of the sample population would be able to complete their tasks successfully, is accepted due to the fact that more than 60% of the student and administrator respondents completed all three tasks successfully.

5.7.2 Average time taken to complete tasks

A five minute time limit was set for the completion of each task. Participants were, however, allowed an additional two minute grace period if they were unable to complete the task within the initial five minute time limit. It should be noted that the time wasted on reading the dialogue or communicating with the observer were subtracted from the total time spent on the task.

71% of the students were able to complete all three tasks within the set time limit. In contrast only 58% of the Administrators were able to complete all three tasks within the set time limit.

Hypotheses fourteen which states that 60% of the participants would be able to complete the tasks within the set time limit, is rejected due to the fact that less than 60% of the administrator respondents completed all three tasks within the set time limit. The fact that less than 60% of the administrator respondents completed all three tasks may be contributed to a lack of experience with the system.

5.7.3 Average error rate for WebCT tasks

The objective error rate can be defined as the percentage of respondents who were able to complete the tasks set out in the task protocol sheet as observed by the usability evaluations observers without making any mistakes. 53% of the students were able to complete all three tasks without making any mistakes. Only 33% of the administrators were able to complete all three tasks without making any mistakes.

Hypothesis fifteen which states that 50% of the sample population would be able to complete the tasks without making any mistakes, is rejected due to the fact that only 33% of the administrators completed their tasks without making any mistakes.

5.8 DESCRIPTIVE STATISTICS CONCERNING THE USABILITY OF MICROSOFT PRODUCER

The previously formulated existential hypothesis was used as the basis against which the findings for each of the usability criteria were tested. These criteria include usefulness, effectiveness, efficiency, reliability, ease of use, consistency, error management, compatibility, learnability and user satisfaction. In addition the discussion will focus on the error rate, the users' general reaction to the system and the general information obtained from the usability questionnaire.

Each item within the frequency table, which represents a criteria scale, refers to a specific question (indicated by the number within the parentheses) in the usability questionnaire. As with the WebCT testing, each item should be read in conjunction with the question it refers to. Note that the negative items within the scale were reversed to positive items prior to the statistical analysis of the scale responses.

5.8.1 General Usefulness/Utility of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree' and 'mostly agree' categories.

- 42% of the respondents mostly agreed that the utilisation of Microsoft Producer would in effect increase their productivity;
- 36% of respondents slightly agreed while 32% of respondents mostly agreed that Microsoft Producer can be considered useful in the execution of their job;
- 40% of the respondents mostly agreed that Microsoft Producer would be useful while sharing information with various role-players;
- The majority of respondents (50%) slightly agreed that Microsoft Producer would enable them to accomplish specific command and control tasks;
- 24% of the respondents slightly agreed and 22% of the respondents mostly agreed that Microsoft Producer's would be able to aid their decision-making;
- A large percentage of respondents (38%) mostly agreed that using Microsoft Producer would make it easier for them to do their job;
- 38% of the respondents mostly agreed that Microsoft Producer aids and improves communication between role-players;
- A large percentage of the respondents (48%) mostly agreed that using Microsoft Producer would in effect enhance their client service/learning/networking/research processes;
- 40% of respondents mostly agreed that Microsoft Producer would add value to their learning experience;
- The majority of respondents agreed to some extent that Microsoft Producer would enhance the overall competitiveness of their department and of the university as a whole;
- The majority of respondents (44%) indicated neutrality with regard to Microsoft Producer's ability to facilitate identity flexibility and anonymity;
- 40% of the respondents agreed that Microsoft Producer would facilitate status equalisation; and
- 42% of respondents mostly agreed that Microsoft Producer would in effect promote flexible learning.

Table 5.16 Frequency Table for Usefulness/Utility of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Usefulness 1 (18)	1	2%	9	18%	3	6%	5	10%	10	20%	21	42%	1	2%
Usefulness 2 (19)			2	4%	2	4%	7	14%	18	36%	16	32%	5	10%
Usefulness 3 (20)	1	2%	1	2%			4	8%	16	32%	20	40%	8	16%
Usefulness 4 (21)			1	2%	1	2%	6	12%	25	50%	16	32%	1	2%
Usefulness 5 (22)			4	8%	13	26%	10	20%	12	24%	11	22%		
Usefulness 6 (23)			3	6%	3	6%	10	20%	13	26%	19	38%	2	4%
Usefulness 7 (24)	1	2%			2	4%	3	6%	14	28%	19	38%	11	22%
Usefulness 8 (25)			1	2%	1	2%	5	10%	13	26%	24	48%	6	12%
Usefulness 9 (26)			4	8%	4	8%	1	2%	15	30%	20	40%	6	12%
Usefulness 10 (27)			1	2%	9	18%	4	8%	12	24%	14	28%	10	20%
Usefulness 11 (28)					1	2%	5	10%	9	18%	20	40%	15	30%
Usefulness 12 (29)	1	2%	3	6%	3	6%	22	44%	6	12%	10	20%	5	10%
Usefulness 13 (30)			1	2%	2	4%	11	22%	20	40%	11	22%	5	10%
Usefulness 14 (31)					2	4%	1	2%	21	42%	13	26%	13	26%

Hypothesis one, which states that a positive perception exists regarding the general usefulness/utility of Microsoft Producer, is accepted due to the fact that the majority of responses concerning the usefulness of Microsoft Producer were positive.

5.8.2 General Effectiveness of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'mostly agree' and 'strongly agree' categories.

- A large percentage of respondents (46%) slightly agreed that they can effectively complete their work using Microsoft Producer;
- 46% of the respondents mostly agreed that Microsoft Producer would enhance their information sharing effectiveness;
- The majority of the respondents (50%) mostly agreed that they would be able to effectively communicate information using Microsoft Producer;
- 46% of the respondents mostly agreed that using Microsoft Producer would improve the accuracy of their communication processes; and
- The majority of respondents (54%) mostly agreed that using Microsoft Producer would improve the accuracy of information sharing between various role-players.

