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

GINA EKERMANS

Thesis presented in partial fulfillment of the requirements for the degree of Master of Commerce (Industrial Psychology) at the University of Stellenbosch.

Supervisor: DR. M. CILLIERS-HARTSLIEF

APRIL 2003

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 to any university for a degree.

ABSTRACT

As the information age evolves, society is undergoing changes based on developments in technology that have tremendous implications for the educational systems. Institutions of tertiary education are increasingly facing the pressures of globalisation. Associated with this is the knowledge society that demands experience with technology, different skills and a different learning experience (US, 2001). Furthermore, new information and communication technologies have demonstrated the potential to transform the way that knowledge is packaged, delivered, accessed and acquired, thereby altering higher educations' core production and delivery processes. Institutions of tertiary education that want to remain competitive, both locally and internationally, should, therefore, act pro-actively to facilitate the successful and innovative integration of relevant technologies into currently established practice and procedures.

The University of Stellenbosch (US) recognises the importance of staying abreast with these global and local changes. The Virtual Information Space (VIS) project for optimal information sharing is a research initiative that developed as a direct response to the need for an inquiry into the functionality of alternative synchronous and asynchronous computer-mediated communication media (CMC), to be provided as part of the technological infrastructure of the US for enhanced information sharing and communication. The VIS project provides the framework within which this study was conducted.

The aim of this study was to conduct an exploratory study through the use of empirical research and prototyping, by quantification of the usability of synchronous CMC media, for application in the South-African on and off-campus tertiary education environment (focused at post graduate level), in order to enhance information sharing between inter alia, information service suppliers, lecturers, students and researchers at the US. It was anticipated, however, that the degree to which the synchronous CMC media add value to the learning and information sharing processes within the VIS, will be influenced by the usability of the software applications within which the media are embedded, the perceived need of the role-players for the media, as well as the feasibility and viability of the systems when employed within the technological infrastructure of the US. These

elements were, therefore, empirically investigated by conducting several usability experiments in a setting which simulated a usability laboratory, in order to acquire the necessary subjective and objective data, related to the identified goals and objectives that encapsulate the aim of this study.

In order to demonstrate the value of the VIS environment, a theoretical perspective is provided by means of a literature review of the fundamental concepts of communities of practice and flexible learning. It is proposed that the use of the synchronous CMC media (embedded within the software applications) will assist in the creation of a VIS that supports the more advanced educational paradigm of constructivism by linking users into collaborative conversational networks, thus forming learning communities (better known as communities of practice) in cyberspace. The purpose of these communities is to create a means through which ideas and materials can be shared and exchanged, aiding individuals in building their own conceptual networks of interrelated ideas, strategies and theories and therefore construct and share knowledge.

Information was obtained concerning participants' characteristics, preferences, needs and evaluation of the usability of the two software applications, *NetMeeting* and *Yahoo Messenger*, when utilised within the technological infrastructure of the US for the purpose of increased information sharing and communication. Performance measurement data (related to selected usability criteria) was obtained during the experimental phase, as well as information about the feasibility and viability of the systems when utilised within the technological parameters of the US. The analysis of the information consisted of descriptive statistics as the research aimed to illustrate the attitudes concerning usability, the perceived needs for the software applications, as well as the feasibility and viability of the systems.

The results revealed that both *NetMeeting* and *Yahoo Messenger* were perceived by the participants as usable, achieving a positive rating on almost all of the dimensions of usability it was tested on. In the case on *NetMeeting*, technological limitations imposed on the system (such as bandwidth and network traffic) severely limited the effectiveness of the system as a whole and require further investigation to ensure successful implementation. Technological limitations in the case of *Yahoo Messenger* mainly centered on the unstable server environment that the system functions within. Hence, further research is therefore needed to ensure successful implementation and utilisation of *NetMeeting* and *Yahoo Messenger* within the technological parameters faced by the US.

OPSOMMING

Soos wat die informasie-era ontplooi, is die samelewing besig om ingrypend te verander. Die dramatiese impak van die tegnologiese revolusie op die hoër onderwyssektor dwarsoor die wêreld hou dus aansienlike implikasies in vir tersiêre onderwysinstellings. Hierdie instellings is toenemend onderhewig aan die druk van globalisering en die kennis-samelewing wat al hoe meer vereistes stel in terme van ondervinding met tegnologie, verskillende vaardighede wat vereis word en 'n veranderende leer ervaring. Nuwe informasie- en kommunikasietegnologieë beskik oor die potensiaal om die maniere waarop informasie herwin, verwerk en gestoor word, te transformeer. Dit impliseer noodwendig 'n wysiging in die kern informasie produksie en -aflewerings prosesse van tersiêre onderwysinstellings. Sulke instellings word dus genoop om daadwerklik en pro-aktief op te tree ten opsigte van die suksesvolle en innoverende integrasie van relevante tegnologieë by bestaande prosedures, ten einde internasionale en nasionale mededingendheid te verseker.

Die Universiteit van Stellenbosch (US) erken the belangrikheid daarvan om op hoogte te bly met verandering. Die Virtuele Informasie Spasie (VIS) projek vir optimale informasiedeling is 'n navorsingsinisiatief wat ontwikkel het vanuit 'n behoefte vir 'n ondersoek na die funksionaliteit van die verskillende sinkrone en asinkrone rekenaar-gebasseerde kommunikasie media, wat as deel van die tegnologiese infrastruktuur van die US voorsien sal word – ten einde verbeterde informasiedeling en kommunikasie teweeg te bring. Die VIS projek het 'n raamwerk verskaf waarbinne hierdie studie uitgevoer is.

Die doel van hierdie navorsing was om 'n verkennende studie uit te voer, deur die gebruik van empiriese navorsing en prototipering, vir die kwantifisering van die bruikbaarheid van sinkrone rekenaar-gebasseerde kommunikasie media. Die spesifieke toepassingsarea is die Suid-Afrikaanse tersiêre onderwysomgewing (spesifiek gefokus op nagraadse vlak) met die doel om informasiedeling tussen informasie-diensverskaffers, dosente, studente en navorsers te verbeter. Daar word egter verwag dat die graad waartoe die sinkrone media waarde toevoeg tot leer- en informasiedelings prosesse binne die VIS, beïnvloed sal word deur die bruikbaarheid van die sagteware

waarbinne die media gesetel is, die waargenome behoeftes van die rolspelers vir die media, sowel as die uitvoerbaarheid en lewensvatbaarheid van die sisteme wanneer dit aangewend word binne die huidige tegnologiese infrastruktuur van die US. Hierdie elemente was dus empiries ondersoek deur die uitvoering van verskeie bruikbaarheidseksperimente in 'n omgewing wat 'n tradisionele bruikbaarheids laboratorium simuleer, ten einde the nodige subjektiewe en objektiewe data te ontgin wat gemik is op die doelwitte en mikpunte wat die strewe van hierdie studie omsluit.

'n Teoretiese perspektief word voorsien deur 'n literatuur-oorsig, ten einde die waarde van die VIS omgewing te konseptualiseer. Konsepte wat veral aandag geniet hou verband met die ontwikkeling van elektoniese gemeenskappe en buigsame leer omgewings. Die aanname word gemaak dat die gebruik van sinkrone rekenaar-gebasseerde kommunikasie media (soos gesetel in die sagteware pakkette, *NetMeeting* en *Yahoo Messenger*) die ontwikkeling van 'n effektiewe VIS sal fasiliteer wat 'n nuwe onderrigparadigma ondersteun. Die uitgangspunt van hierdie paradigma is dat kennis nie net weergegee moet word nie, maar dat dit gekonstrueer kan word soos wat die partye betrokke raak in relevante gespreksnetwerke binne die virtuele informasie spasie. So word elektroniese gemeenskappe dus geskep waarbinne individue idees en materiaal met mekaar kan deel en uitruil, terwyl kennis effektief geskep en gedeel word.

Informasie is ingewin aangaande die deelnemers se kenmerke, voorkeure, afkeure, behoeftes en persepsies oor die bruikbaarheid van die sagtware pakkette, *NetMeeting* en *Yahoo Messenger,* wanneer dit aangewend word binne die tegnologiese infrastruktuur van die US, ten einde verhoogde informasiedeling en kommunikasie te bewerkstellig. Prestasiemetingsdata (gekoppel aan sekere bruikbaarheidskriteria) was ook verkry tydens die eksperimentele fase, sowel as informasie oor die uitvoerbaarheid en lewensvatbaarheid van die onderskeie sisteme wanneer dit aangewend word binne die huidige tegnologiese parameters van die US. Die analise van die data het beskrywende statistieke behels aangesien die navorsing ten doel gehad het om die ingesteldhede betreffende die bruikbaarheid en behoefte aan die sagteware pakkette, sowel as sekere tegniese aspekte rakende die stelsels, uit te lig.

Die resultate het getoon dat die respondente beide *NetMeeting* en *Yahoo Messenge*r as bruikbaar waargeneem het, aangesien 'n positiewe beoordeling op bykans al die dimensies van bruikbaarheid bereik was. In die geval van *NetMeeting* het sekere tegnologiese beperkinge van die sisteem, soos beperkte bandwyte, egter die effektiwiteit van die sisteem beduidend beinvloed. Tegnologiese beperkinge in die geval van *Yahoo Messenger* was hoofsaaklik as gevolg van die onstabiele omgewing waarbinne die bediener funksioneer. Verdere navorsing is dus nodig om suksesvolle implementering en aanwending van *NetMeeting* en *Yahoo Messenger* te laat realiseer, gegewe die tegnologiese parameters van die US.

ACKNOWLEDGEMENTS

I would like to extend my gratitude and appreciation to the following people and institutions for their valuable contributions to make this study possible:

- My supervisor, Dr Marna Cilliers-Hartslief, for her hard work, advice, encouragement, recommendations, shared expertise, innovative way of thinking and most of all her ability to inspire her students to reach their full potential.
- Karin Scholtz, for being a valuable research partner throughout this whole project.
- Douw van Wyk, for his valuable and immeasurable contribution on the technical side of things, without whom this project could not have been completed successfully.
- Mr Matthew Syphus, for acting as the VIS project manager.
- All the lecturers, students and library personnel whom agreed to take part in the experiments.
- The National Research Foundation (NRF), for research funds. Opinions expressed in this thesis and conclusions arrived at, are those of the author and not to be attributed to the NRF.
- My parents, for their love and support throughout all my years of studying. Their investment in me is greatly appreciated.
- All my friends (especially my cell members), Erika van Velden, Debbie Kelly and Jan-Willem de Jager for their encouragement and understanding. Going through this process together made the load much more bearable.
- Most of all, I would like to praise and thank God the Father, my Saviour Jesus Christ and the Holy Spirit for inspiring, sustaining and granting me with the ability, courage and strength to complete my studies.

TABLE OF CONTENTS

CHAPTER 5: DISCUSSION OF FINDINGS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES (AS AVAILABLE ON CD ROM)

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

1.1.1 World trends

There is little doubt that major changes in higher education are taking place all over the world. The use of the Internet and communication and information technology is increasingly becoming an important part of the learning and teaching strategies of many institutions of tertiary education. Claims that the Internet is revolutionising our lives are now becoming commonplace. In part, these claims are based on the Internet's rapid growth. According to Huber (cited in Ryan, Freeman, Scott & Patel, 2000, p.8), "the Internet's pace of adoption eclipses all other technologies before it. Radio was in existence 38 years before 50 million people where tuned in, TV took 13 years to reach that point. Once the Net was opened to the general public, the Internet crossed that line in four years."

As the information age evolves, society is undergoing massive changes that have tremendous implications for the educational systems. Universities are increasingly facing the pressures of globalisation and the knowledge society that demands experience with technology, different skills and a different learning experience. Another challenge prompting universities to rapid change, pertain to the high amount of non-traditional providers of higher education that have entered the higher education market in the past few years (US, 2001). In this arena, web-based distance courses have gained a lot of ground and are increasingly becoming a competitive contender in the market of higher education.

The relevance of communication and information technology for universities also needs to be viewed within the context of an increasing emphasis on lifelong learning. From this perspective, education is not something that only happens during childhood and early adulthood, but is rather viewed as a continuing process throughout an individual's life. According to Fleming (cited in Palloff & Pratt, 1999, p.15), "Campuses are increasingly working to develop learning communities through the utilisation of various computer-mediated communication technologies, because of the power they hold in facilitating a culture of lifelong learning." Consequently, institutions of tertiary education should start to acknowledge that it is the relationships and interactions among people through which knowledge is primarily generated. Thus, the learner should no longer only receive information, but should also be given an opportunity to construct knowledge.

Considering these changes, it is becoming clear that advances in information technology are inspiring new paradigms for education. It is increasingly being acknowledged that learning is an active process in which both the instructor and learners must participate if it is to be successful. Facilitated by the appropriate computer-mediated communication technologies, virtual communities - a "web of learning" - are created. These virtual communities encapsulate a network of interactions between the instructor and the other participants through which the process of knowledge acquisition is collaboratively created. According to Rowley (cited in Heydenrych, 2002, p.15), the outcomes of this process, then, should not be measured by the number of facts memorised and amount of subject matter rehearsed – but by the depth of knowledge and the number of skills gained. Evidence of critical thinking and independent and lifelong learning skills become the desired learning outcomes, as providers of higher education adopt a system that is able to facilitate knowledge construction and refinement.

The utilisation of information and communication technologies in higher education has not only had a significant impact on learning and education, but also on the research methodologies and practices utilised in practically all disciplines (US, 2001). The use of computer-mediated communications media that enhance both synchronous (interactions that occur at the same time) and asynchronous communication (interactions that occur on different times, regardless of time and place differences) has become imperative in ensuring cooperation between researchers over geographical boundaries.

One cannot deny that the biggest contender for a competitive advantage among traditional residential universities and other institutions of tertiary education, is the successful and innovative integration of relevant technologies into currently established procedures. Universities are thus forced to act pro-actively in this area in order to ensure their competitiveness in both the national and international arena. It is thus increasingly becoming the ideal to integrate appropriate technologies with the traditional "brick and mortar" model of higher education providers. Hence, technology within this context is not only viewed as a supplement to the existing structure, but is increasingly being viewed as a new ingredient that has the potential to change the traditional institution through its implementation as a strategic benefit.

It is evident that the context of higher education teaching, learning and research is changing. The focus of higher education institutions should, therefore, also adapt towards meeting the evolving needs with a new and innovative manner of presenting and conducting learning and research within the tertiary context.

In summary, the following remarks regarding the international trends in the changing context of higher education can be made:

- Information and communication technology is at present causing significant changes in the higher education sector. New learning technologies can transform the way knowledge is packaged, delivered, accessed, acquired and measured, altering higher education's core production and delivery processes;
- It appears that universities which will survive the present and future demands cannot ignore these developments in their strategic planning;
- There is significant evidence to support the notion that non-traditional providers of higher education occupy a strong presence in education and that they are beginning to become significant contenders in the higher education market;

- A significant amount of residential universities have incorporated relevant information technologies in traditional programmes, service deliverance and research activities with increasingly success; and
- There are strong indications that the traditional university model experiences the strongest competition from traditional universities that have succeeded in incorporating relevant computer-mediated communication technologies as a strategic asset into the current infrastructure, educational programmes and research activities (US, 2001).

1.1.2 South African Perspective

Higher education in South Africa does not function in isolation from changes that happen in this area in the rest of the world. The issues mentioned above, that to a very large extent dictate the nature of higher education today, should be considered with much more urgency within the context of a developing nation such as South Africa.

The importance of the effective utilisation of information and communication technologies in the higher education domain in South Africa, is emphasised in a recent report - *Towards a New Higher Education Landscape: Meeting the Equity, Quality and Social Development Imperative of South Africa in the 21st Century* - of the National Commission of Higher Education.

The commission has identified one particular challenge that will require explicit attention by all higher education providers in South Africa: the development of information and communication technologies (CHE, cited in US, 2001, p.7). It maintains that the rapid growth and convergence in functionality of these technologies over the past few years is being harnessed by a growing number of higher education systems, implying that these examples should be followed within the South African context.

1.2 RELEVANCE OF THE STUDY

The University of Stellenbosch (US) is known as a South African university that embraces a tradition of excellence and prestige. In accordance with this tradition, it thus becomes extremely important to stay abreast of global changes in the academic domain to ensure local, as well as international competitiveness.