Table 5.17 Frequency Table for the Effectiveness of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Effectiveness 1 (32)	1	2%	3	6%	1	2%	5	10%	23	46%	11	22%	6	12%
Effectiveness 2 (33)			4	8%	5	10%			13	26%	23	46%	5	10%
Effectiveness 3 (34)	1	2%	1	2%	1	2%	3	6%	9	18%	25	50%	10	20%
Effectiveness 4 (35)			2	4%	3	6%	5	10%	4	8%	23	46%	13	26%
Effectiveness 5 (36)			1	2%			4	8%	8	16%	27	54%	10	20%

Hypothesis two, which states that a positive perception exist that Microsoft Producer will lead to improved effectiveness, is accepted due to the fact that the majority of responses concerning the effectiveness scale of Microsoft Producer were positive.

5.8.3 General Efficiency of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree' and 'mostly agree' categories.

- A high percentage of respondents (38%) mostly agreed that they would be able to efficiently complete their work using Microsoft Producer;
- The majority of the respondents (50%) mostly agreed that they would be able to save time by using Microsoft Producer while sharing information; and
- 40% of the respondents mostly agreed that the speed of the software application was fast enough.

Table 5.18 Frequency Table for the Efficiency of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Efficiency 1 (37)	2	4%			2	4%	8	16%	18	36%	19	38%	1	2%
Efficiency 2 (38)	1	2%			3	6%	4	8%	10	20%	25	50%	7	14%
Efficiency 3 (39)	3	6%	2	4%	10	20%	9	18%	20	40%	6	12%		

Hypothesis three, which states that a positive perception exist that Microsoft Producer will lead to improved efficiency, is accepted due to the fact that the majority of responses concerning the efficiency scale of Microsoft Producer were positive.

5.8.4 The Reliability of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'mostly agree', 'strongly agree' and 'neutral' response categories.

- A high percentage of respondents (34%) mostly agreed with the fact that the system seldom stops or hangs during the execution of their tasks;
- Although a high percentage of respondents (44%) indicated neutrality, 24% mostly agreed and 10% strongly agreed that if the system stops it would be easy for them to restart it on their own; and
- 44% of the respondents indicated neutrality while 14% of the respondents mostly agreed that they would not need the help of someone else to restart the system if it stops.

Table 5.19 Frequency Table for the Reliability of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Reliability 1 (40)					1	2%	18	36%	7	14%	17	34%	7	14%
Reliability 2 (41)	1	2%	1	2%	4	8%	22	44%	5	10%	12	24%	5	10%
Reliability 3 (42)	1	2%	2	4%	9	18%	22	44%	4	8%	7	14%	5	10%

Hypothesis four, which states that a positive perception exists regarding the reliability of Microsoft Producer, is rejected due to the fact that the majority of responses concerning the reliability of Microsoft Producer fell into the neutral category and that less than 50% of the total responses fell into the positive response categories.

5.8.5 General Ease of Use of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- A total of 64% of the respondents agreed to some extent that Microsoft Producer does not require too many steps to perform/complete specific tasks;
- The majority of respondents (60%) mostly agreed that it is easy to read the various characters on the screen with regard to Microsoft Producer;

- 34% of respondents mostly agreed and 16% of respondents strongly agreed that they were satisfied with the level of ease with which they completed scenarios;
- 30% of respondents mostly agreed that using Microsoft Producer were not frustrating;
- 20% of respondents indicated neutrality with regard to their own confidence level using Microsoft Producer. It should, however, be noted that a total of 44% of respondents agreed to some extent that they felt confident while using Microsoft Producer;
- A large percentage of respondents (36%) slightly agreed that Microsoft Producer were easy to use and 38% slightly agreed that Microsoft Producer were user friendly;
- 28% of the respondents slightly agreed that they would not need the support of a technical person to be able to use Microsoft Producer.
- 24% of the respondents mostly agreed and 24% of respondents slightly agreed that Microsoft Producer were designed for all levels of users;
- The majority of respondents (52%) slightly agreed that Microsoft Producer were flexible to interact with; and
- 32% of the respondents agreed on some level that Microsoft Producer allowed users to customise windows. The majority of respondents (56%) did, however, indicate neutrality with regard to the user's ability to customise windows.

Table 5.20 Frequency Table for General Ease of Use of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Ease of use 1 (43)	2	4%			11	22%	5	10%	12	24%	14	28%	6	12%
Ease of use 2 (44)					2	4%	1	2%	12	24%	30	60%	5	10%
Ease of use 3 (45)	1	2%	3	6%	6	12%	4	8%	11	22%	17	34%	8	16%
Ease of use 4 (46)	1	2%			11	22%	6	12%	11	22%	15	30%	6	12%
Ease of use 5 (47)	2	4%	6	12%	10	20%	10	20%	10	20%	8	16%	4	8%
Ease of use 6 (48)	2	4%			10	20%	2	4%	18	36%	13	26%	5	10%
Ease of use 7 (49)	1	2%	2	4%	4	8%	5	10%	19	38%	13	26%	6	12%
Ease of use 8 (50)	1	2%	4	8%	13	26%	4	8%	14	28%	8	16%	6	12%
Ease of use 9 (51)	2	4%	4	8%	6	12%	8	16%	12	24%	12	24%	6	12%
Ease of use 10 (52)			2	4%	1	2%	4	8%	26	52%	12	24%	5	10%
Ease of use 11 (53)	1	2%	3	6%	1	2%	28	56%	7	14%	7	14%	3	6%

Hypothesis five, which states that a positive perception exists regarding the general ease of use, is accepted due to the fact that the majority of responses concerning the ease of use of Microsoft Producer were positive despite the strong neutral responses received for three of the eleven items.

5.8.6 The Consistency of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree' and 'mostly agree' and 'neutral' response categories.

- 24% of the respondents slightly agreed and 16% of the respondents mostly agreed that they felt in control when they were using Microsoft Producer; and
- A large percentage of respondents (44%) indicated neutrality with regard to the consistency with which Microsoft Producer responded to their inputs.

Table 5.21 Frequency Table for the Consistency of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Consistency 1 (54)	2	4%	2	4%	7	14%	13	26%	12	24%	8	16%	6	12%
Consistency 2 (55)	1	2%			1	2%	22	44%	8	16%	13	26%	5	10%

Hypothesis six, which states that a positive perception exists regarding the consistency of Microsoft Producer, is accepted due to the fact that a total of 52% of the responses for each of the items concerning the consistency of Microsoft Producer fell into the positive response categories, despite the 44% of responses that fell into the neutral category.

5.8.7 The Error Management of Microsoft Producer

The frequency table demonstrates that a high percentage of responses fall within the neutral response category.