The Virtual Information Space (VIS) Project for optimal information sharing is a research initiative that developed as a direct response to the need for an inquiry into the functionality of different synchronous and asynchronous computer-mediated communication (CMC) media, to be provided as part of the technological infrastructure of the US for enhanced information sharing and communication. In the US report for the proposed 'quantum leap' towards an e-campus at the US, a strategic initiative that was identified pertained specifically to the expansion of the employment of synchronous and asynchronous communication possibilities. These communication methods were identified as pivotal in the development of interactive communication between lecturers and students, as well as between students. It was acknowledged that these communication methods could also be utilised within the research context to promote collaboration between individuals and teams, as well as between researchers – both locally and abroad. Lastly, these communication methods would empower the information service suppliers to effectively and efficiently manage information delivering and access, aiding all the above-mentioned role-players in their quest for effective knowledge sharing and creation (US, 2001).

It is anticipated that the CMC media that supports the synchronous and asynchronous modes of communication, will enhance learning and information sharing between the different role-players (or user groups) at the US. Limited research has shown that such technological initiatives have the potential to be implemented so as to create and enhance constructivist learning environments (Palloff & Pratt, 1999). Successful implementation, therefore, leads to effective virtual learning and information sharing environments that support the development of elaborate collaborative conversational networks between different role players. Hence, this study is relevant in that it specifically explores challenges and constraints of the implementation of synchronous communication media, for the purposes stated above, within the technological infrastructure of the US. This study, should furthermore be viewed as a sample sight of the situation as it pertains to the US and other institutions of tertiary education in South Africa.

1.3 AIM OF THE STUDY

The use of technology for the enhancement of education and information sharing, needs to be well tested, easy to implement, reliable and proven to having added value to the specific application scenario (Lindsay & Grant, 1998). Limited research has been conducted in this domain.

The aim of this research is to conduct an exploratory study through the use of empirical research and prototyping, through the quantification of the usability of synchronous CMC media, for application in the South-African on and off-campus tertiary education environment (focused at post graduate level), in order to enhance information sharing between inter alia, information service suppliers, lecturers, students and researchers. The VIS project therefore provided a framework (in the context of the US) within which this exploratory research could be conducted. The specific focus of this study was the synchronous CMC media, whereas another study was conducted in parallel with this one, focusing specifically on the asynchronous CMC media. The researcher, however, acknowledged that the degree to which the synchronous CMC media adds value to the learning and information sharing processes within the VIS, will be influenced by three elements.

These three elements include:

- the usability of the software applications (e.g. desktop-based video conferencing systems like *NetMeeting*) in which the media (e.g. whiteboard), are embedded;
- the perceived need of the role-players for the specific media; as well as
- the feasibility (the internal and external quality of the systems) when employed within the technological infrastructure of the US.

Laister and Kober (2002) emphasise the importance of the usability of the software used to create a virtual collaborative environment. They maintain that, "...the usability of the software applications is a general requirement of a successful online community as high usability makes it possible for users to interact and perform their tasks easily and intuitively" (Laister & Kober, 2002, p.5). The importance of establishing the needs of the users in terms of the specified media is confirmed by Palloff and Pratt (1999, p.23) as they state that, "...even in the virtual community, educators must realise that the way the media is used depends largely on the human needs, and that meeting the needs of both the lecturers and students are the prime reason that electronic communities are formed." It is proposed by the researcher that the emergence of such electronic 'communities', that Palloff and Pratt refer to, is embodied within the concept of communities of practice (COP), that is considered as the pivotal element in fostering collaborative conversational networks between the different role-players in the VIS. COP, commonly named 'knowledge networks,' are referred to as institutionalised, informal networks of different role-players managing and sharing domains of knowledge (Gongla & Rizutto, 2001). Furthermore, Ubon and Kimble (2002) suggest that the concept of communities is essential because knowledge in often built up and generated by a network of practitioners – a community. They furthermore emphasise that such communities are regarded as a appropriate model for dynamic, productive knowledge creation and sharing in education. Ultimately, the VIS should support and promote the development of as many of these COP, for it is within these communities that the value of the VIS is embodied. Figure 1.1 depicts the VIS environment, as well as the elements influencing the value of the VIS that were researched in this study.

The aim of this study as stated above, created a frame of reference within which the following research goals and objectives were identified:

Goal 1: Conduct a Needs Analysis

Objective 1: To describe the needs of the role-players (students and lecturers) regarding the synchronous CMC media, before and after usability testing. Sub-objectives include:

- Objective 1 (a): To describe the specific needs of the lecturer role-player group regarding the synchronous CMC media, before and after usability testing.
- Objective 1(b): To describe the specific needs of the student role-player group regarding the synchronous CMC media, before and after usability testing.

Objective 2: To prioritise the needs of the different role-player groups. Sub-objectives include:

- Objective 2 (a): To prioritise the needs of the lecturer role-player group.
- Objective 2 (b): To prioritise the needs of the student role-player group.

Goal 2: Evaluate the usability of the software applications

Objective 3: To describe the software applications, *NetMeeting* and *Yahoo Messenger*. Sub-objectives include:

- Objective 3(a): To describe the software application, *NetMeeting*.
- Objective 3(b): To describe the software application, *Yahoo Messenger*.

Objective 4: To define the concept of usability within the VIS project environment in operational terms.

Objective 5: To evaluate the usability of *NetMeeting* and *Yahoo Messenger*, by conducting formal usability testing in a controlled experimental environment, in order to obtain subjective data through a subjective measurement technique (usability questionnaire). Sub-objectives include:

- Objective 5 (a): To evaluate the usability of *NetMeeting* by conducting formal usability testing in a controlled experimental environment, in order to obtain subjective data through a subjective measurement technique (usability questionnaire).
- Objective 5 (b): To evaluate the usability of *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, in order to obtain subjective data through a subjective measurement technique (usability questionnaire).

Objective 6: To evaluate the usability of *NetMeeting* and *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, to obtain objective data through an objective measurement technique (human performance measurement). Sub-objectives include:

- Objective 6 (a): To evaluate the usability of *NetMeeting* by conducting formal usability testing in a controlled experimental environment, in order to obtain objective data through an objective measurement technique (human performance measurement).
- Objective 6 (b): To evaluate the usability of *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, in order to obtain objective data through an objective measurement technique (human performance measurement).

Goal 3: Investigation into the feasibility and viability of the software applications.

Objective 7: Conducting prototype experiments with *NetMeeting* and *Yahoo Messenger*. Sub-objectives include:

- Objective 7 (a): Conducting prototype experiments with *NetMeeting*.
- Objective 7 (b): Conducting prototype experiments with *Yahoo Messenger*.

Objective 8: To acquire information about the internal quality of the technological infrastructure of the US, such as its bandwidth capabilities, average network usage and hardware capabilities or limitations.

Objective 9: To acquire information about the external quality (audio, video and data collaboration quality) of software applications *NetMeeting* and *Yahoo Messenger*, when utilised within the technological infrastructure parameters of the US. Sub-objectives include:

- Objective 9 (a): To acquire information about the external quality (audio, video and data collaboration quality) of *NetMeeting*, when utilised within the technological infrastructure parameters of the US.

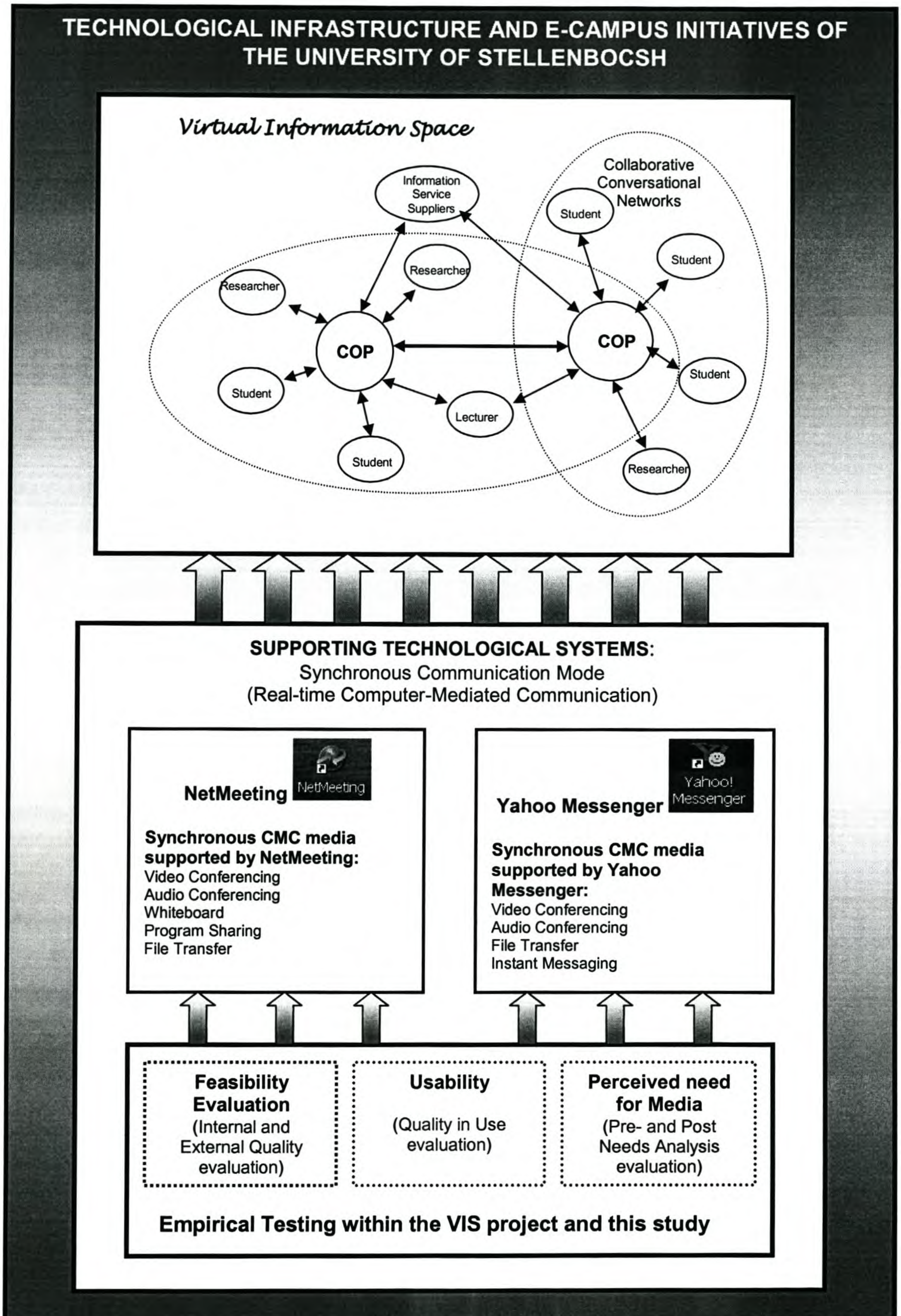


Figure 1.1: Overview of the elements influencing the VIS environment that formed the focus of the research in this study (COP refers to Communities of Practice).

- Objective 9 (b): To acquire information about the external quality (audio and video quality) of *Yahoo Messenger*, when utilised within the technological infrastructure parameters of the US.

Objective 10: To document findings regarding general limitations of the respective software applications when utilised within the current technological infrastructure of the US. Sub-objectives include:

- Objective 10 (a): To document findings regarding the general limitations of the *NetMeeting* when utilised within the current technological infrastructure of the US.
- Objective 10 (b): To document findings regarding the general limitations of the *Yahoo Messenger* when utilised within the current technological infrastructure of the US.

Goal 4: Investigation into the value of the VIS environment

Objective 11: To conceptualise the value added to information sharing and knowledge creation through the use of the software applications *NetMeeting* and *Yahoo Messenger* within the information sharing context at the US.

1.4 OUTLINE OF THE THESIS BY CHAPTER

The purpose of chapter one of this thesis, is to present a reasoned explanation of the necessity and significance of the research. A background to the study, as it pertains to the world trends and relevance in the specific context, as well as the purpose of the study and research goals, are discussed.

Chapters two and three present the literature review which is based on the fundamental concepts of this study. Chapter two provides an in-depth review of the present challenges and trends regarding information sharing and learning communities in cyberspace – viewed as relevant to the higher education perspective. Important terminology related to the computer-mediated communication environment is clarified. An integrated view of the value of the VIS project, and specifically this study, for the US is presented. For this purpose, a conceptual link is made between the relevant concepts of flexible learning, knowledge management and communities of practice and the role they fulfil in the creation of the value of the VIS environment at the US.

Chapter three describes the concept of usability through the presentation of a thorough theoretical background on important issues pertaining to usability. Amongst others, a discussion on the determinants of usability and different usability attributes is included. A context specific view of the concept of usability as is applied within this study is provided.

Chapter four is focused on a discussion of the research methodology and the specific research goals and objectives. The measurement instruments are described. Chapter five provides a discussion of the research findings, whilst chapter six presents concluding remarks and further recommendations.

CHAPTER TWO: LEARNING COMMUNITIES AND INFORMATION SHARING IN CYBERSPACE, TRENDS AND CHALLENGES IN HIGHER EDUCATION

2.1 INTRODUCTION

> "Imagine yourself having an evening conversation with a student in which you and he/she are each chatting over a computer linkup. You are both in your respective homes. You see and hear one another. You share a whiteboard on which both of you can see changes made by the other. This rather personalized interaction, not particularly bound in time or place, is now possible and is becoming commonplace"
>
> (Brooks, 1997, p.28).

The world is changing. The Internet has brought about changes in the way in which communication is conducted and viewed. Education is the practice of a kind of communication, thus changes in communication imply changes in education.

The 1990's saw the rise of the "information age" or the "information superhighway", sometimes called the *Global Information Infrastructure*. These terms refer to instantaneous and global communication via optical fiber-wired communication networks (Naudé, 2001). In simple language, this means that it is now possible to communicate with virtually anyone around the world via a personal computer that is linked to the communication network, called the Internet. More recently, the rapid growth of the Internet has resulted in enthusiastic claims for technology's ability to provide high quality education for all (Alexander & Boud, 2001).

The focus of this chapter is to explore the issues and challenges related to the creation of an integrative virtual environment, through which the researcher, student, lecturer and information service supplier can interact, in ways similar to the scenario described above. The nature of the relationship between these role-players continues to change as developments in technology allow them not only to communicate in various ways, but also to access and generate a wide range of resources. Thus, the web-based delivery format chosen, influences the way in which information can be represented, accessed, and manipulated by the lecturer, student, researcher and information service supplier (for both on-campus and off-campus application), and requires careful investigation in order to apply the best suited technology solutions for each group's unique needs.

First of all, an overview of current developments in higher education is discussed with the aim to describe the changing context of higher education at present. The notion of education and information sharing in cyberspace, with a particular focus on virtual learning environments, virtual communities and virtual universities and classrooms is presented. The next section aims to clarify concepts related to technologies that are used to conduct education and information sharing in cyberspace. The concept of computer-mediated communication (CMC) as applied within collaborative learning environments, with a specific emphasis on the new paradigm of education (constructivism) that these technologies afford, is discussed. Subsequently, the concepts related to CMC media needs to be clarified. This is done, with a specific focus on the media applicable to this study. Lastly, the proposed value of the VIS environment is discussed. This is done by presenting an integrated discussion of the concepts of flexible learning, knowledge management (KM) and communities of practice (COP) as proposed catalysts of the value of virtual information sharing and learning, within the context of the US.

2.2 THE CHANGING CONTEXT: IMPLICATIONS FOR HIGHER EDUCATION

Today's academic institutions are in transition and are faced with a number of important challenges. Educational institutions everywhere are suffering increasing fiscal constraints, facing a need and growing pressure to make better use of resources through collaboration between departments, faculties and even institutions (Lindsay & Grant, 1998). As Palloff and Pratt (1999, p.4) point out, "...universities are feeling the pressure to control costs, improve quality, focus directly on customer needs, and respond to competitive pressures."

In addition, it is clear that global economic markets are changing rapidly and there are very specific skills and information needs that must be addressed. In this sense, higher education institutions are facing pressures both from within and externally to adapt to the requirements of a different role in global society.

These demands place higher education institutions in a challenging position. To a certain extent, they are forced to explore new delivery modes that accommodate learner needs in the global village (Heydenrych, 2002). One particular challenge is that of meeting the educational and training needs of an increasingly diverse student population, whilst ensuring that the provision, integrity and quality of the educational experience is not diminished (Lander, Burns & Spence, 1999).

Kovel-Jarboe and Inglis (cited in Heydenrych, 2002, p.14) and Barcley (2001) identified the following factors that contribute to global change and therefore significantly impact higher education institutions in all areas. The factors include:

- Globalistion, which is leading to increased emphasis on internationalisation of curricula;
- Changing demographics deriving from longer lives, longer work days, larger urban areas and more diverse populations;
- Restructuring of employment, as future workers may have to contend with six or seven varying sequential careers;
- Accelerating technological change;
- Increased demand for educational institution accountability;
- Increasing sophistication of higher education consumers;
- Increasing interests in partnerships between business and education;
- Continuing growth of knowledge;
- New ideas about teaching and learning; and
- The growing interest in educational institutions as communities.

The question arise: how are universities responding to these changes and demands? Research has shown that institutions of higher education are, with increasing frequency, turning to the use of the Internet to deliver courses to students at a distance, as well as to enhance educational programs that are delivered on campus (Palloff & Pratt, 1999). According to Ryan et al. (2000), Internet-based communication and information technology is rapidly becoming an important part of the learning and teaching strategies of many universities.

Information technology, therefore, seems to display the potential to provide many opportunities for academic institutions to respond to the many changes and demands that they face. According to Horgan (cited in Palloff & Pratt, 1999, p.4), information technology has the capability to change the roles of students and faculties, facilitate more learner-centered, personalised education, to save money through improved business processes and distance education, and to expand the scope and content of the curriculum. In a case study by Lander et al. (1999), video conferencing was presented as one example of how a university could use information and communication technologies to meet the various challenges facing higher education institutions. It offers, for example, the potential to reach a wider audience, to make use of scarce expertise, to reduce the time spent on travel and accommodation and enhance communication channels between remote groups of learners and their tutors.

As all academic institutions are forced to contend with unprecedented change driven by globalisation of business and education, Palloff and Pratt (1999, p.16) highlight perhaps the greatest challenge of all, "we have not yet begin to tap the power and potential of technology in the educational arena."

2.3 EDUCATION AND INFORMATION SHARING IN CYBERSPACE

2.3.1 Introduction

The recent technological developments and the possibilities that they offer provide useful tools in the introduction of educational innovations. Barajas and Owen (2000) propose, in the same way as Palloff and Pratt above, that implementation of technology in educational environments and in the learning process, poses a real challenge for the education or training institutions undertaking it. With the implementation of technology in the educational arena, different virtual environments have emerged. The following section will give a broad overview of various alternative virtual learning and information sharing environments, formed through several technological configurations.

2.3.2 Virtual Learning Environments

The term 'cyberspace' refers to any form of online communication in the web of computer networks across the globe. It is similar to what is sometimes described as 'virtual reality' – the experience of a quasi-reality in the world of computer-mediated communication (Naudé, 2001). Virtual reality is defined as a cognitive valid computer-generated environment, in which a participant is able to sense and experience and is stimulated to think (De Jager, 2002). Virtual reality seeks to create the effect of actually being inside a simulated reality (Tiffin & Rajasingham, 1995).

Virtual learning environments have long been written about, but it is only with the recent advances in communication technologies that they are becoming a reality (Ryan et al., 2000). Stephenson (2001, p.57) described virtual learning environments as, "Learning management software systems that synthesise the functionality of computer-mediated communications software and online methods of delivering course materials." Barajas and Owen (2000) emphasised the fact that virtual learning environments have first and foremost to be considered as learning environments. The 'learning' aspect drives the activity; virtuality rather refers to the technology that is incorporated in order to support learning. They define virtual learning environments as any combination of distance and face-to-face interactions, where some form of time and space virtuality are present.

A virtual learning environment requires the implementation of powerful and readily accessible computing and network technology, with effective communications software and systems (American Association of Collegiate Registrars and Admissions Officers Policy Summit, 1998. p.115). Although these requirements have to be met for successful implementation of a virtual learning environment, Haddad (2002) warns that they should not become the focus. Virtual education is not about technology - it is about education. Therefore, opting for a virtual e-learning mode does not provide a shortcut around the necessary elements that make any education relevant, responsive and effective. In the planning for virtual education, the temptation is to focus on the technologies and to ignore the important educational policy and strategy issues.

2.3.3 Virtual Communities

Cyberspace is a social space where users interact with one another. Communication here fosters a sense of community and thus generates what is known as a virtual community. The virtual learning community is the vehicle through which learning occurs online. In an attempt to define the concept of a virtual community, Rheingold (cited in Palloff & Pratt, 1999, p.21) provides a rather simplistic look at this developing concept. His reasoning is as follows, "computer, modems, and communication networks furnish the technological infrastructure of computer-mediated communication; cyberspace is the conceptual space where words and human relationships, data and wealth and power are manifested by people using computer-mediated communication technology and virtual communities are cultural aggregations that emerge when people bump into each other often enough in cyberspace."

Communities today are formed around issues of identity and shared values; they are not place-based (Palloff & Pratt, 1999). Education is not a location anymore, but a teaching and learning activity that can take place in different context, locations and times for different objectives, clienteles and occasions (Haddad, 2002). The functionality of virtual learning communities thus meets this challenge by providing a platform for collaborative learning to take place, regardless of time and place. The virtual learning community has an extremely important element that sets computer-mediated learning apart from the traditional classroom setting. The key to the learning process is the interactions among students themselves, the interactions between faculty and students, and the collaboration in learning that results from these interactions. In other words, the formation of a learning community through which knowledge is imparted and meaning is co-created - sets the stage for successful learning outcomes (Palloff & Pratt, 1999).

More and more higher education institutions are beginning to acknowledge that knowledge building is the result of a process of construction from many sources. The learner should no longer receive information, but construct knowledge and thus universities can no longer claim to be the ultimate source of knowledge and remain with a content transmission approach (Heydenrych, 2002). Campuses are working to develop learning communities because of the power they hold in facilitating a culture of lifelong learning. In the online classroom, it is the relationships and interactions among people through which knowledge is primarily generated. The online learning community takes on new proportions in this environment and consequently must be nurtured and developed so as to be an effective vehicle for education (Fleming, cited in Palloff & Pratt, 1999, p.15).

Traditional Multi-User Dimensions (MUDs) and Object Orientated Multi-user Dimensions (MOOs) are two types of 'formalised' virtual communities that have immense potential within the educational environment. MUDs are synchronous text-based virtual reality environments on the Internet (Ryan et al., 2000). Instead of using sophisticated tools to see, touch and hear the virtual environment, users of the MUD systems are presented with textual descriptions of virtual locations. Technically, a MUD software program consists of a database of 'rooms', 'exits' and other objects. The program accepts connections from users on a computer network, and provides each user with access to the database. Within each of these systems users can interact with each other and with the virtual environment that the MUD presents to them (Reid, cited in Sempsey, 1995, p.3). A MUD thus creates a space where people can meet and collaborate on various projects (Evard, 1993).

A MOO is a MUD built on object-orientated principles (Ryan et al., 2000). A MOO offers a set of tools that can be used to create a socio-cultural environment, thus allowing the depiction of a virtual environment that can be laden with cultural and communicative meaning. MOOs have, according to Ryan et al. (2000), immense potential for use in educational environments where there is a need for virtual 'face-to-face' communication. An example of a MOO being used in an educational environment, is the *BioMOO* used as a part of an online course offered by Birkbeck College, University of London. Another example is the *LinguaMOO* of the University of Texas that was specifically founded and aimed at exploring the advantages and opportunities of MOO technology in education and research.

"When we started *LinguaMOO*, we wanted to see whether or not a technology that had been developed for gaming and social interaction could in fact also prove viable for 'serious' online teaching and research" (Hayes & Holmevik, 2000, p.1). As the design and building of the *LinguaMOO* system began, the following set of key objectives was identified. These can be considered to be generic objectives applicable to the creation of any similar type of virtual learning environment. They include:

- the system should be geared towards the facilitation of collaboration;
- encouraging of communication;
- the stimulation of students' interest in reading and writing;
- the system must be easily and globally accessible; and
- fun to work in.

About the sufficiency of the MOO to reach the above mentioned goals, Hayes and Holmevik (2000, p.2) noted that, "MOO technology proved to be ideally suited to fulfil these goals. The research project started in 1995 and by 1997 it was evident that the MOO held a much greater potential for learning than most people had anticipated". The researchers continued to provide the following remarks regarding the MOO technology as applied within the education and research context (Hayes & Holmevik, 2000):

- The spatial orientation provided by such concepts as rooms and locations, exits and entrances, objects and players proved to reinforce the sense of space, place and time which the online learning experience is situated. Because these are concepts that we all know well from the physical world, they also eased the transition form the physical to the digital learning environment by giving students known concepts and cues with which to navigate, negotiate, and domesticate the space;

- The MOO system provides simple but effective tools for extending and decorating new spaces, and by doing this, students domesticated their learning environment by investing in it;
- The very reasonable technical requirements for accessing and using the MOO system made it possible for anyone with an Internet connection, regardless of the computer platform to be able to access the system and use it productively.

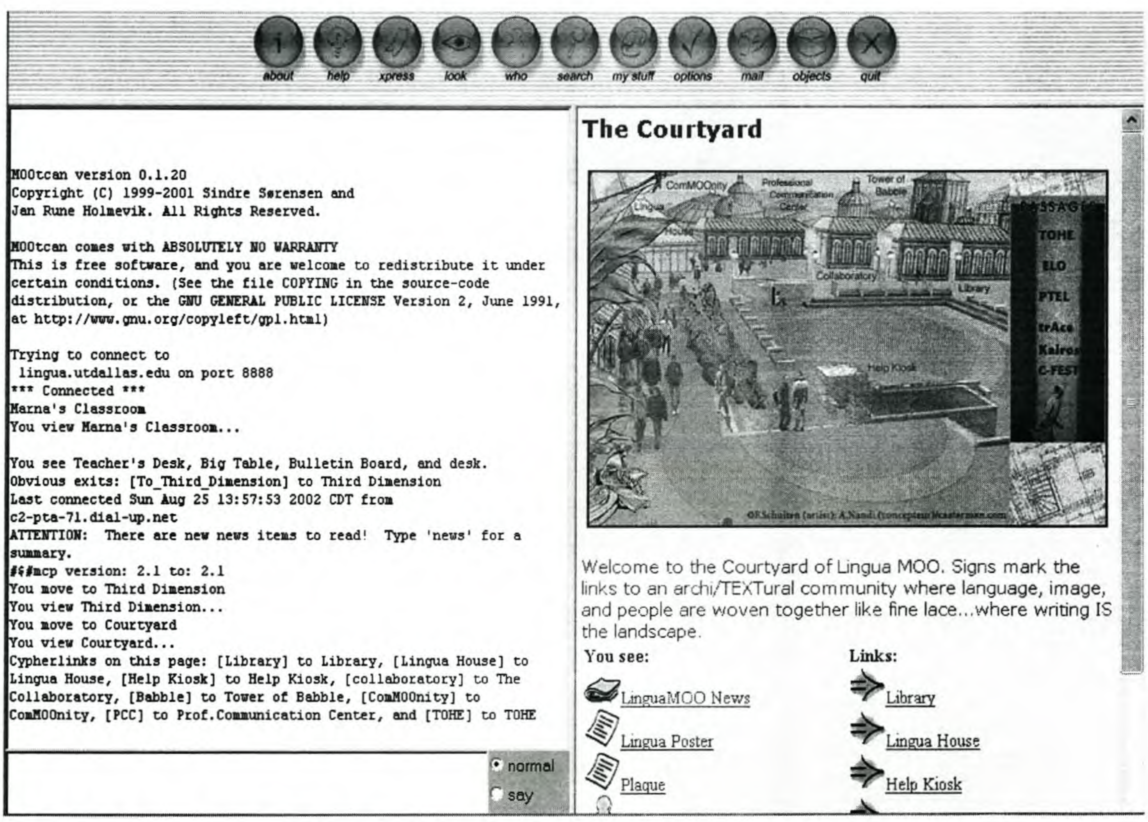


Figure 2.1: Screen capture of the courtyard at *LinguaMOO*, the University of Texas' MOO.

2.3.4 Virtual Universities

New technologies are transforming the way knowledge is packaged, delivered, accessed and acquired, and is most certainly altering higher education's core production and delivery processes. The term "virtual university" is currently being used widely, with its suggestion of a university in cyberspace offering courses to remote students working from home or work. A virtual education institution can be defined, according to Ryan et al. (2000), as an institution which is involved as a direct provider of learning opportunities to students, using information and communication technologies to deliver its programmes and courses and provide tuition support. Such institutions are also likely to be using information and communication technologies for such core activities as administration, materials development, delivery and tuition, career counseling, prior learning assessment and examinations.

2.3.5 Virtual Classroom

Virtual Classrooms use web-based collaboration tools that mimic the structure and activity of a physical classroom course. Successful virtual classroom courses usually depend more on human interaction than on technological infrastructure (Horton, 2000). A combination of synchronous and asynchronous computer-mediated communication technologies has been used in another model that is emerging for the creation of a 'virtual classroom'. Groups of learners physically get together and meet in local centres with facilities such as video-conferencing to interact in real time with a wider 'virtual' learning community. This community could be national or international. This is supplemented by interaction using computer conferencing for asynchronous communication (Ryan et al., 2000).

2.4 COMPUTER-MEDIATED COMMUNICATION FOR COLLABORATIVE LEARNING: IMPORTANT CONCEPTS

2.4.1 Computer-Mediated Communication (CMC)

2.4.1.1 Introduction

The nature of information and communication technologies is changing. As have already been established, these new technologies have immense potential to change the nature of collaborative learning at higher education institutions. Recent growth in telecommunications has led to the use of online services, electronic networks, and the World Wide Web, readily accessible to homes, schools and businesses (Tam, 2000). Telecommunications include e-mail and Internet access. E-mail makes online discussion groups, student-to-student projects and class-to-class projects possible. In addition, the Internet provides many resources, including text, pictures, video, sound, and downloadable software, and is an endless source of activities and information.

2.4.1.2 Computer-Mediated Communication defined

In light of the developments mentioned above, computer-mediated communication (CMC) defines the ways in which telecommunications technologies have converged with computers and digital networks to create a new set of tools to support human communication (Hildreth, Kimble & Wright, 1998; Ryan et al., 2000). Khan (1997) states that CMC is a much broader concept than 'computer conferencing'. It includes any form of organised interaction between people, utilising computers or computer networks as the medium of communication. It has been established that the Internet's greatest potential for education is in its capacity to bring people separated by space and time together online and to give them access to learning resources from around the world. This form of communication mediated by the computer offers great opportunities for interaction that is essential to the learning process (Ryan et al., 2000).

The potential of CMC technologies thus lays in its ability to function as a gateway; a gateway to resources, collaborative learning and individual achievement (Palloff & Pratt, 1999). As Tam (2000, p.57) points out,

"...telecommunication technologies easily lend themselves to constructivist principles by providing students with opportunities to communicate with people all over the world, conduct research, discuss issues and work cooperatively. The advent of CMC has permitted learners to benefit from the shared experience of a group engaged in the same study and the opportunity to measure his or her ideas against those of others in the group. By way of CMC, the teaching and learning styles of both instructors and learners are transformed from information dissemination to critical inquiry and from instructor dominated to collaborative learning."

2.4.1.3 New educational paradigm required by CMC

"Those things for which the most money is demanded are never the things that the student most wants. Tuition, for instance, is an important item in the term bill - while for the far more valuable education, which he gets by associating with the most cultivated of his contemporaries, no charge is made"

(Horton, 2000 p.342).

CMC courses and programmes are appearing rapidly. Consequently, this requires a new paradigm of education suitably facilitated through CMC media. Mayes (cited in Stephenson, 2001, p.16) supports this view by stating that before a new educational technology is adopted, the underlying pedagogical basis should be clarified.

According to Tam (2000), CMC has the potential to support the new educational paradigm, 'knowledge as construction'. Firstly, because of its versatility and accessibility its use in education may help to shift the focus from knowledge-as-possession to knowledge-as-construction, and from learning as outside-guided to learning as self-guided. Secondly, learning is increasingly being viewed as a personal, as well as social activity (Palloff & Pratt, 1999). The penetration of technology into the learning process thus has profound consequences for how learning takes place socially. The technology allows for much more diversified and socially rich learning contexts, i.e. peer tutoring via computer, computer networks, e-mail and telecommunications.