- 32% of respondents slightly agreed that it would be easy to recover from a mistake they made while using Microsoft Producer;
- A large proportion of participants (68%) neither agreed nor disagreed with regard to the helpfulness of the on screen help messages;
- The majority of responses (70%) were neutral with regard to the ability of the error messages to diagnose the source and cause of a problem;

- The majority of responses (64%) were neutral with regard to the error messages' capability to suggest solutions to the problems; and
- 48% of the respondents neither agreed nor disagreed that it would be easy to find help on the Microsoft Producer system.

Table 5.22 Frequency Table for the Error Management Capabilities of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Error management 1 (56)	1	2%	4	8%	5	10%	10	20%	16	32%	8	16%	6	12%
Error management 2 (57)	1	2%			2	4%	34	68%	6	12%	4	8%	3	6%
Error management 3 (58)	1	2%					35	70%	7	14%	5	10%	2	4%
Error management 4 (59)	1	2%	3	6%	3	6%	32	64%	5	10%	4	8%	2	4%
Error management 5 (60)	2	4%	1	2%	8	16%	24	48%	8	16%	6	12%	1	2%

Hypothesis seven, which states that a positive perception exists regarding the error management capabilities of Microsoft Producer, is rejected due to the fact that a large percentage of responses were neutral and that less than 50% of the total responses for most of the items fell within the positive response categories. Only one item (Error Management 1) can be considered to be positive.

5.8.8 The Compatibility of Microsoft Producer

The frequency table demonstrates that the majority of responses falls within the 'slightly agree' and 'mostly agree' response categories.

- A high percentage (44%) of the respondents slightly agreed that Microsoft Producer corresponds with their idea of the way tasks should be executed;
- 50%% of the respondents agrees to some extent that the results of commands entered into Microsoft Producer were similar to other interfaces they have been trained on;
- 44% of the respondents mostly agreed that the menus and icon organisation were logical;
- 28% of the respondents mostly agreed, and 20% slightly agreed that Microsoft Producer uses icons similar to other interfaces they have used or have been trained on;

- 30% of the respondents mostly agreed that command names within Microsoft Producer were meaningful and clearly understandable;
- The majority of respondents (50%) mostly agreed that the Microsoft Producer terminology were in line with standard terminology; and
- The majority of respondents (54%) mostly agreed that Microsoft Producer did what was expected thus meeting their needs.

Table 5.23 Frequency Table for the Compatibility of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Compatibility 1 (61)			1	2%	1	2%	6	12%	22	44%	14	28%	6	12%
Compatibility 2 (62)	2	4%	1	2%	3	6%	16	32%	13	26%	12	24%	3	6%
Compatibility 3 (63)	1	2%			4	8%	6	12%	11	22%	22	44%	6	12%
Compatibility 4 (64)	1	2%	1	2%	6	12%	14	28%	10	20%	14	28%	4	8%
Compatibility 5 (65)	1	2%			5	10%	6	12%	14	28%	15	30%	9	18%
Compatibility 6 (66)	1	2%	1	2%	3	6%	6	12%	11	22%	25	50%	3	6%
Compatibility 7 (67)	1	2%					7	14%	10	20%	27	54%	5	10%

Hypothesis eight, which states that a positive perception exists regarding the compatibility of Microsoft Producer, is accepted due to the fact that the majority of responses concerning the compatibility of Microsoft Producer were positive.

5.8.9 The Learnability of Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree', 'mostly agree' and 'strongly agree' response categories.

- The majority of respondents agreed to some extent that there is enough information available when it is needed;
- 32% of the respondents mostly agreed that the majority of people would be able to learn to use Microsoft Producer quickly;
- A total of 44% of the respondents agreed and disagreed respectively to some extent that it was unnecessary to learn a lot of things before they could use Microsoft Producer;
- 44% of the respondents slightly agreed that they quickly became skilful with Microsoft Producer;
- A total of 46% of the respondents agreed and a total of 34% of respondents disagreed to some extent that they seldom wondered if they were using the right command;

- 34% of the respondents mostly agreed that learning to operate Microsoft Producer were easy; and
- 34% of the respondents slightly agreed that it was easy to remember the names and uses of the specific Microsoft Producer commands.

Table 5.24 Frequency Table for Learnability of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Learnability 1 (68)	1	2%	4	8%	9	18%	10	20%	14	28%	10	20%	2	4%
Learnability 2 (69)	2	4%	4	8%	3	6%	6	12%	11	22%	16	32%	8	16%
Learnability 3 (70)	2	4%	10	20%	12	24%	4	8%	8	16%	8	16%	6	12%
Learnability 4 (71)	1	2%	4	8%	6	12%	3	6%	22	44%	10	20%	4	8%
Learnability 5 (72)			3	6%	14	28%	10	20%	12	24%	8	16%	3	6%
Learnability 6 (73)	1	2%	2	4%	8	16%	11	22%	8	16%	17	34%	3	6%
Learnability 7 (74)			5	10%	6	12%	6	12%	17	34%	16	32%		

Hypothesis nine, which states that a positive perception exists regarding the learnability of Microsoft Producer, is accepted due to the fact that the majority of responses concerning the learnability of Microsoft Producer were positive despite the negative responses received for items 70 and 72.

5.8.10 The User Satisfaction Rate for Microsoft Producer

The frequency table demonstrates that the majority of responses fall within the 'slightly agree' and 'mostly agree' response categories.

- 38% of the respondents mostly agreed that working with Microsoft Producer were satisfying;
- 46% mostly agreed that they would like to use Microsoft Producer frequently;
- A large proportion of respondents (42%) mostly agreed that they did not feel awkward while using Microsoft Producer;
- 38% of the respondents slightly agreed that using Microsoft Producer were pleasant;
- 34% of the respondents slightly agreed that they would recommend Microsoft Producer to other role-players;

- A large percentage of respondents (48%) mostly agreed that Microsoft Producer has a very attractive presentation;
- 34% of the respondents mostly agreed that the time it took to complete a task using Microsoft Producer were satisfactory; and
- A large percentage of respondents (44%) mostly agreed that both regular and occasional users would like Microsoft Producer.