Tam (2000) holds that it is no coincidence that these shifts, implied by CMC technologies, happen to be highly congruent with the constructivist principles of learning and teaching. Constructivism and computing technology, separately and often together, have redefined the challenges of learning and have brought about new learning possibilities for almost all teaching and learning situations.

2.4.2 Constructivism

2.4.2.1 Introduction

> "Constructivism is a fundamental departure in thought about the nature of knowing, hence of learning and thus of teaching"
>
> (Tam, 2000, p.51).

The constructivist learning experience can be described as one in which the learner is building an internal representation of knowledge, a personal interpretation of experience. This representation is constantly open to change, its structures and linkages forming the foundation to which other structures are attached (Heydenrych, 2002). The constructivist perspective thus describes learning as, "a change of meaning constructed from experience" (Tam, 2000, p.51).

A basic concept is that people are active learners and must construct knowledge for themselves (Barclay, 2001). Education and instruction should thus then provide learners with a collaborative situation in which they have both the means and the opportunity to construct new and situationally-specific understandings by assembling prior knowledge from diverse sources (Ertmer & Newby, cited in Moallem, 2001, p.117).

It has already been established that CMC technologies provide learners with the capability to 'talk' to one another through text, audio and video communication over the Internet. CMC technologies thus offer new methodologies for supporting the constructivist learning experience, especially in important aspects such as:

- frequent contact between students and lecturers / tutors in and out of class to encourage student motivation and involvement;
- cooperation and collaboration to enhance learning – sharing and discussing ideas deepens understanding and teamwork can increase involvement in learning;
- talking about, reflecting on, and applying their learning facilitates students' active engagement in learning, which enables them to make what they learn a part of them;
- continuous feedback to enable students to reflect on what they have learnt and know and what they still need to know;
- diverse learning experiences – different students bring different talents and learning styles to learning, which add to the richness of the learning process (Ryan et al., 2000).

2.4.2.2 Principles of the constructivist educational paradigm

Various researchers have made an effort to demonstrate how constructivist values might influence instructional design. Jonassen's "Constructivist Learning Environment" model is widely used to design and develop instruction for a computer-based learning environment (Moallem, 2001). In his model, Jonassen lists a number of design principles that can be used to develop what he calls the "constructivist-learning environment". These design principles are as follows:

- Create real world environments that employ the context in which learning is relevant;

- Focus on realistic approaches to solving real-world problems;
- The instructor is a coach and analyzer of the strategies used to solve these problems;
- Stress conceptual interrelatedness, providing multiple representations or perspectives on the content;
- Instructional goals and objectives should be negotiated and not imposed;
- Evaluation should serve as a self-analysis tool;
- Provide tools and environments that help learners interpret the multiple perspectives of the world, and
- Learning should be internally controlled and mediated by the learner.

In incorporating these principles into the online learning environment, an authentic learning environment is created which is based on constructivist principles that facilitate a process of knowledge creation and sharing.

2.4.2.3 Information sharing and knowledge creation in the constructivist environment: VIS project application

The aim of the this study was to investigate certain challenges related to the creation of a shared virtual space through the use of synchronous CMC technologies based on sound constructivist principles. The purpose of the shared space will be to facilitate increased information sharing between role-players (students, lecturers, researchers and information service suppliers). In essence, these information sharing processes should contribute to increased knowledge creation and sharing – an process of utmost importance to higher education institutions. As Heydenrych (2002, p.15) points out, "…universities can no longer claim to be the ultimate source of knowledge and remain with a content transmission approach. Knowledge building is the result of a process of construction from many sources."

Knowledge represents itself in two forms: tacit and explicit knowledge. Stenmark (2000) suggests that tacit knowledge can best be defined as knowledge that cannot be easily articulated and thus only exists in people's hands, minds and manifest itself through their actions. Marwick, (2001, p.814) elaborates further on the concept and describes tacit knowledge as, "knowledge that is derived from experience and embodies beliefs and values. Tacit knowledge is best described as 'actionable knowledge', and is therefore most valuable." Explicit knowledge, however, is represented by some artifact, such as a document or a video, which has typically been created with the goal of communicating with another person (Marwick, 2001).

It has been established that knowledge building entails a process of construction. This process of construction, defined within the parameters of tacit and explicit knowledge, is described by Nonaka (cited in Marwick, 2001, p.814) when he states that, "...the key to knowledge creation lies in the mobilisation and conversion of tacit knowledge". Thus, the conversion of tacit to explicit knowledge encapsulates a process of forming a shared mental model, which is then articulated through dialogue. CMC technology collaboration systems, that the VIS aims to provide, support this kind of interaction. Tam (2000) supports this view, by stating that a central strategy for building constructivist-learning environments is to create a collaborative learning environment. In this sense, collaborative learning does not just entail sharing a workload or coming to consensus, but rather allows learners to develop, compare and understand multiple perspectives on an issue. In essence, it is the rigorous process of developing and evaluating the arguments – the 'dialogue' that Nonaka refers to - that is the goal of collaborative learning and knowledge building.

Along the same line of argument, Jonassen, McAleese and Duffy (cited in Moallem, 2001, p.117) proposed the Continuum of

Knowledge Acquisition Model (figure 2.2), in which they identified three approaches of learning and matched them with what they believe to be appropriate learning theory approaches. They described a continuum of knowledge acquisition that leads from ignorance to expertise. The learning phases that characterize the knowledge growth are introductory, advanced and expert. Introductory learning occurs when learners have very little directly transferable prior knowledge about a skill or content area. In the second phase of knowledge building, learners acquire more advanced knowledge to solve more complex, domain specific problems.

Expertise is the final phase where learners usually assume extensive experience that can be transferred from previous phases of learning, and learners require very little guidance in learning the new content. The assumption is that initial knowledge acquisition is better served by instructional techniques that are based upon traditional instructional design models whereas constructivist-learning environments are most effective for advanced knowledge acquisition stages of learning.

When considering this model (figure 2.2), the creation and use of a virtual information space designed according to constructivist principles for post-graduate level students at the US becomes significant. The significance is mainly embedded in the VIS' ability to create opportunities for knowledge construction and thus the sharing of tacit knowledge – activities to be supported by the CMC media (i.e. video and audio conferencing) which facilitate the creation of the virtual information space.

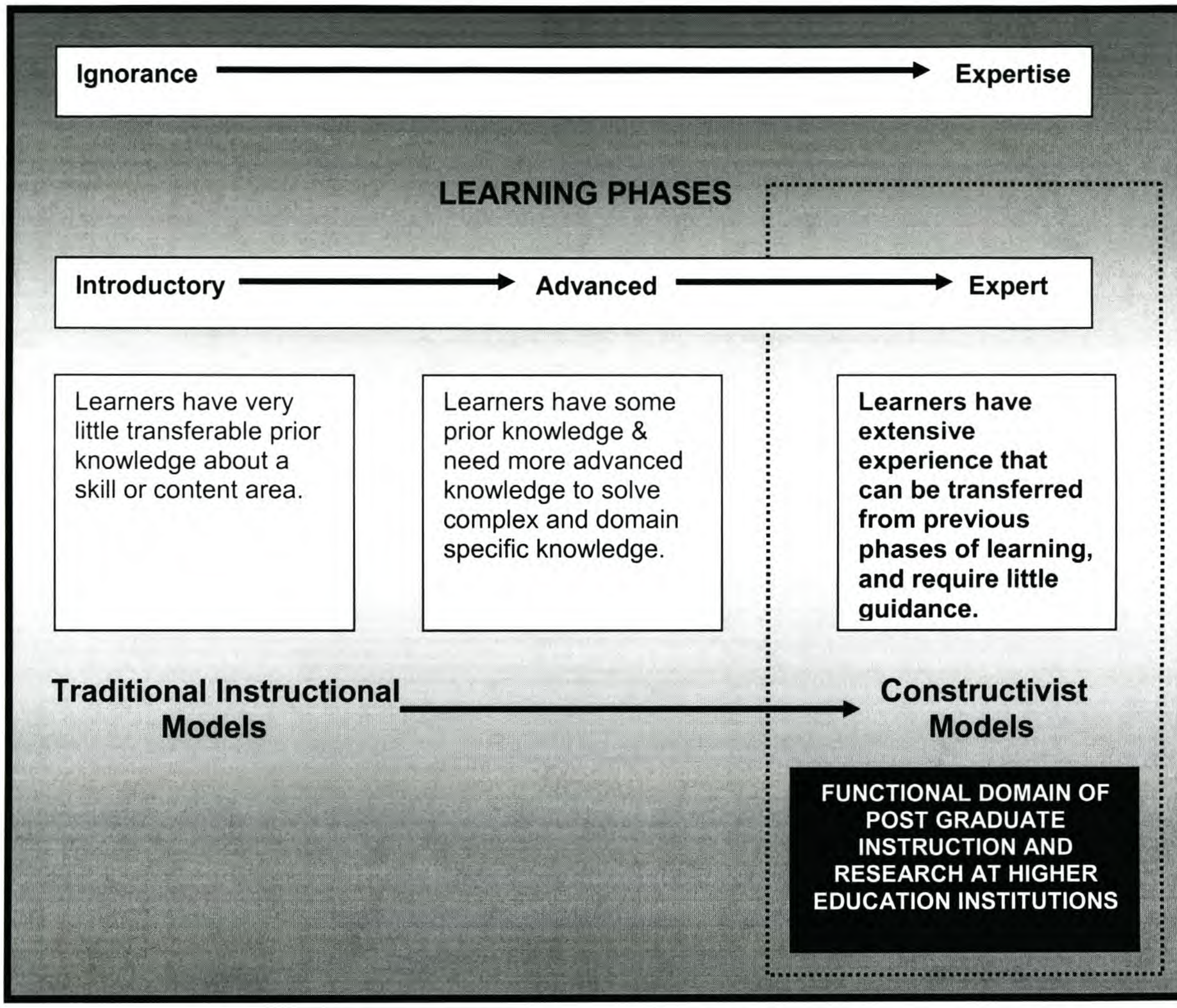


Figure 2.2: The Continuum of Knowledge Acquisition Model (adapted from Jonassen, McAleese & Duffy; cited in Moallem, 2001, p.117).

2.5 COMPUTER-MEDIATED COMMUNICATION (CMC) MEDIA

2.5.1 Introduction

In order for CMC to take place, certain CMC media need to be utilised. CMC media (also referred to as tools or instruments) refer to the technologies that have converged with computers and digital networks to support technology-based human communication.

Haddad (2002, p.5) states that learners in a virtual system need a new set of learning tools. They need to know how to use the technologies, how to manipulate the applications, how to access information and how to assess and assimilate information. Likewise, Scardamalia et al. (cited in Tam 2000, p.56) provide a similar, but somewhat challenging view on the importance of CMC tools. According to the authors it is important that computer-supported constructivist environments should not involve the knowledge and intelligence to guide and structure learning processes, but should rather create situations and offer tools that stimulate students to make maximum use of their own cognitive potential. For the purpose of this study the following concepts related to CMC media will be clarified.

2.5.2 Communication Modes

According to Benbunan-Fich and Hiltz (1999), computer-mediated communication tools allow for interactions to occur at the same time (synchronous) or at different times (asynchronous). Likewise, these tools also allow people to meet at the same place (proximate) or in different places (dispersed). Synchronous activities are sometimes also called real-time or live events. Such events include chat and whiteboard sessions, screen-sharing and videoconferences. Asynchronous activities, on the other hand, are ones that participants can experience whenever they want. Permanently posted web pages and e-mail are clearly asynchronous, because learners can read them at any time (Horton, 2001).

Morris and Organ (cited in Naudé, 2001, p.38) argue that the Internet can be studied as a communication medium that represents a continuum of communication levels. They identify the following categories of communication on this continuum, as well as provide examples of tools that facilitate communication at each point on the continuum:

- one-to-one asynchronous communication, such as electronic mail;
- many-to-many asynchronous communication, such as electronic bulletin boards, and listservs;
- synchronous communication that can be one-to-one, one-to few, or one-to-many and that can be organized around a topic, the construction of an object, or role playing, such as MUDs (Multi-User Dungeons and their various transformations in virtual reality such as

MOOs), Internet Relay Chat (IRC), and chat rooms on commercial services; and

- asynchronous communication characterized by the receiver's need to seek out a web site to access information, which may involve many-to-many, one-to-one, or one-to-many source-receiver relationships (for example websites).

These different levels of communication illustrate that the Internet represents an immense combination of opportunities for interpersonal (or point-to-point) communication, group communication, organisational communication and mass communication.

To clarify the different factors that would most likely influence a decision made on the CMC media used within an environment-specific application (i.e. web-based training course, virtual classroom), the following classification (figure 2.3) is presented. To this end, the following three parameters should be taken into account: the time at which learning and information sharing will take place, the place where learning and information sharing for each person involved will take place, as well as the number of participants involved in the learning and information sharing process.

2.5.3 Synchronous vs. Asynchronous Communication Modes

There is no doubt that technology support for collaborative working and learning should support both synchronous and asynchronous communication as these communication modes clearly have distinct goals. Mulder, Swaak and Kessels (2002, p.36) briefly clarified these 'goals' when they stated that, "…synchronous settings are more suited for reaching a shared understanding (convergence), whereas asynchronous settings are better for exchanging information (conveyance)."

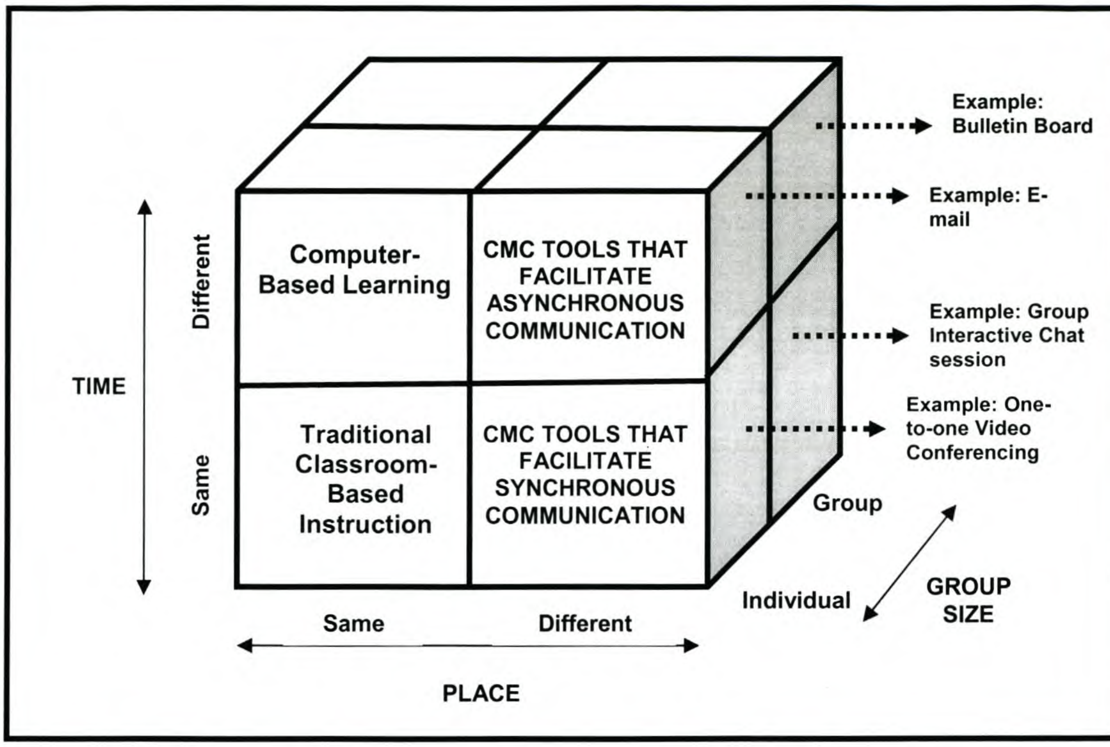


Figure 2.3: Classification of time, place and group size parameters to clarify instances when asynchronous and synchronous CMC media are applicable (adapted from Khan, 1997, p.24).

With the development of the Internet the edges of the synchronicity continuum are stretched (Naudé, 2001). Until recently, most collaborative technology has supported either synchronous or asynchronous interaction. Fortunately, developments in technology are moving in the direction of better integration of synchronous and asynchronous tools, trying to solve problems concerning the switching between these communication modes (Mulder et al., 2002). Tam (2000) states that research should be conducted to further exploit the potentials and capabilities of information technologies to foster two-way, interactive communication and collaboration (synchronous communication) between the instructor and learners and among the learners themselves. Barcley (2001) holds a similar view in this regard. She maintains that the specifics of online learning interaction is an issue often neglected in the rush to embrace the Internet for learning, and therefore proposes that improving upon currently available communication tools is imperative if the online learning experience is to become a serious proposition.

2.5.4 Video Conferencing

2.5.4.1 Introduction

One of the key focus areas of this study was to investigate the feasibility and usability of desktop-based video conferencing systems, *NetMeeting* and *Yahoo Messenger*, which mainly supports synchronous CMC media (e.g. whiteboard or audio conferencing). These video conferencing systems constitute the supporting technological systems that are necessary for the creation of the VIS. The following section provides an overview of the use of video conferencing systems in the higher education context, with a specific focus on research that has been conducted in this regard.

2.5.4.2 Defining video conferencing

Palloff and Pratt (1999, p.39) described video conferencing as, "...conducting a conference between two or more computers at different locations by the use of networks to transmit and receive audio and video data." Video conferencing thus facilitates two-way audio and video communication in real time, allowing individuals or groups of participants in different locations to hold interactive conversations (Ryan et al., 2000). It can also facilitate collaborative work, since the system enables participants to meet across several sites, exchanging data together on screen and discussing ideas whilst viewing the same documents (Gornall, Pengelly & Shearn; 1999). Videoconferencing covers a wide range of applications using a variety of hardware, software and network facilities, including the person-to-person videophone, desktop videoconferencing systems and sophisticated studio-based systems (Ryan et al., 2000).

The latest trend in video conferencing is desktop video conferencing, where audio and video interaction is executed by means of multimedia desktop computers. Desktop systems are often distinguished from 'room-based' video conferencing systems, as implying a difference between personal, office-based equipment that is PC-based and room-based facilities, which have many users and have to be scheduled and booked in advance. Desktop-based systems, i.e. *NetMeeting*, eliminate some of the problems of room-based systems, such as scheduling problems and the need for special rooms. In addition, the desktop conferencing system can be integrated into the familiar computer environment and support data sharing and desktop applications (Patrick, 1999). Gornall et al. (1999) maintain that the advantage of room-based systems is that they usually have a more 'studio' like environment with higher quality equipment. On the other hand, such a room, unlike the desktop-based system, would not be so multipurpose – which would imply that what is gained in quality may be lost in flexibility and range of functionality.

A typical desktop-based video conferencing application digitises images and sounds at one site, encodes them into a standard format, and transmits the resulting data over a network connection. At the receiving site data it is collected, decoded, and presented to the user. The multimedia data produced during video conferencing is very bandwidth demanding. Audio encoding schemes typically require 71 Kb/s, while low quality (2-5 frames per second) video requires 128 Kb/s (Patrick, 1999). All desktop-based video conferencing systems have five basic components – cameras that capture the images, microphones that capture the sound, a device known as a 'codec' (Compressor / DECompressor) which compresses and decompresses the audio and video signal for transmission over the network, a monitor for viewing participants, and loud-speakers to hear the participants (Ryan et al., 2000).

For the purpose of this study, the term video conferencing will be used to denote a desktop-based video conferencing system

(*NetMeeting* or *Yahoo Messenger*), used to facilitate synchronous audio and video exchange, as well as data collaboration mechanisms (program sharing, file transfer and whiteboard).

2.5.4.3 Benefits and applications of video conferencing

Cunningham (cited in Gornall et al., 1999) has set out the various approaches in which video conferencing is generally used within the educational environment. They include:

- one-to-one (point-to-point) meetings that provides full two-way communication with audio, video and data collaboration functionalities like file sharing and the interactive whiteboard;
- many-to-many conferencing (multi-point communication). Some systems show only one site on screen at the time – the camera switching is voice activated so the current speaker is displayed. Continuous presence software allows all sites to be seen co-present on each screen up to a limit often of 4-5 participants. Participants may also join in on audio only; and
- one-to-many communications, such as the use of video conferencing to 'broadcast' a talk or presentation from a main site to other sites.

Within the VIS environment, video conferencing will be focused on one-to-one and many-to-many (group) sessions, with the aim of facilitating increased information sharing.

According to Patrick (1999), recent research on the role of video in video conferencing has revealed some positive effects of the video channel, but these effects are often subtle and indirect. "Video can give a sense of presence that is not available with audio alone and seeing a speaker allows for nonverbal forms of communication, including expressions and gestures, that can be very important for effective interaction" (Patrick, 1999, p.19).

Furthermore, Gornall et al. (1999) and Lander et al. (1999) propose that video conferencing has several strong positive and practical features that include:

- bringing participants together in a real-time face-to-face situation, making remote communication more personal (unlike e-mail);
- saving time, hassle and travel costs, making remote communication potentially cheaper; and
- with desktop video conferencing, work applications can be used interactively, files exchanged, stored, modified and transferred, making remote communication more productive.

2.5.4.4 Constraints with the use of video conferencing

Lindsay and Grant (1998) summarise the most common problems encountered with the use of desktop-based video conferencing under the following two headings:

- *Lack of network bandwidth* – this inevitably causes degradation of image and audio quality, often to the extent of masking the message being presented. It is the lack of network bandwidth that currently represents the largest barrier to progress in this field; and
- *Lack of familiarity with the medium* - resulting in the user focusing on the technology itself, rather than its application.

Ryan et al. (2000) and Brooks (1997) place an emphasis on problems that typically occur due to insufficient bandwidth. During a video conferencing session, the audio and video are compressed for transmission and decompressed on arrival at the remote site. Compressing the information causes a very small time lag and reduction in the quality of the video and to a lesser extent the sound quality. The main factor, though, affecting the quality is the bandwidth of the network. The compression and decompression causes a loss of 'redundant' information that often translates to some loss of 'body language' and facial expressions. This can cause misunderstandings.

Although still in early phases, recent research has shown that the limitations imposed on video conferencing because of bandwidth can be overcome (Lindsay & Grant, 1998). Schnurr and Smith (cited in Lindsay & Grant, 1998, p.5) appropriately state that, "...the negative aspects of struggling with a limited technology base may outweigh the cognitive benefits of having visual communication."

2.5.4.5 Using video conferencing in the educational context

Video conferencing is a form of communication with great potential for learning in higher education. According to Coventry (undated), the potential of video conferencing lies in the greater opportunity for dialogue that it creates, which facilitates more effective learning than working in isolation. Dialogue may, for instance, be between lecturers, tutors or researchers and learners, or amongst learners themselves. However, the success of video conferencing may well be dependent on factors other than the technology. Institutional issues, costs, and the attitudes of users towards the technology, could all influence the success of the video conferencing system.

According to Ryan et al., (2000) video conferencing is becoming more widely available in higher education institutions. Gornall et al. (1999) found desktop-based video conferencing inexpensive and easy to use, and concluded that it helped them to explore the potential of improving educational access. Lindsay and Grant (1998) maintain, however, that to date video conferencing has not been fully exploited by higher education institutes. They conclude that reluctance to embrace this technology has perhaps been a result of its unreliability and poor visual/audio resolution caused by a lack of network bandwidth. However, with the advent of improved communications protocol and broad bandwidth networks the major drawbacks previously experienced may now be overcome.

Video conferencing is widely used in higher education to support many different activities that require real-time visual and audio communication between participants in different locations (Ryan et al., 2000). A survey conducted for *Toshiba* (cited in Gornall et al., 1999) found that many higher education institutions have been using video conferencing for some time. Some examples of the use of video conferencing in higher education include (Ryan et al., 2000; Gornall et al., 1999; Lander et al., 1999):

- to give remote learners the opportunity to participate in a 'traditional classroom', without having to travel between campuses, and to show them overhead slides, videotapes, computer application charts;
- to enable staff to teach students across the world remotely;
- to enable students and staff to interact with experts from related fields from all over the world, thus facilitating access to other sources of knowledge / expertise;
- to enable students to work with their peers, across the world;
- to enable students to participate in courses not offered at a particular campus;
- to support students on international exchange programmes by enabling staff to have regular meetings with the students; and
- to facilitate collaboration, information sharing and searching, problem-solving and decision making that involved people at various locations.

2.5.4.6 Technologies for video conferencing

More than two hundred desktop-based video conferencing solutions are currently available on the market (Gornall et al., 1999). Some popular Internet-based desktop video conferencing systems include White Pine's *CUSeeMe*, *RealVideo* by

Progressive Networks and Microsoft's *NetMeeting*. The quality, reliability, price and product compatibility of these systems can, however, vary widely (Ryan et al., 2000). Accessibility to these applications will however increase, as personal computers in the near future are likely to have video conferencing software built into them, with the only additional purchase to the system being the camera (webcam) on top (Gornall et al., 1999).

CUSeeMe, which was developed at Cornell University, was the first Internet desktop video conferencing system available (Ryan et al., 2000; Brooks, 1997). It is relatively cheap and has the significant advantage of being platform independent. Research has shown that *CUSeeMe* has, to date, facilitated much interaction and collaborative work between higher education academics (Gornall et al., 1999). The desktop video conferencing solutions chosen for utilisation within the VIS environment, are Microsoft's *NetMeeting* and *Yahoo Messenger*'s Instant messaging service. *Yahoo Messenger* is primarily an instant messaging service, but also incorporates video conferencing capabilities and will thus be referred to as a video conferencing system. For a detailed discussion on *NetMeeting* and *Yahoo Messenger*, refer to sections 2.5.5.3 (a) and (b) of this chapter.

2.5.4.7 Video conferencing and interactivity

New communication technology such as the Internet has one outstanding feature that the so-called "old media" (newspapers, television, radio) lacked to a large degree, namely interactivity. There are different definitions of interactivity, but the following definition makes the concept clear for initial understanding: Interactivity refers to the extent to which participants can participate in modifying the form and content of a mediated environment in real time. Face to face interpersonal communication has the highest level of interactivity, because the participants are in each other's presence and can react immediately to whatever the other one has said. Internet desktop-based video conferencing systems simulate the characteristics of interpersonal communication and make it possible to communicate on several levels: one-to-one, one-to-many and many-to-many (Naudé, 2001, p.7).

Gornall et al. (1999) maintain that the information society will change teaching methods, replacing excessively passive teacher/pupil relationships with a new interactive relationship. In accordance with these changes in recent years, there has been increasing interest in Vygotsky's theory of social cognitive development for instructional purposes. Vygotsky argued that instruction is most efficient when students engage in activities within a supportive learning environment and when they receive appropriate guidance that is mediated by tools. Tools in such an interaction can be defined as a mentor, peers, computers, printed materials, or any instrument that organises and provides information for the learner (Relan & Gillani, cited in Khan, 1997).

Ryan et al. (2000) propose that interactivity is the key to using videoconferencing effectively for teaching and learning. Video conferencing systems incorporate a selection of the tools as mentioned by Vygotsky, and thus provide a level of interaction that enhances the learning experience. Whilst there seems to be no doubt that video conferencing can add value to the learning process, Gornall et al. (1999) state that more needs to be learned about how real-time interaction, mediated through communication technology, is most useful to enhance learning, and how learners respond to this.

2.5.5 Contextualising CMC media within the VIS project Environment and this study

2.5.5.1 Introduction

One of the key focus areas of this study is to examine the usability of software applications *NetMeeting* and *Yahoo Messenger*. Both these applications are desktop-based video-conferencing facilities supporting the synchronous communication mode by accommodating CMC media that facilitate synchronous communication. The following section will focus on the clarification and description of the following concepts – communication mode, media and interface - within the context of the VIS project and specifically this study. The relationship between the three concepts is depicted in figure 2.4.

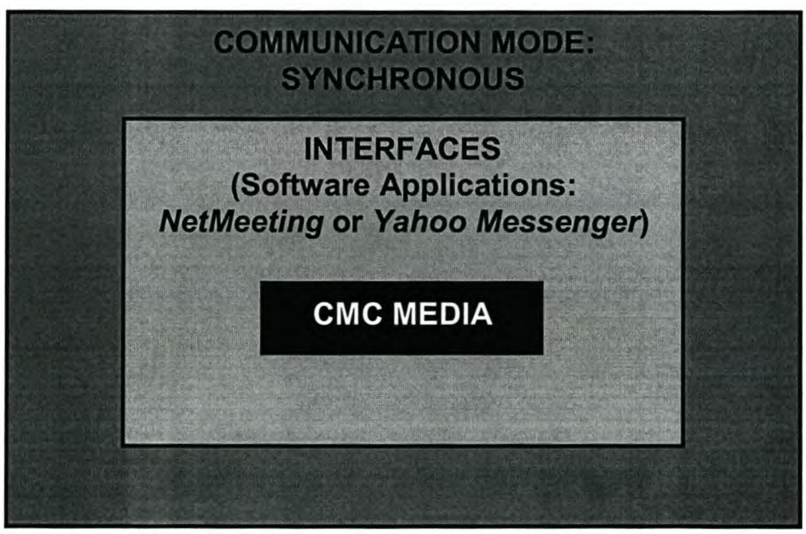


Figure 2.4: Relationship between Communication Mode, Interface (Software Application) and Media (CMC Tools) within the VIS Project Environment.

2.5.5.2 Communication mode

Within the Virtual Information Space environment, communication and collaboration will always be conducted in either a synchronous or asynchronous manner. This constitutes the communication mode that the specific interface (e.g. *NetMeeting*) supports. The communication mode thus refers to the way in which the communication is conducted. The focus of this study is the synchronous communication mode as supported by software applications *NetMeeting* and *Yahoo Messenger.* A description of the media that support the synchronous communication mode that is the focus of this study is portrayed in figure 2.5.

2.5.5.3 Media

Media is defined as the CMC tools or instruments that facilitate communication and collaboration in the Virtual Information Space environment. The media are embedded within a specific software application, as is depicted in figure 2.5. The media embedded within *NetMeeting* and *Yahoo Messenger* include interactive video and audio, interactive text (chat), the whiteboard function, program sharing and real-time file transfer function (see figures 2.5 & 2.6 for specific classifications). The following section provides a brief review of the different media.

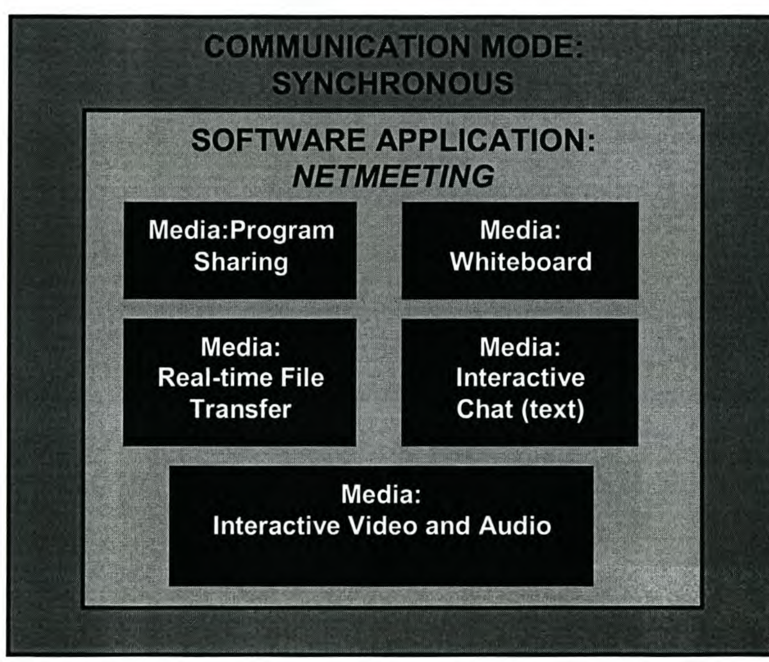


Figure 2.5: Media embedded in software application *NetMeeting*, supporting the synchronous communication mode.