Table 5.25 Frequency Table for User Satisfaction of Microsoft Producer

	Strongly Disagree		Mostly Disagree		Slightly Disagree		Neutral		Slightly Agree		Mostly Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
User Satisfaction 1 (75)			3	6%	1	2%	6	12%	17	34%	19	38%	4	8%
User Satisfaction 2 (76)			2	4%	2	4%	2	4%	13	26%	23	46%	8	16%
User Satisfaction 3 (77)			3	6%	8	16%	1	2%	15	30%	21	42%	2	4%
User Satisfaction 4 (78)			3	6%	5	10%	6	12%	13	26%	19	38%	4	8%
User Satisfaction 5 (79)			2	4%			2	4%	17	34%	15	30%	14	28%
User Satisfaction 6 (80)			1	2%			4	8%	12	24%	24	48%	9	18%
User Satisfaction 7 (81)	3	6%	3	6%	6	12%	2	4%	9	18%	17	34%	10	20%
User Satisfaction 8 (82)			1	2%	1	2%	4	8%	12	24%	22	44%	10	20%

Hypothesis ten, which states that participants feel highly satisfied with Microsoft Producer, is accepted due to the fact that the majority of responses concerning the user satisfaction rate of Microsoft Producer were positive.

5.8.11 Error Rate with Regard to Microsoft Producer

The highest percentage of respondents (44%) claimed to have made only one error during the execution of the specific tasks set out in the task protocol sheet. 20% of the respondents claimed to have made no errors and 18% claimed to have made between two and three errors during the execution of the tasks set out in the task protocol sheet. A total of 54% of the respondents perceived their error rate to be acceptable, while a total of 18% of the respondents perceived their error rate to be unacceptable. The majority of respondents (48%) strongly disagreed with the statement that they made more errors that the average user.

The majority of respondents thus perceived their error rate to be less than the error rate of the average user.

Hypothesis eleven, which states that that an acceptable perceived error rate for the application exists, is accepted due to the fact that the majority of responses concerning the users' perceived error rate of Microsoft Producer were positive.

5.8.12 General Reaction to Microsoft Producer

Section C of the Usability Questionnaire requested respondents to rate their general reaction towards Microsoft Producer on a bipolar rating scale with positive attributes listed on the one end and negative attributes listed on the other end of the six point rating scale. The highest percentage of responses falls on the positive ends of the five bipolar scales.

Refer to Appendix I (Figure I.6 to I.10) for frequency charts showing the count and percentage of the responses for each of the items within the general reaction scale.

Hypothesis twelve, which states that a positive general reaction towards Microsoft Producer exists, is accepted due to the fact that the majority of responses concerning the user's general reaction of Microsoft Producer were positive.

5.8.13 General Information Regarding Microsoft Producer

Section D of the Usability Questionnaire used open-ended questions to extract general information with regard to the respondents' likes and dislikes about the Microsoft Producer system. Respondents were required to list the most positive, the most negative aspects and aspects which they would like to alter or add to Microsoft Producer.

With reference to figure 5.16 respondents listed the following characteristics that they most liked about Microsoft Producer:

- The interactivity of Microsoft Producer;
- Microsoft were considered to be very practical;
- Ease of use and user-friendliness;

- Microsoft Producer opens up a new range of possibilities;
- Microsoft Producer adds value to the educational experience;
- Microsoft Producer increases communication between role-players;
- It is an interesting system to work with; and
- It is efficient.

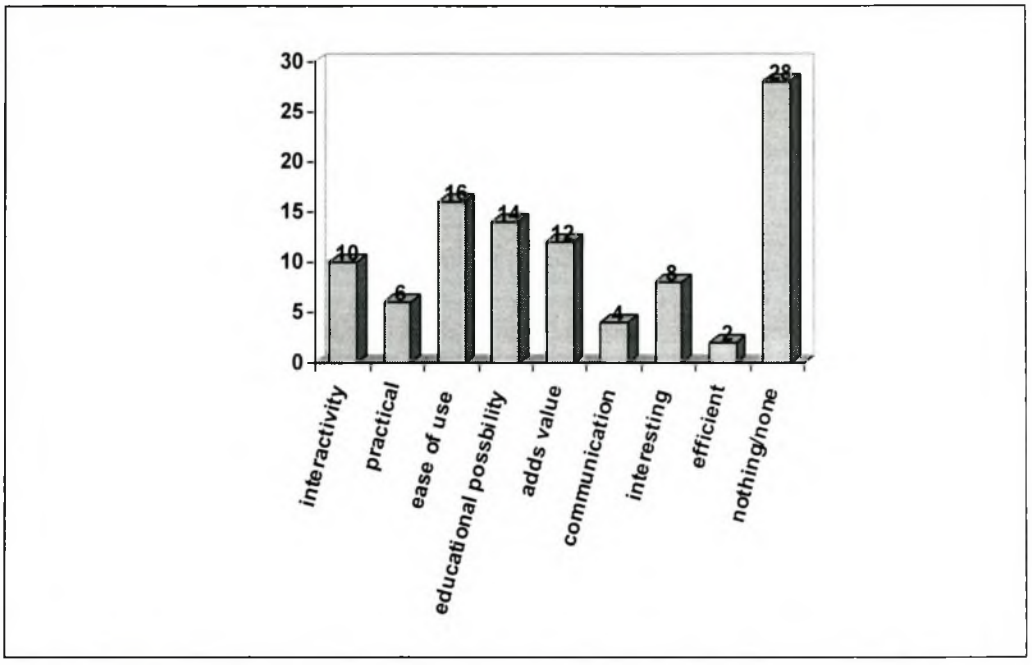

Figure 5.16 Most Liked Feature of Microsoft Producer

With reference to figure 5.17 the respondents listed the following features they most disliked about Microsoft Producer:

- The original unfamiliarity with the system;
- Expensive equipment such as the cameras;
- The pop-up screens are to small;
- It takes a long time to download large files; and
- It is complicated in some ways

With reference to figure 5.18 the respondents listed the following suggestions:

- The help function should cover more features;
- More extensive training should be provided;
- Online instructions should be made available; and
- The system can be more flexible in terms of the design templates.

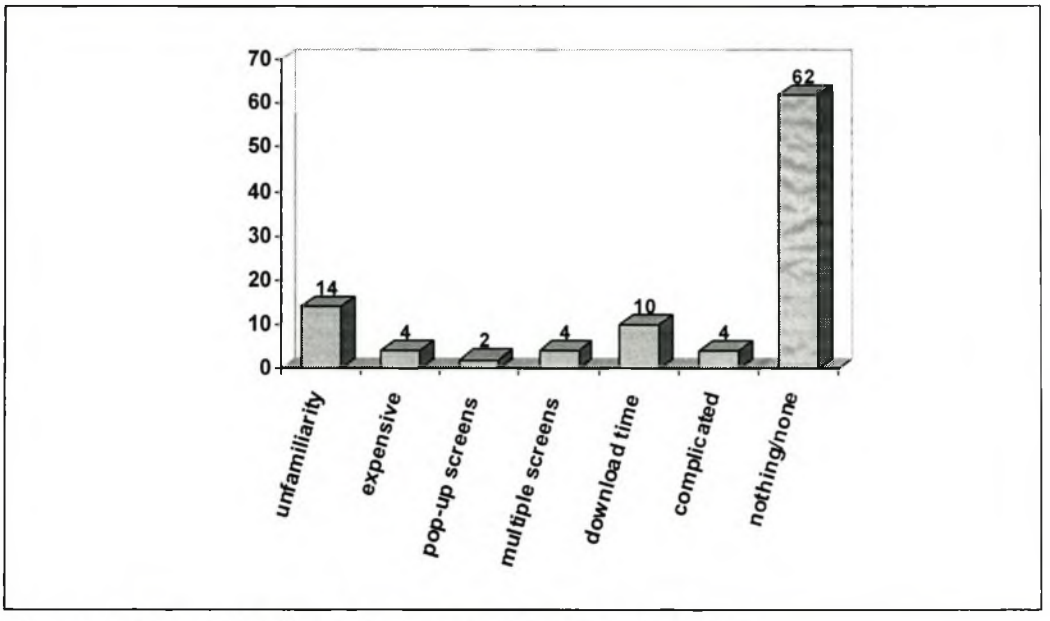

Figure 5.17 Most Disliked Features of Microsoft Producer

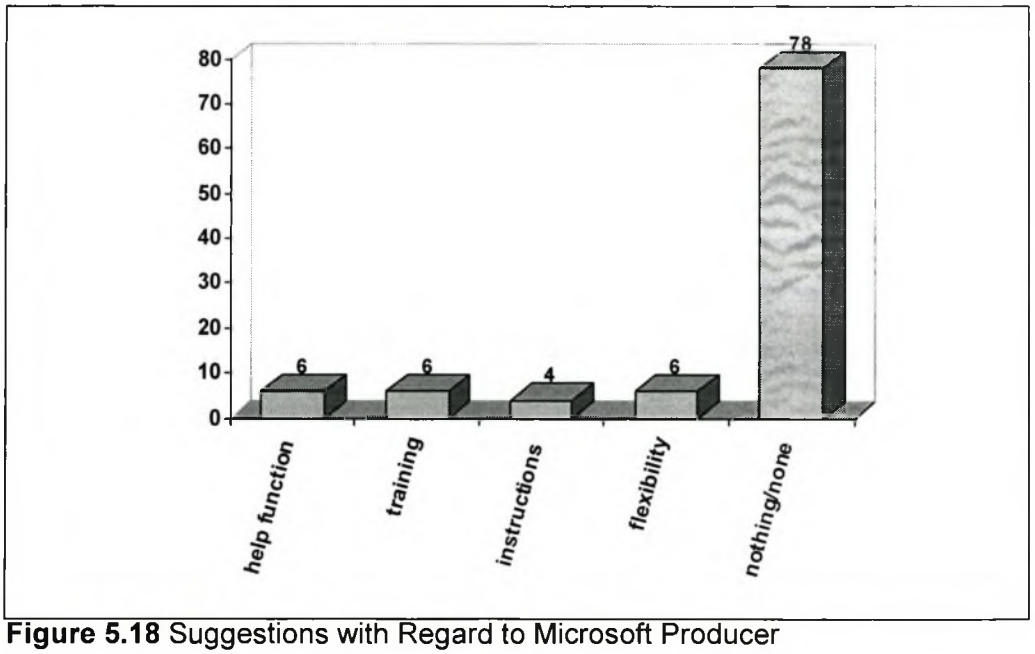

Figure 5.18 Suggestions with Regard to Microsoft Producer

5.9 DESCRIPTIVE STATISTICS OBTAINED FROM THE MICROSOFT PRODUCER ERROR RATE AND TASK LOGGING SHEET

The error rate and task logging sheets were used to obtain objective measurements with regard to the average error rate of the respondents, average time taken to complete specified tasks and the success rate with which tasks were completed.

The findings for each of the criteria tested will be discussed in accordance with the previously formulated existential hypothesis. As was explained in previous sections the benchmarks set during the formulation of the hypothesis are based on the researchers experience with the software application and on expert evaluations conducted prior to the formal usability study.

5.9.1 Success Rate

The success rate of the Microsoft Producer evaluation can be defined in terms of the total percentage of participants who successfully completed all of the tasks set out in task protocol sheet within the set time limit. The execution of a task was considered to be successful if the participant were able to fully complete the task within the seven minute (5 minutes & 2 minute grace period) time limit despite the amount of errors made. 82% of the respondents successfully completed al three tasks set out in the task protocol sheet. 98% of the respondents successfully completed task one, 92% successfully completed task two and 90% of the respondents successfully completed task three.

Hypothesis thirteen, which states that 60% of the sample population would be able to complete their tasks successfully, is accepted due to the fact that the more than 60% of the respondents completed all three tasks successfully.

5.9.2 Average time taken to complete tasks

A five minute time limit was set for the completion of each task. Participants were, however, allowed an additional two minute grace period if they were unable to complete the task within the initial five minute time limit. It should be noted that the time wasted on reading the dialogue or communicating with the observer were subtracted from the total time spent on the task. 70% of the respondents were able to complete all three tasks within the set time limit. Hypotheses fourteen which states that 60% of the participants would be able to complete the tasks within the set time limit, is accepted due to the fact that more than 60% of the respondents completed all three tasks within the set time limit.

5.9.3 Average error rate for Microsoft Producer tasks

The objective error rate can be defined as the percentage of respondents who were able to complete the tasks set out in the task protocol sheet as observed by the usability evaluations observers without making any mistakes. 52% of the respondents were able to complete all three tasks without making any mistakes. Hypothesis fifteen which states that 50% of the sample population would be able to complete the tasks without making any mistakes, is accepted in the light of the fact that more than 50% of the respondents completed their tasks without making any mistakes.