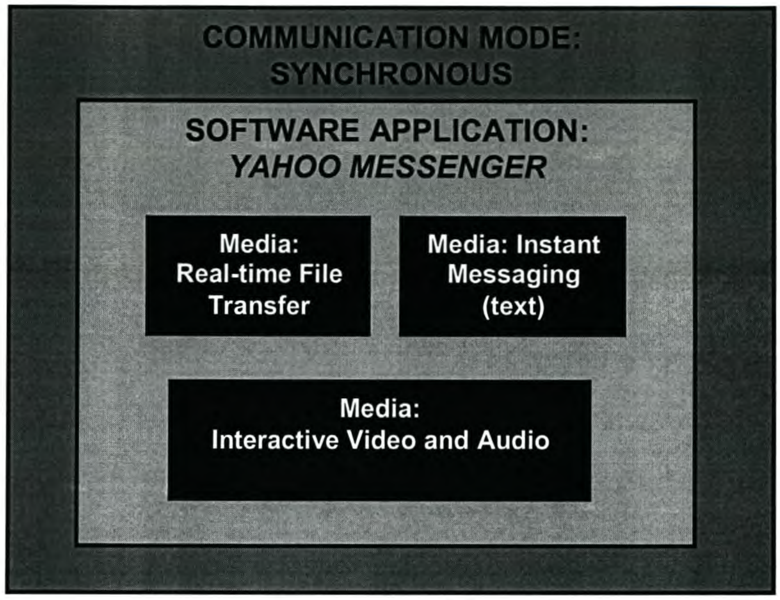


Figure 2.6: Media embedded in software application *Yahoo Messenger*, supporting the synchronous communication mode.

a. Interactive Video and Audio

Advances in digital compression technologies, the increases in bandwidth and the power of computers is making it possible to send audio and video in relatively small amounts across the Internet (Ryan et al., 2000). Thus, video and audio conferencing allows participants to connect with one another in order to collaborate in real-time while using video and audio (see figures 2.7 & 2.8).

Audio conferencing uses the network as a telephone. With the use of audio conferencing (also called voice-conferencing) participants can talk to one another in real time. The primary feature of a voice-only conferencing system is that it does not require skilled typing to achieve nearly face-to-face rates of communication. Patrick (1999) states that the role of the audio channel in video conferencing is well established, as audio is crucial for most forms of communication because it often carries the bulk of the information, especially during interpersonal communications.

Horton (2001) suggests the use of audio conferencing when the discussion is complex and a chat session would thus require too much typing and have too many delays that break the continuity of the conversation. Audio conferencing should further be used when emotions and sounds are important and when users lack writing or typing skills needed to collaborate fluently in written media.

Research has shown that poor audio quality could most often be attributed to one, or several, of the following factors (Patrick, 1999):

- Poor audio quality mostly results from an audio signal that is captured in an ineffective way. This often occurs because of bad microphone placements and the use of inexpensive microphones;
- Audio echo occurs when the audio that is received at a remote site is echoed back to the sender and the other participants through the receiver's microphone. Echo occurs when loud speakers and microphones are located too close together and are active at the same time (full-duplex mode);
- On the Internet, audio packets can be lost for a variety of reasons. The two most common reasons include network congestion, where router buffers overflow and reject packets, and routing instability, where network paths become unavailable for periods of time. Until audio packets can be received reliably it is likely that audio conferencing will only have limited success; and
- Audio delay occurs when there is significant time needed for the audio to travel from the source to the destination. Sources that contribute to the delay are

encoding time, transmission time, and decoding time. Significant audio delay can be distracting for the users and delay makes turn-taking awkward, decreasing the effectiveness of remote interactions. The performance decrease was due to the users' interrupting each other more often in the delayed audio conditions. Audio delay also becomes a problem if it causes the audio to be out of synchronization with the other media channels, especially the video.

Video conferencing has already been discussed at length in this chapter and needs no further introduction. It should, however, be noted that the role of video in video conferencing is enigmatic (Horton, 2001). The quality of the video images varies widely though and depends on the quality of the connection, the quality of the video camera, and the processor speed of the camera.

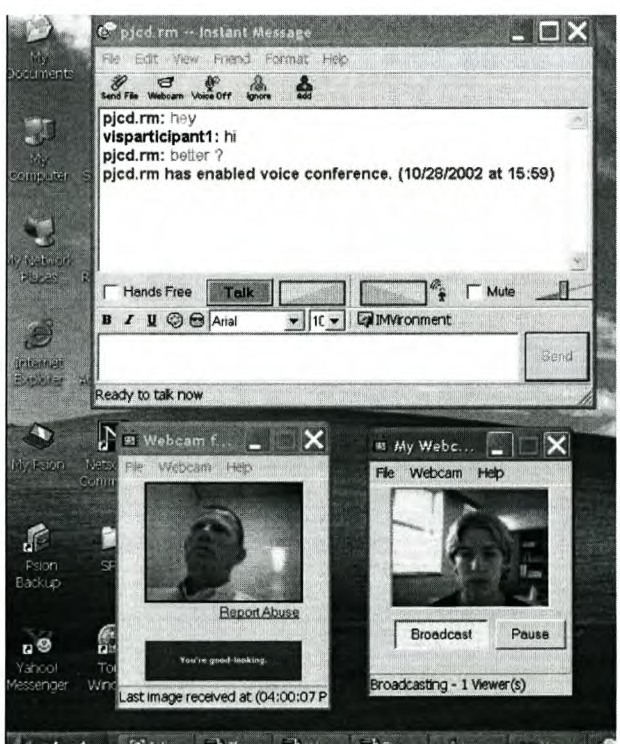


Figure 2.7: Screen capture of video and audio conferencing interfaces in *Yahoo Messenger.*

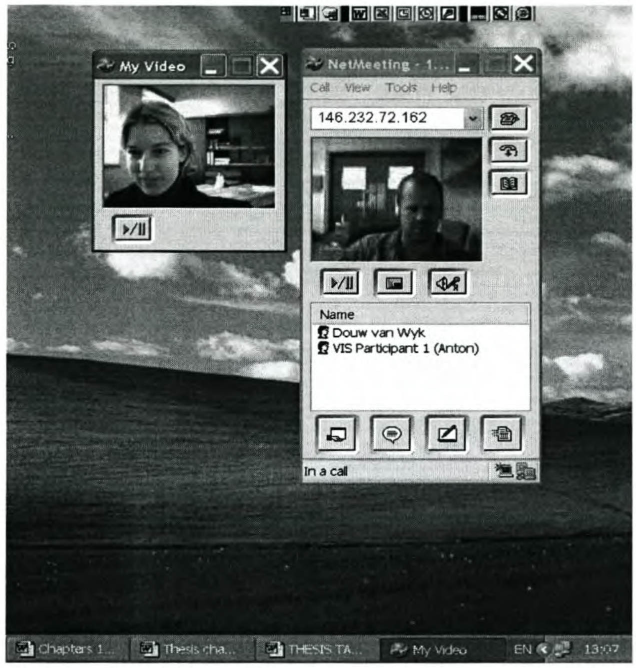


Figure 2.8: Screen capture of video and audio conferencing interfaces in *NetMeeting*.

b. Interactive text (chat)

Chatting (also called synchronous discussion) enables real-time conversations among a group of people over a low speed Internet connection. Users exchange typed in messages over a network and each member of the conference sees all the messages that are typed by the others (see figures 2.9 & 2.10). Chat sessions resemble an instantaneous discussion group (Horton, 2001). Ryan et al. (2000) state that an advantage of chat is the immediacy of communication. Although large groups may be supported if suitable moderator and floor control functions are provided, text-based conferencing is generally more engaging and effective for learning when used with small groups in open discussion (Horton, 2001, p.354).

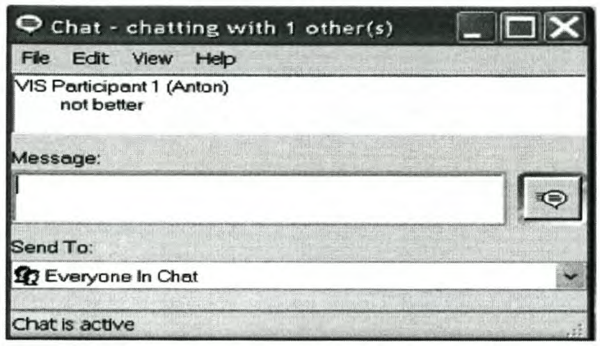


Figure 2.9: Screen capture of text-based conferencing (chat) dialogue box in *NetMeeting*.

Figure 2.10: Screen capture of text-based conferencing (chat) dialogue box in *Yahoo Messenger*.

c. The whiteboard

A shared workspace can be very useful during a videoconference. A popular tool here is the whiteboard (Patrick, 1999). The whiteboard enables participants to collaborate in real-time while using graphical information (see figure 2.11). Whiteboard users can draw on the large canvas and all the participants will see the results on their screens. Users can also select from a variety of drawing tools, or simply type onto the shared space. Text files and graphical images can also be imported into the whiteboard.

Whiteboards are important for those with limited language skills and those who express themselves well visually. Research has shown that in most cases, the use of a whiteboard for presenting new material is not as effective as making that material available through an asynchronous medium. Whiteboards are, however, very effective for enhancing discussions in which material is being developed by dynamically editing jointly viewed resources. Materials such as graphical representations or mathematical equations may be presented well using whiteboards. Texts that are jointly created by a class during discussion can also be effectively developed and presented by using a whiteboard. Although few independent whiteboard tools are available, they are an increasingly common component of integrated learning environments (Horton, 2001).

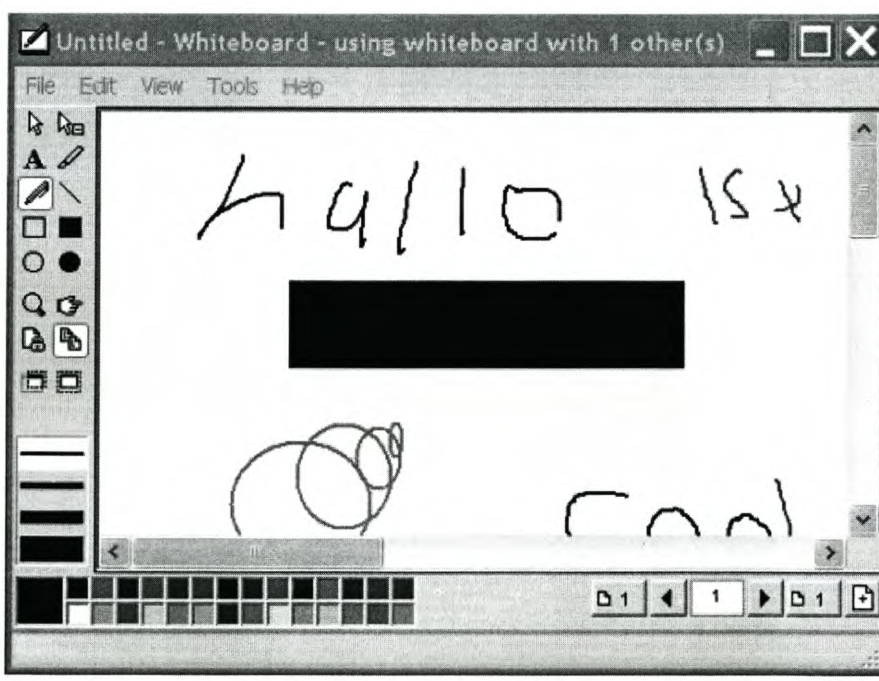


Figure 2.11: Screen capture of the whiteboard in *NetMeeting*.

d. Program sharing

A data collaboration mechanism typically found within multimedia conferencing systems, is program sharing. Program sharing (also known as screen sharing) allows participants to share different applications and programs in real-time, whilst giving the person that is sharing control over who uses it (figure 2.12).

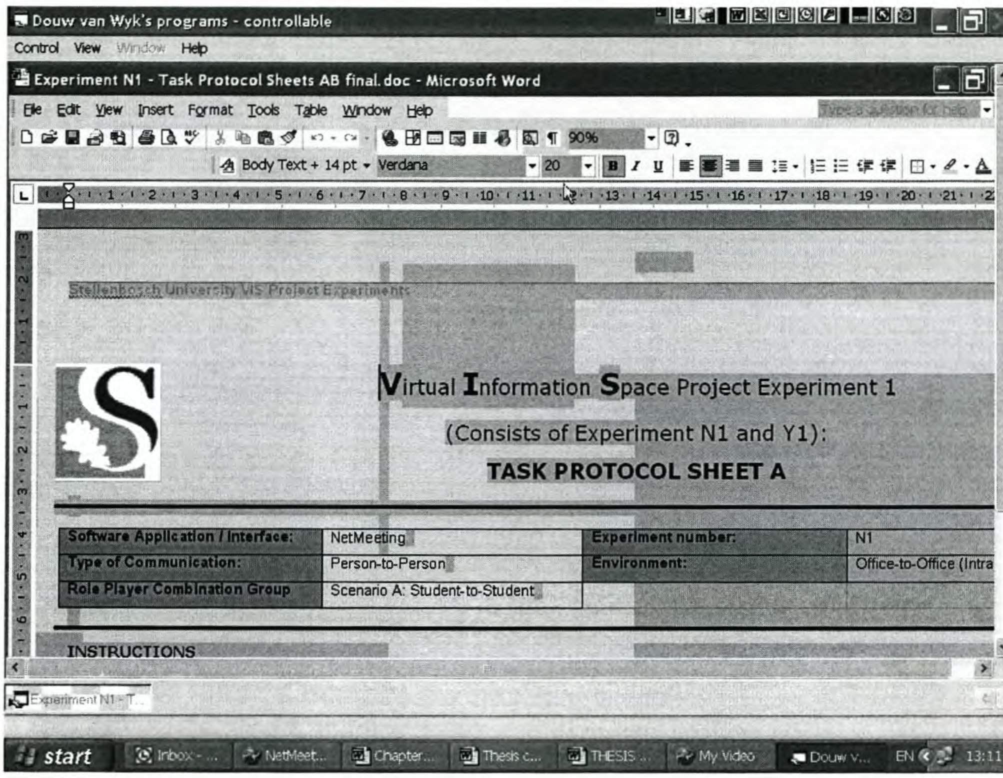


Figure 2.12: Screen capture of a shared document during a *NetMeeting* conferencing session.

Most program sharing tools allows the participant that is sharing, to share the entire screen, a particular application, or just a single window. Horton (2001) provides the following tips for ensuring an effective program sharing session:

- Share only what needs to be shared. Ensure to share an individual application or window rather than the whole desktop. Always be sure to not let other windows cover the application that is being shared;
- Use audio to narrate if bandwidth permits it. Take precautions like speaking slowly and clearly as audio may be delayed and distorted;

- Keep security in mind. The sender should consider that in granting control to others, they can open, modify and delete files on the sender's system; and
- Quit unnecessary programs. For better reliability and speed, exit other programs that require computer and network resources.

e. Real-time file transfer

With the file transfer capability, a user can send a file (or files) in the background during a conferencing session in real-time to one or all of the conference participants. The file transfer function has the advantage that relatively large files can be transferred because of the huge amount of available bandwidth (figure 2.13).

Figure 2.13: Screen capture of the File Transfer dialogue box in *NetMeeting*.

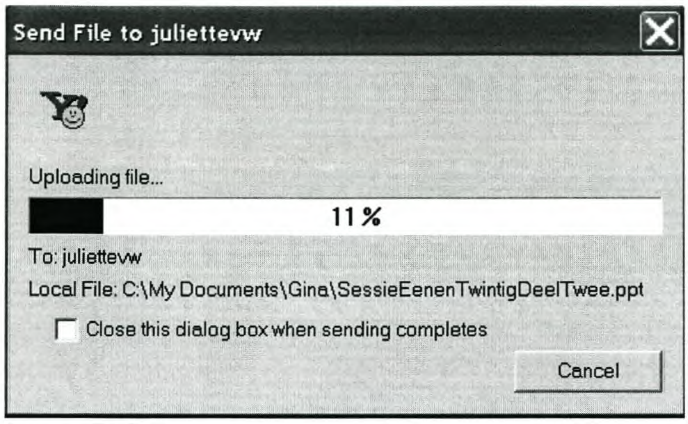


Figure 2.14: Screen capture of the File Transfer dialogue box in *Yahoo Messenger*.

f. Instant messaging

Instant messaging is synchronous computer-based one-on-one communication (see figure 2.15). With a fast network, transmission times are fractions of a second and the experience is like that of synchronous interaction (Nardi, Whittaker, & Bradner, 2000). Most instant messaging systems also provide awareness information about the presence of others (Podoski, 2001).

Although first used to provide message board real time communication in the mid-80s, the concept of instant messaging did not take until 1996 (Podoski, 2001). Instant messaging systems such as America's Online Instant Messenger, Microsoft Network's Messenger, or Yahoo!'s Messenger service have over 70 million users and research shows that the number of users are growing rapidly. The benefits of instant messaging are numerous, including the ability to know when personal contacts are available, instantaneous communication, and the ability to carry on several conversations at once (Czerwinski, Cutrell & Horvitz, undated).

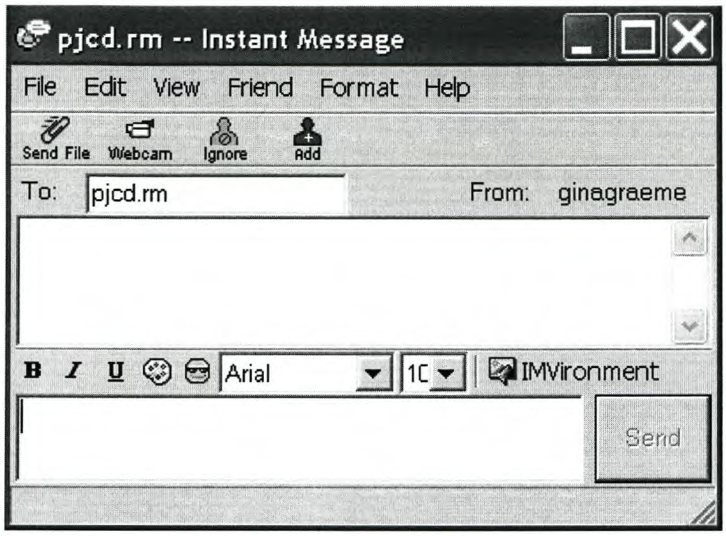


Figure 2.15: Screen capture of *Yahoo Messenger's* Instant Messaging dialog box.

2.5.5.4 Software applications: *NetMeeting* and *Yahoo Messenger*

Specific constraints and technological requirements were taken into account when the decision was made to include the following four software applications in the Virtual Information Space environment for testing. They include the *WebCT* course management system, *Windows XP's* video streaming package, as well as *Yahoo Messenger* and *NetMeeting* that are both desktop-based video conferencing systems.

These software applications each house a unique combination of media, and support either the synchronous or asynchronous mode of communication in the virtual information-sharing environment. The two applications evaluated for the purpose of this study is *NetMeeting* and *Yahoo Messenger*, which support the synchronous communication mode. The software applications can also be referred to as interfaces, and formed the basis for the usability testing.

a. ***NetMeeting***

The growth of distance education schools continues while today's educators and learners raise serious concerns about the reduced levels of human interaction during their on-line classes. Educators are fearful that computer mediated education will reduce human interaction and writers stress the need to devise strategies that bridge the communication gap between physically isolated on-line learners (Muirhead, 2001). According to Greenberg & Chang (1989), the role of technology in conferencing emphasizes bringing people and their materials together in a way that allows participants to orchestrate the conversation as effectively as they do in face-to-face meetings, and to share their otherwise inaccessible materials over distance.

NetMeeting aims to meet the emerging needs as described above. *NetMeeting* is a desktop-based video conferencing system that allows real-time communication and collaboration over the Internet or corporate intranet (i.e. Stellenbosch University network). Also called a multimedia conferencing system, it incorporates real-time voice and video technology as well as data collaboration tools like the whiteboard, program sharing and file transfer function.

On the Internet, connecting to other *NetMeeting* users is made easy with the Microsoft Internet Locator Service (ILS), allowing participants to call each other from a dynamic directory within *NetMeeting* or from a web page. *NetMeeting* supports international communication standards for audio, video, and data conferencing and thus with the use of *NetMeeting*, people can communicate and collaborate with users of *NetMeeting* and other standards-based, compatible products (Microsoft Windows *NetMeeting 3* Resource Kit, 2001).

Gornall et al. (1999) maintain that many users are currently experimenting with internal and local area network (LAN) - based software for collaborative work, using netware such as Microsoft's *NetMeeting*. One example of the successful use of *NetMeeting* is at De Monteford University, where applications sharing (*NetMeeting*s) are being used to teach Java and C++ programming to Computing Science students in face-to-face laboratory sessions.

A *NetMeeting* session enables a group of students and the tutor to 'see' the same computer screen. The tutor then uses the 'whiteboard' facility to show students the screen with relevant programmes, or to discuss a particular question or problem a student may have by displaying the screen to the class. Students can also work in groups on the same programming problem.

When the class is over, students can contact the tutor remotely via *NetMeeting* to discuss any programming problems. Using the *NetMeeting* audio conferencing facility, the tutor can view the programme, identify the problem and point the student in the right direction. This is now being extended to be a regular service within the student resource center, where a research student will be available to deal with queries from students over a *NetMeeting* conferencing session (Smith, cited in Ryan et al., 2000, p.119).

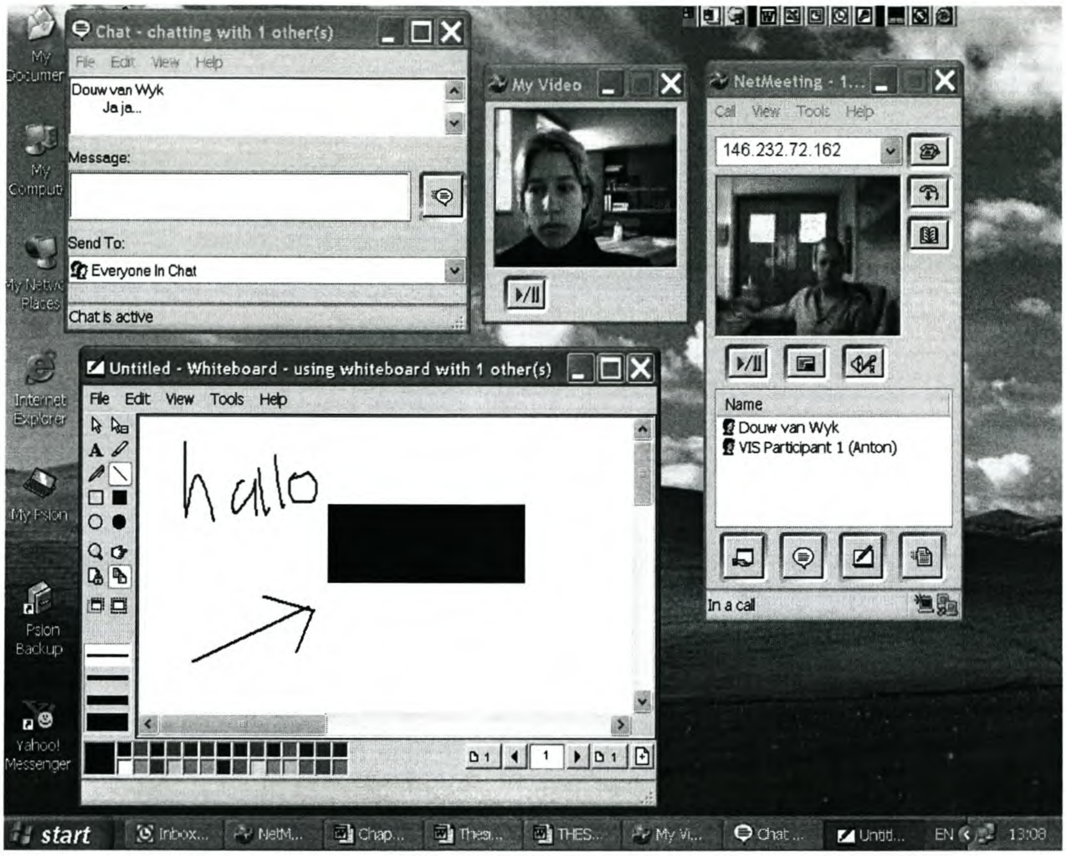


Figure 2.16: Screen capture of *NetMeeting*, with the interactive chat, audio and video, as well as whiteboard being utilised.

b. *Yahoo Messenger*

Yahoo Messenger is a free, client-based instant messaging (IM) service that allows participants to communicate instantly with other students, lecturers, information service suppliers and researchers through the Internet. *Yahoo Messenger* originally incorporated only instant messaging, interactive chat, file transfer and voice conferencing tools, but has recently added video capability to its *Yahoo Messenger* IM service. Due to the video conferencing capabilities, *Yahoo Messenger* has, therefore, been referred to as a desktop-based video conferencing system in the context of this study. Yahoo is, according to Davis (2001), the first major IM service provider to officially add video. Davis (2001, p.4) states that,

"...video is a natural add to IM, it complements the IM user paradigm very well. It is reported that 14% of Internet users have web cams, so IM video will expose a reasonable amount of consumers to video...the combination of IM with quality video may be the single event that will cause desktop videoconferencing growth to finally become non linear."

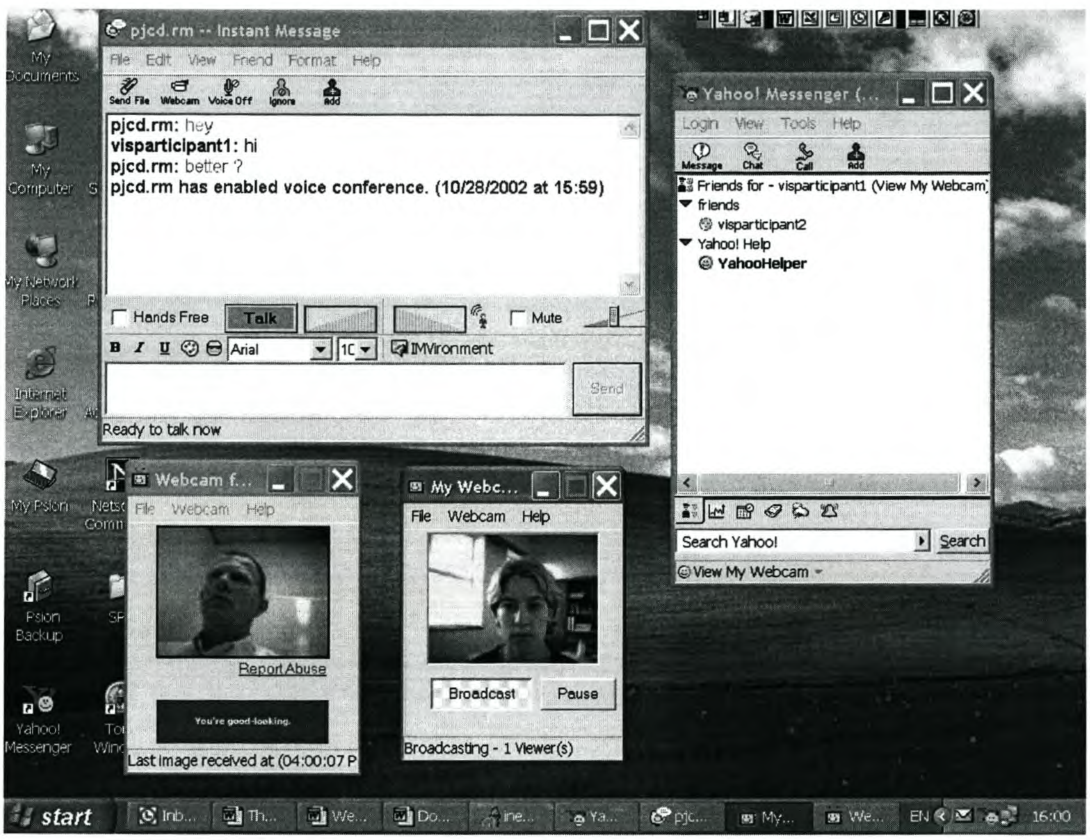


Figure 2.17: Screen capture of *Yahoo Messenger* with the instant messaging, audio and video being utilised.

2.6 THE VALUE OF THE VIS ENVIRONMENT: A CONCEPTUAL INTEGRATION OF THE CONCEPTS OF FLEXIBLE LEARNING, KNOWLEDGE MANAGEMENT AND COMMUNITIES OF PRACTICE TO DEMONSTRATE THE VALUE OF THE VIS ENVIRONMENT

2.6.1 Introduction

The ultimate purpose of the creation of an effective VIS environment is to provide a means for the US to gain a competitive advantage through the effective utilisation of three of its most important resources: people, knowledge and technology. In January 2002, the US implemented a plan, called the e-campus initiative, to make its campus 'electronically compatible'. The e-campus initiative has three main goals that include:

- to increase the quality of the university's main functions – education, research and community service;
- to improve the optimal use of information technology; and
- to integrate e-learning with contact education.

According to Aspelding (US Kampusnuus, 2002) the aim is a 'networked' university with a stable and reliable information and communication infrastructure. In the quest to demonstrate the significance of the VIS in reaching these goals, the following section intends to explain the concepts of flexible learning, knowledge management and communities of practice. The focus of the discussions is an attempt to establish the respective roles that these concepts play in the creation of an effective VIS, and ultimately in the achievement of the goals of the e-campus initiative of the US.

2.6.2 Flexible Learning

2.6.2.1 Introduction

> "As we move into the twenty first century, the concept of flexible learning is a major strategic plank of most universities and is the driving force behind the significant changes that are currently taking place in teaching and learning practices in these institutions"
>
> (Andrews & Ferman, 2001, p.39).

One of the main goals of the e-campus initiative of the US is to integrate electronic learning and contact education. This seems to be a general trend, as research has shown that for many universities, immediate issues centre on how to develop a virtual presence alongside the physical one, so that students and lecturers can move easily between the two. For the conventional university, this may well be its point of entry to a more comprehensive approach to flexible learning (Moran & Myringer, 1999).

With this in mind, the researcher proposes that the above-mentioned goal regarding the e-campus initiative at the US is encapsulated in the concept of flexible learning. It is proposed by the researcher that the creation of a VIS environment could be the first essential constituent to the establishment of the flexible learning environment at the US.

The flexible learning approach will, however, furthermore require slightly different approaches in the way knowledge is packaged, delivered, accessed and acquired, altering core information production and delivery processes. In this sense the role of the information service supplier will be altered as these new approaches to learning will require 'just in time' delivery of critical information where and when it is needed, in just the amount it is needed and in a format preferred by the user. The following section will focus on the clarification of the concept of flexible learning, as well as an illustration of how the VIS is pivotal in the development of flexible learning opportunities and environments at the US. Furthermore, the potential impact of flexible learning on the respective roles of the different role-player groups (lecturers, students, information service suppliers and researchers) will also be highlighted.

2.6.2.2 The concept of flexible learning

Over the last two decades, a number of phrases have come into play that attempt to capture the ideas behind new approaches to teaching and learning (Ryan et al., 2000). Flexible learning is one of these. For a concept that has become so widely used in education and training, flexible learning continues to resist easy definition. What is easy to state about flexible learning is that it aims to provide students with increased access to learning, providing them with greater choices within the teaching and learning environment (Centre for Higher Education, undated).

Flexible learning refers to both an educational philosophy and a set of techniques for teaching and learning. Flexible learning places student learning, needs and choices at the centre of educational decision-making and recognises that learning is a lifelong process, and that generic lifelong learning skills should be important attributes of all graduates (CHED, undated). Wade (1994) places a specific emphasis on the concept from a higher education perspective, by referring to flexible learning as an approach to university education which provides students with the opportunity to take greater responsibility for their learning and to be engaged in learning activities and opportunities that meet their own individual needs.

Clegg and Steel (2002) discuss the concept of flexibility and flexible learning with a specific emphasis on the higher education context. They propose that higher education is currently positioned so as to meet the needs of increasingly flexible, global, and technology driven markets. This gives new technologies a symbolic importance that is surplus to their capacity to enhance the learning experience, as involvement with media is seen as an essential ingredient in the 'knowledge economy'. Secondly, higher education must meet the needs of students who demand more 'flexible' provision; again new media are critically positioned as enabling more flexible delivery.

Another term that is often used interchangeably with the concept of flexible learning, is resource-based learning. Ryan et al. (2002, p.30) state that, "...resource-based learning has become particularly popular, partly because it reflects new trends and developments in the use of learning technologies and also because it serves as an umbrella term for the other terms found in the education literature, such as flexible learning, computer aided learning and student-centred learning." Resource-based learning is defined as an integrated set of strategies to promote student-centred learning in a mass education context, through a combination of specially designed learning resources and interactive media and technologies (Ryan et al., 2002).