5.10 CONCLUSION

The purpose of Chapter 5 was to describe the data obtained from the various subjective and objective research measurements. The analysis and interpretation of the data was conducted in terms of the specific research objectives formulated in preceding chapters. The description of the data strongly focussed on the formulated existential hypothesis in order to determine whether this preliminary hypothesis represents the status quo of communication and educational systems within the University of Stellenbosch.

Chapter 6 provides a summary of the general conclusions that can be drawn from the interpretation of the data. Chapter 6 will also discuss the problems and limitations experienced and will offer recommendations for future research.

CHAPTER SIX
FINAL CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The final chapter summarises the main findings of the research project. The conclusions that were drawn from the needs analysis and usability questionnaire as well as from the objective laboratory measurements will be discussed in accordance with the specific research objectives. The chapter will also provide an outline of the various problems that were encountered in the research process and the limitations of the study. Finally recommendations for future research will be made.

6.2 KEY FINDINGS

The aim of the study was to conduct empirical research in order to quantify and test the usability of asynchronous communication media and learning environments and to examine and describe the end users' perceived need for the specific communication media with the underlining rationale to enhance and improve the quality of the learning and information sharing processes between role-players within the University of Stellenbosch. Survey research methods and laboratory tests were conducted to examine the usability of WebCT and Microsoft Producer and to describe the typical end users' perceived need for the specific communication media.

The following represents a summary of the main conclusions obtained from the data analysis as described in Chapter 5.

6.2.1 User Characteristics

The limited proportion of participants currently using distance education and web-based educational tools confirm the fact that educators are highly unfamiliar with these methods and have not widely accepted their use as complementary to traditional education methods. The high frequency of regular internet users indicates that the majority of respondents are, to some degree, familiar with the technology imbedded in distance education and Web-based educational tools. The participants' familiarity and usage of the Internet may have a positive impact

on the acceptance and perception of new technology based educational systems.

The findings indicate that students are the user group with the highest percentage of WebCT, PowerPoint and Video Streaming media usage. These findings suggest that students as a specific generation are more willing to adapt and implement the use of new technology than older generations who reflect a reluctance to give up traditional methods of education and communication and move to more technologically advanced alternatives.

6.2.2 Perceived needs with regard to WebCT and Microsoft Producer

Objective three, as described in Chapter 1 states that the findings of the usability study, together with an examination of the user needs and applicable concepts, will be used to make recommendations to assist in future decisions regarding the value of the integration of these media into the creation of a high value interactive virtual learning environment.

The following paragraphs summarise the most important findings obtained from the needs analysis questionnaires.

(a) Conclusions regarding the responses obtained from the lecturers, researchers and information service providers.

Administrators does not perceive the functions as described by the needs analysis questionnaire to be of value during their interaction with other information service providers, suggesting that this type of information exchange and the reason for their interaction with information service providers, drastically differs from the type of information exchanged and the reason for interaction with other role-players such as students and researchers. The findings could also suggest the interaction with information service providers takes place on a less frequent basis than interaction with students, lecturers and researchers. Interaction with information service providers could also take place primarily on a face-to-face basis accounting for the negative responses.

In addition it can be speculated that:

- The respondents have limited experience and exposure to computer based interaction with information service providers;
- Non-traditional interaction has not been developed to its full potential within the University of Stellenbosch;
- Role-player is unaware of the explicit value of improved interaction within the context of the University.

The low frequency of use reported for most of the functions may be due to the fact that a large percentage of the respondents reported limited experience with WebCT and Video Streaming, indicating that respondents have not yet experienced the full potential of the software applications.

More extensive research should be conducted to determine whether these findings would be the same for all of the departments and faculties within the University of Stellenbosch.

In collaboration with a more extensive task analysis these findings could be used to personalise communication media for the various role-players. It would for instance, be senseless to promote WebCT as the media of choice to role-players who only interact with information service providers, as none of WebCTs' functions were identified as being useful during interaction with information service providers.

(b) Conclusions regarding the responses obtained from students.

It is evident from the calculated modes that the students would use the various functions regardless of the scenario. With regard the sub-functions within each of the four given scenarios, the majority of respondents either perceived the sub-functions to be useful in their interaction with various role-players or showed neutrality towards the usefulness of the sub-functions.

This may be ascribed to the respondents' lack of previous exposure and experience, and/or to their limited understanding of the potential value of the system.

None of the functions elicited extremely negative responses from the majority of respondents.

In conclusion it is evident that students' perceptions toward the use of various functions were on average more positive than the lecturers', researchers' and information service providers' perception toward the use of various functions within WebCT and Microsoft producer.

(c) Conclusions with regard to the discrepancies between the pre-test and post-test needs analysis questionnaire.

The difference between the lecturers, researchers and information service providers' pre-test and post-test scores did not present a significant difference. The pre-test and post-test for the students did, however, present a significant change in the scores for the video streaming function within each of the scenarios as well as the mail and the test function in scenario one.

In general the respondents did not drastically change their perception with regard to the functions after they received training and interacted with the software applications. This would not conclusively suggest that their initial perceptions can not be attributed to a lack of knowledge or training.

6.2.3 Findings with regard to the respondents' qualification and experience in terms of computer usage

The end users' level of computer literacy, computer exposure and previous computer experience may have had an impact on the perceived ease of use and error management qualities of communication and information sharing software applications.

The majority of respondents involved in the usability testing of WebCT and Microsoft Producer, indicated high computer literacy levels, more than one year experience with computers, frequent computer usage and acceptable computer exposure. The sample population can thus be considered to be relatively familiar with computers and related concepts.

In order to enhance the acceptance of new technology within the educational domain it is recommended that the University of Stellenbosch should determine to a larger degree the level of computer literacy and exposure and where applicable introduce extensive training and expose programs in order to establish a much more advanced level of computer literacy.

In general, a higher percentage of respondents have been exposed to WebCT than to Microsoft Producer. These findings reflect the fact that WebCT has been introduced and made available to role-players within the University of Stellenbosch on large scale by the Uni-Ed department, while Microsoft Producer is still a relatively new program that has not been widely advertised.

The majority of respondents indicated that they have received less than two hours of training on the software applications. Respondents indicated that the WebCT training and Microsoft Producer training received has been insufficient. The findings strongly suggest that more extensive training is required with a wide scale introduction of WebCT and Microsoft Producer. It is imperative to ensure that all role-players receive sufficient training as this may improve the users' level of comfort with the system, subsequently improving the perceived usability and acceptance of the system.

6.2.4 Findings concerning the usability of WebCT and Microsoft Producer

Objective one described in Chapter 1, paragraph 1.4, states that through the use of alternative subjective and objective test methods, including observation and the use of a questionnaire, an empirical study will be conducted to evaluate the usability of the various asynchronous media, with specific focus on course management systems and video streaming. Objective two as described in Chapter 1, paragraph 1.4, states that based on the findings of the study, recommendations will be made to potential users (information services, lecturers, students and researchers) with regard to the alternative media and applications in terms of the limitations and benefits.

The following section summarises the key findings obtained from the subjective and objective tests methods used to evaluate the usability of WebCT and Microsoft Producer.

(a) General usefulness/utility

WebCT would not necessarily aid users' decision making processes but would improve communication between role-players and promote flexible learning. In general, a positive perception exists regarding the usefulness and utility of WebCT.

Microsoft Producer was considered to be useful by the majority of respondents. The majority of respondents indicated that Microsoft Producer would enhance their client service/learning/networking or research processes. It is perceived that this system would promote flexible learning and make it easier for users to do their job.

(b) General effectiveness

The largest percentage of respondents perceived WebCT and Microsoft Producer to be effective and that these systems would enhance the effectiveness and accuracy of their communication and information sharing processes.

(c) General efficiency

The data indicated that WebCT and Microsoft Producer were considered to be efficient and that it would enable end users to efficiently completed their work and save time on information sharing.

With regard to the efficiency of Microsoft Producer, the data indicated that a large percentage of respondents perceived the speed of Microsoft Producer to be too slow. A number of respondents commented that large files took to much time to download. The speed of Microsoft Producer may be attributed to the specific computer speed or the size of the specific file. Before incorporating Microsoft Producer a thorough investigation should be conducted in order to determine possible reasons and feasible solutions for the delayed download time.

(d) Reliability

In general the respondents regarded WebCT to be dependable. Microsoft Producer, on the other hand, was not perceived to be reliable and dependable as the majority of respondents were indecisive with regard to the reliability statements provided in the usability questionnaire. Although the findings reflect negatively on the perceived reliability of Microsoft Producer, these findings should not form the basis of assumptions made regarding the actual reliability of the system. The perceived unreliability of the system can be attributed to the respondents' level of expertise and not to the systems' actual reliability. None of the observers reported system failure during experiments.

Neutral answers with regard to the reliability of the systems could be attributed to the fact that respondents have not been using WebCT or Microsoft Producer long enough to truly rate the reliability of the system. It is thus recommended that a usability study specifically focussed on determining the reliability of the system should be conducted during later stages of product usage.

(e) Ease of use

The majority of respondents rated WebCT and Microsoft Producer to be easy to use and user-friendly. The majority of respondents perceived WebCT and Microsoft Producer to be designed for all levels of users.

Microsoft Producer was not considered to be designed in such a way as to allow users to customise various windows. As the customisability of the system may impact the satisfaction level of the user, it is important to take note of, and further investigate, the negative responses received with regard to the customisability of Microsoft Producer. A thorough task analysis would also indicate whether or not the ability to customise windows should be included as an essential element for the effective and efficient completion of tasks.

A large percentage of respondents indicated that WebCT requires too many steps to complete a specific task. This could have implications for

the efficiency with which end-users can complete their work. Designers could improve the user friendliness of WebCT by re-evaluating the number of steps required to complete a specific task. Consideration can be given to determine ways and means of reducing the steps required and thus improving the time needed to complete a task.

(f) Consistency

WebCT and Microsoft Producer can be regarded as being consistent in the way it responds to user inputs in the same manner. The majority of users indicated that they felt in control when they were using WebCT and Microsoft Producer.

(g) Error management

Research results indicate that the majority of respondent could not assess the error management capabilities of WebCT and Microsoft Producer. This could be due to the fact that a respondent does not have sufficient experience with the system and has of yet not made serious errors while using the system. It is, however, recommended that training efforts should include a focus on the error management of WebCT and Microsoft Producer, indicating respondents where to access and how to use the help function within the separate systems. Designers should also reassess the helpfulness of the on-screen help messages and error messages during future design alterations.

(h) Compatibility

The majority of respondents indicated that WebCTs' and Microsoft Producers' method of operation matches with their own expectation of way things should be done. Respondents indicated that the menu and icon organisation of the systems were logical, the command names were meaningful and understandable and that the terminology was in line with standard terminology.

(i) Learnability

In general WebCT and Microsoft Producer were considered to be extremely learnable. The majority of respondents reported that most people would be able to learn to use WebCT and Microsoft Producer with relative ease and within an acceptable time frame.

One particular aspect of concern with regard to the learnability of WebCT is that there is a lack of information on the screen when required. This problem can be eliminated with sufficient training efforts. The more expensive option would be to redesign WebCT as to supply more relevant information as and when required.

An aspect of concern with regard to the learnability of Microsoft Producer is that a large percentage of respondents regarded it necessary to learn a number of functions before they could use Microsoft Producer. Respondents regularly wondered whether or not they were using the appropriate command. This problem can be addressed by supplying end users with sufficient and intensive training before the incorporation of the system, alternatively providing an improved help facility or implementing an improved Human Computer Interface.

(j) User satisfaction

In general the respondents were satisfied and comfortable with WebCT and Microsoft Producer which reflected the potential for more frequent use of the system. Respondents indicated that WebCT and Microsoft Producer were pleasant to work with and have an attractive presentation. The majority of respondents would recommend the systems to other role players.

(k) Error rate

An acceptable error rate for tasks carried out with WebCT and Microsoft Producer exist as the majority of respondents claimed to have made only one error during the experiment. The majority of respondents perceived

their error rate to be acceptable and that they made fewer errors than what they perceived to be average.

(l) General reaction towards the system

In general, the majority of respondents perceived WebCT and Microsoft Producer in a positive light, describing it as wonderful, easy to use, satisfying, stimulating and flexible. The strong positive feelings toward WebCT and Microsoft Producer suggest that the possibility exist for the successful integration of systems within the University of Stellenbosch as these perceptions would lead to the acceptance of the system by the majority of end users leading to high levels of usability and utility.

(m) Objective measurements

The error rate and task logging sheets were used to obtain objective measurements with regard to the average error rate of the respondents, average time taken to complete specified tasks and the success rate with which tasks were completed.

These findings compliment the subjective measures with regard to the error management, ease of use, effectiveness and efficiency of WebCT and Microsoft Producer. The majority of respondents successfully completed the tasks set out in the task protocol sheet within the set time limit.

The task error rate of the respondents was not as positive with only 51% of students and 33% of participants being able to complete all three tasks within WebCT without making any mistake. Only 51% of the participants were able to complete all three tasks within Microsoft Producer without making any mistakes. The findings once again confirm that more extensive training is needed with regard to the use of WebCT and Microsoft Producer.

To conclude WebCT and Microsoft Producer can be regarded as being useful, easy to use, consistent, compatible, learnable and likeable. Respondents also indicated that WebCT and Microsoft Producer enabled them to complete their

tasks with accuracy in a timely competent and economical fashion. The positive perceptions that exist with regard to the general usability of WebCT and Microsoft Producer are extremely important, as it increase the promotional value of WebCT and Microsoft Producer and will facilitate the acceptance and wide scale integration of systems within the University of Stellenbosch.

Most importantly the findings suggest that WebCT and Microsoft Producer hold potential for enhancing and improving the quality of the learning and information sharing processes between role-players within the University of Stellenbosch by providing a useful, reliable, easy to use, consistent, compatible, learnable and likeable system. In effect this would ultimately lead to the improvement of knowledge sharing and an increase in valuable research activities.

6.3 PROBLEMS AND LIMITATIONS OF THIS STUDY

Descriptive research methods aimed at describing a specific situation within the University of Stellenbosch were used to conduct the research. The research design specifically employed survey research methods which were considered to be appropriate for the specific study, although, it is not without weaknesses. The major weakness of survey research is that it is generally considered to be weak on validity, inflexible and can seldom deal with the content of social life.
Due to the limitation and the descriptive nature of the study, not all of the extraneous variables, that might impact the usability of the systems, were controlled and accounted for.

Although laboratory tests can be extremely advantageous during usability testing, the limitations imbedded in the study limited the advantages of laboratory tests. First and foremost, access to appropriate locations was limited. Secondly, budgetary constraints limited the equipment available to the researcher to conduct a comprehensive laboratory test. Measures were, however, taken to simulate the ideal laboratory setting as best as possible.

Time constraints on the part of the respondents caused the sample population to decrease from 86 to 50 participants after the initial needs analysis phase. To eliminate the recurrence of this problem during the usability testing of the systems, measures were taken to accommodate the varying schedules of the participants. In order to

accommodate all of the participants the laboratory tests could not be conducted on a single participant at a time, which potentially would have been more ideal.

The convenience sampling methods used during the study and the fact that responses were to a large degree limited to the Arts and Economic and Management departments, restrict the generalisability and/or the external validity of the findings. The small sample size used further restricts the ability of the researcher to conclude that the same results would have been obtained if the research was conducted on a larger, fully representative university population. The needs analysis questionnaires were not validated or tested for reliability. Findings with regard to the needs analysis questionnaires should thus be interpreted with caution and can not be considered to be a true reflection of the wider populations' needs. In this sense the study has many features of an exploratory study.

6.4 RECOMMENDATIONS FOR FUTURE RESEARCH

One of the objectives of the research was to examine and describe the usability of WebCT and Microsoft Producer. The general lack of consensus, with regard to the definition of usability and its operational criteria in this particular context, as well as the lack of adequate benchmarks, created pertinent problems with regard to the validity of the measurements. It is recommended that future studies should aim specifically at developing valid and reliable measurements for usability studies within the context of evaluation of software systems that contribute towards education and training at South African Universities and Institutions for Tertiary Education. Future research should, therefore, include more extensive evaluations of the validity and reliability of the measurement instruments.

The research was limited to findings based primarily descriptive statistics. Future studies should, however, include statistical analysis aimed at describing correlations and relationships between variables. The additional analysis would compliment existing findings in that it would provide valuable information with regard to the relationships that exist between the usability criteria.

With regard to the usability analysis it is recommended that more extensive training should precede the usability analysis of any given system. Increased levels of experience and exposure would assist participants in making more informed decisions

with regard to the usability of the system, especially with regard to the error management and reliability criteria.

It is recommended that in future research a needs analysis should incorporate an analysis of the specific user tasks performed on a daily basis associated with a clearly defined functional analysis. A task analysis used in conjunction with a needs analysis would provide a reliable view of the specific communication, educational and information sharing needs of the end user.

Chapter 3, paragraph 3.8 described a model for the development of an integrated virtual learning and information sharing environment. With regard to the mentioned model, future usability analysis should include additional elements such as the examination of governance, the feasibility and the acceptance of the technology, as well as the inputs and outputs of the communication and information sharing processes.

The specific study made assumptions regarding the value added to the educational process based on a review of relevant literature. It is, however, recommended that media should also be tested with regard to their potential to enhance and add value to the information sharing and communication processes within the educational domain with specific focus on the University of Stellenbosch.

6.5 CONCLUSION

Empirical research methods as described in Chapter 4 were used to effectively quantify and test the usability of asynchronous communication media and learning environments and to examine and describe the end users' perceived need for the specific communication media with specific focus on the application of these media in the on-and of campus tertiary education environment. The study employed both subjective and objective measurements to examine the usability of WebCT and Microsoft Producer within the scope of interaction between the role-players boundaries at the University of Stellenbosch.

Findings were used to describe the status quo and make recommendations aimed at enhancing and improving the communication and information sharing processes within the University of Stellenbosch.

The study provides evidence of the fact that WebCT and Microsoft Producer have the ability to contribute towards the enhancement of information sharing and communication aimed at improved knowledge building, by enabling role-players to complete their tasks with accuracy in a timely competent and economical fashion and providing a system that can be regarded as being useful, easy to use, consistent, compatible, learnable and likeable.

The study's contributions towards the enhancement of education includes valuable insight with regard to the use of communication and information sharing environments at the University of Stellenbosch, as well as, contributions towards the development of valid and accepted usability definition and criteria measurements.

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