Whether called flexible learning or resource-based learning, there is a definite shifting focus in education from the institution and the teacher to the learner. As Andrews and Ferman (2001, p.40) point out, "...the notion of students as active participants in the learning process can be considered a central theme of flexible learning." They continue to explain that this notion directly relates to the increasing influence of constructivist philosophies – as was discussed earlier - in tertiary teaching and learning as opposed to more traditional "objectivist" philosophies. In this sense, flexible learning should be seen, not as an alternative mode of education, but as an overarching driving force, a move to allow off-campus and on-campus students greater choice in how, when and where learning and thus information sharing and knowledge construction takes place.

Stephenson (2001, p.224) summarizes the challenges of this new paradigm in teaching and learning, by stating that: "the challenge facing educators is not whether to give their learners responsibility for their own learning, but how much responsibility they are going to deny or facilitate, and how they are going to do it." In the light of these challenges, teachers and administrators at higher education institutions everywhere should reflect on the teaching and learning environments they have created, and determine new ways to engage with learners.

2.6.2.3 Analysing Flexible Learning

Flexible learning should neither be seen as a distinct educational mode nor an ideal condition for teachers to attain. Rather, it embraces, extends and combines a number of existing and evolving approaches to teaching and learning (CHED, undated). Two of these approaches that the paradigm of flexible learning, within the context of South African higher education institutions, heavily draws upon - are the concepts of distance and open learning (Technikon SA, 2001).

Distance learning consists of instruction through print or electronic communications media to persons engaged in learning in a place or time different from that of the instructor or other students (Hill, 1997). According to Moran and Myringer (1999), flexible learning borrows the idea from distance education in that education should go to people and not the other way around, and should harness extended experience in fostering student-centred learning. It builds on distance educators' expertise in design and production of learning materials, and choice and utilisation of technologies appropriate to the learning process. Flexible learning also draws on the recognition of the importance of interaction and personal contact between teacher and learner - although distance education has shown that personal contact need not be face to face for effective, stimulating learning (synchronous CMC media is used to facilitate this interaction).

At the core of the concept of open learning is the belief that there is a range of strategies and methods that can be applied to the design and development of teaching material in order to ensure the achievement of effective learning (Ryan et al., 2000). According to TSA (2001), the idea of open learning within the distance education framework emerged together with an increased level of interaction and learner-centeredness. This openness has particular reference to varying degrees of freedom of place, time, pace access and exit.

Bringing it together, the idea of flexible learning allows for the application of elements of open learning to both distance and on-campus situations. The concept of flexible learning is thus being defined as approaches to teaching and learning that are learner-centred, free up the time, place and methods of learning and teaching, and use appropriate technologies in a networked environment (Moran & Myringer, 1999).

According to CHED (undated) increasing flexibility is not necessarily 'good' in itself. Rather, the important matter in flexible learning that should be a focus area, is how increasing flexibility can improve the student learning experience. This line of reasoning is emphasised by Van der Merwe (cited in US Kampusnuus, 2002, p.4) when stating that, "...one should remember that e-learning is only an instrument and will never replace the human element of contact education."

2.6.2.4 Flexible learning and change

Flexible learning issues need to be addressed at all levels of the US for fundamental change to take place. The VIS project aims to start the process of creating a culture of flexible learning by initiating an awareness of the learning resources and interactive media and technologies to be available to assist this paradigm shift.

Specifically at student level, flexible learning can lead to changes in the processes involved in learning. The emphasis on interaction with a person in a classroom can change to a variety of interaction with persons using communication media (either synchronously or asynchronously), with learning materials and with support persons (information service suppliers, computer personnel) in the learning environment (CHED, undated). Thus, flexible learning offers the student increased access, increased choice and relevance of learning activity and assessment.

Changes in students' study processes obviously affect the academic level. The process of interaction with students will include a greater variety of mechanisms in a flexible learning environment. Lecturers are thus offered an opportunity to re-examine current teaching approaches and to use a range of technologies in improving the quality of the student experience. For the institution, clear policies, co-ordination, resource planning and management are required if flexible learning is to become part of the fabric of the organisation (CHED, undated).

The changes that flexible learning requires will furthermore significantly impact the role and function of the information service supplier role-player group. An increased flexible delivery of information will be required with the 'just in time' delivery of critical information where and when it is needed, in the amount and format preferred by the user. The information service supplier will furthermore assist the other role-players to work more efficiently, ensuring the avoidance of excessive and extraneous information, by making the information load more manageable and meaningful for the user. The information service suppliers should therefore be made aware of the potential of synchronous CMC media and how the media could be used to promote effective information sharing and dissemination.

2.6.2.5 The role of the VIS Environment in promoting Flexible Learning at the University of Stellenbosch (US)

Two reports, issued by the university, were consulted in an attempt to clarify the framework for the promotion of flexible learning at the US. The goal was to ascertain the strategic initiatives that indirectly relate to flexible learning at the US. According to the *Strategic Framework Report* of the US, published in March 2000, the following strategic priorities regarding the two core processes, teaching and learning and research, were identified (US, 2000).

a. Teaching and learning

Strategic priorities related to teaching and learning that implies flexible learning, include:

- fostering a student-centred learning ethos (4.3.2.2); and
- innovative facilitation of learning / study, inter alia by bringing into play appropriate modes of delivery and technology, including decentralised teaching and learning (4.3.2.3).

b. Research

A strategic priority regarding research that implies flexible learning includes:

- developing the financing, infrastructure and technology for research (4.2.2.2).

It is interesting to note, furthermore, that the Department of Education of South Africa, in its required report on the *Proposed Programme and Qualification Mix for the years 2002-2006 for the University of Stellenbosch,* only required of the US to make provision for two kinds of programme delivery modes, namely contact and distance education (US, 2002). However, an additional mode was incorporated into the report of proposed programmes by the US. The reason for this inclusion points to an acknowledgement of the emergence of flexible learning, as it is stated that (US, 2002, p.1), "...the *University of Stellenbosch* provides information on a third group of programmes, called mixed modes, since they cannot be seen as purely distance education programmes and because all programmes at the *University of Stellenbosch*, including contact education programmes, are increasingly being technology mediated."

Based on these reports, evidence, therefore, clearly states that the US acknowledges the importance of a flexible learning environment as part of the strategies for creating an environment in which knowledge can be discovered and shared – two of the main elements of the mission of the US.

The question arise: what is the role of the VIS environment in promoting flexible learning at the US? It is proposed that the VIS project has triggered a process of creation of an awareness of the technologies and media available to facilitate the process of increased information sharing between the four different role-player groups (students, lecturers, researchers and information service suppliers). In terms of flexible learning, the VIS has the potential to provide students with an opportunity to take greater responsibility for their learning and to be engaged in learning, information sharing and research activities and opportunities that meet their own individual needs – fostering the student-centred learning ethos.

For lecturers it could create new opportunities to embrace the paradigm shift towards constructivism by allowing for new and innovative ways of delivering teaching and conducting research. Increased efficient information sharing with other researchers and subject experts will also be facilitated by the supporting technological systems. For the information service suppliers role-player group, expected outcomes can translate into increased relevance in the services that are supplied, more cost-effective delivery and dissemination of relevant information and a overall quicker, more efficient service that is being provided to the relevant role-player groups. The VIS project research results (both synchronous and asynchronous) should thus aid the creation of these opportunities by making recommendations regarding the supporting technological systems that will facilitate the process of flexible learning, a process that is increasingly being acknowledged as pivotal in the global competitiveness of the US.

2.6.2 Knowledge Management and Communities of Practice

2.6.2.1 Introduction

Most organisations realise that 'knowledge' is a strategic resource that provides a sustainable competitive advantage (Ubon & Kimble, 2002). Higher education institutions today are subject to the same pressures of the marketplace as organisations, and profound changes in competition have made them think in similar ways to the business environment regarding many issues – knowledge being one of them. Smola, Schwager, Sutton and Uzumeri (1999, p.5) maintain that, "Universities are increasingly attempting to prepare graduates for a life within a technology-and knowledge-based environment." Therefore, just as businesses attempt to improve the efficiency and effectiveness of their operations through knowledge management, so educational institutions could use the potential of knowledge management to enhance the learning of students whilst better preparing them for the technology and knowledge-based environments they are most likely to face in the workplace.

According to Allee (undated), knowledge cannot be separated from the communities that create it, use it, and transform it. Consequently, as networks and practice communities are increasingly being acknowledged as powerful resources for learning and knowledge, a rapid convergence of knowledge management efforts with a focus on learning communities is taking place. The following section will focus on clarifying the two key concepts, namely knowledge management and communities of practice in an attempt to demonstrate the value of these concepts within the higher educational framework. The role of the VIS in promoting knowledge management and communities of practice at the US will also be discussed.

2.6.2.2 Knowledge Management and Communities of Practice defined

Knowledge management (KM) is the management of processes that govern the creation, dissemination, and utilisation of knowledge by merging technologies, organisational structures and people to create the most effective learning, problem solving, and decision-making in an organisation (Ubon & Kimble, 2002). For the purpose of this discussion, the concept of KM will specifically refer to the processes involved in the creation and dissemination of knowledge within an educational context.

Several authors refer to the relation between KM and communities of practice. Hildreth et al. (1998), maintain that within the knowledge management context, there is a growing interest in computer support for knowledge sharing and the role that communities of practice play in this. Ubon and Kimble (2002), suggest that from a KM perspective, the concept of communities is essential because knowledge is often built up and generated by a network of practitioners – a community. In addition, the current advances in information and communication technologies also create new forms of settings in which people communicate and share their knowledge across both geographical and temporal boundaries.

According to Ubon and Kimble (2002) communities are regarded as the model for dynamic, productive knowledge creation and sharing in education. Terms used to describe the phenomenon of groups (communities) of individuals learning together include 'learning communities' and 'communities of practice'; these terms are appearing more frequently in literature (Imel, 2001). Lave and Wenger (cited in Hildreth & Kimble, 2000, p.30) first introduced the concept of communities of practice (COP) in 1991. They described a COP as a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping COPs. It is important to note that they regard a COP as an intrinsic condition for the existence of knowledge. Originally, Wegner (cited in Allee, undated, p.5), described three important dimensions of COP:

- **Domain.** People organise around a domain of knowledge that provides members a sense of joint enterprise and brings them together. Members identify with the domain of knowledge and a joint undertaking that emerges from shared understanding of their situation.
- **Community.** People function as a community through relationships of mutual engagement that bind members together into a social entity. They interact regularly and engage in joint activities that build relationship and trust.
- **Practice.** The community builds capability in its practice by developing a shared repertoire and resources such as tools, documents and a vocabulary that embody the accumulated knowledge of the community. This shared repertoire serves as a foundation for future learning.

The addition of computer technology has meant that communities could move online. Incorporating the opportunities that new CMC media affords, Preece (cited in Harris & Niven, 2002) describes the COP concept and focuses specifically on the online community. He cites four key features of these communities that include, shared purpose; people who interact socially; policies, which guide people's interactions; and computer systems, which should support interaction and facilitate a sense of togetherness (see figure 2.18).

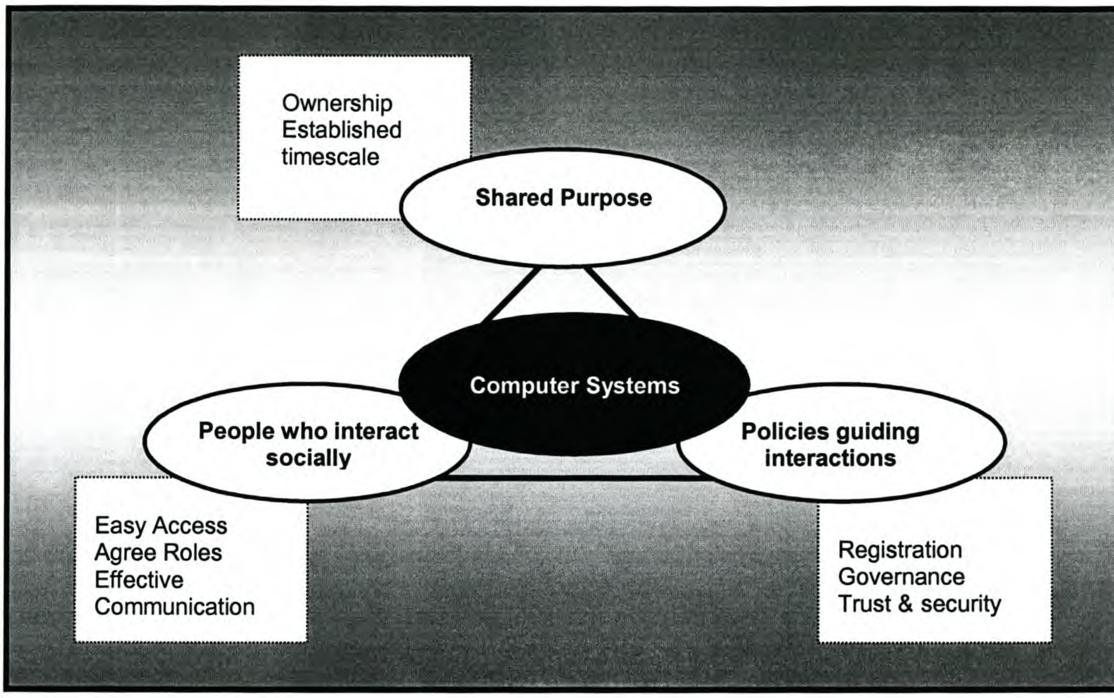


Figure 2.18: Key features of an online community, with associated characteristics (adapted from Harris & Niven, 2002).

2.6.2.3 The role of the VIS Environment in promoting KM and COP at the University of Stellenbosch (US)

The underlying intent of the VIS is to provide a collaborative online environment where communities of interest can meet to share experience and understanding within the specific context for which the VIS is utilised (i.e. research, information sharing, learning). It can thus better be described as an online space that encapsultes many evolving communities of practice. The philosophy underpinning the VIS is based on collaboration and constructivism, as was discussed earlier.

It is a well known fact that the employable adult of the future must develop the skills of thinking critically and reflectively, both using and creating new knowledge structures and networks. The known effective learning strategies (facilitated by the higher education institution) for the development of such skills involve intensive interaction not only with content structured into knowledge networks, but also in association with other people who have an interest in the specific knowledge domain. These interactions should have the characteristics of conversations between members of a network people with common interests, thus a community of practice (Romiszoski, 1997). Edwards (2002, p.5) points towards the need for video conferencing media to facilitate the above described process of knowledge construction,

> "...if knowledge construction is the task, then the sharing of different perspectives through debate and dialogue is, within the social constructivist framework, a precondition for it but does not simply constitute it. Getting to the point of actually constructing knowledge requires skilled, sustained, purposive and directed analytic and creative conceptual communication practices. Attempting to do this, using a technological medium that requires participants to express their ideas through text only, add another challenge to the process."

Laister and Kober (2002) hold that a system for synchronous knowledge sharing and creation (i.e. desktop-based video conferencing systems like *NetMeeting* and *Yahoo Messenger*) can support these learning and information sharing/communication processes the best, by providing a feeling of social presence through supporting a variety of interaction stimuli. Ubon and Kimble (2002) also point to the advantages of using systems that support synchronous media. According to the authors, advanced technologies such as video conferencing allow people to interact over synchronous interactive media, and increase the level of interactivity in online communication. This should increase the effectiveness of the evolving communities of practice, as it is suspected that the increased level of interactivity leads to an increased level of trust, identity and commitment, and thus making members of an online community more comfortable and willing to collaborate and share their knowledge.

NetMeeting and *Yahoo Messenger* being desktop-based video conferencing systems are examples of systems that support the evolvement of online communities, facilitating the knowledge creation and information sharing processes as described above. Laister and Kober (2002) propose that one of the fundamental and essential requirements of a successful online community is the usability of the systems in support of the information sharing and knowledge creation processes. The systems or software should make it possible for users to interact and perform their tasks, easily and intuitively. Software with good usability supports lower error rates, high productivity, rapid learning and efficient use.

Figure 2.19 depicts the different elements of the VIS. It becomes clear that the supporting technological systems or computer networks are merely technological devices that link human beings (students, lecturers, information service suppliers and researchers) into collaborative conversational networks. The aim of these conversational networks is to create a means through which ideas and materials can be shared and exchanged with the ultimate aim of helping individuals to build their own conceptual networks of interrelated ideas, strategies and theories. These are the networks that are essential for the process of critical analysis and evaluation of existing knowledge and the creative synthesis of knowledge: the essential components of knowledge work (Romiszoski, 1997).

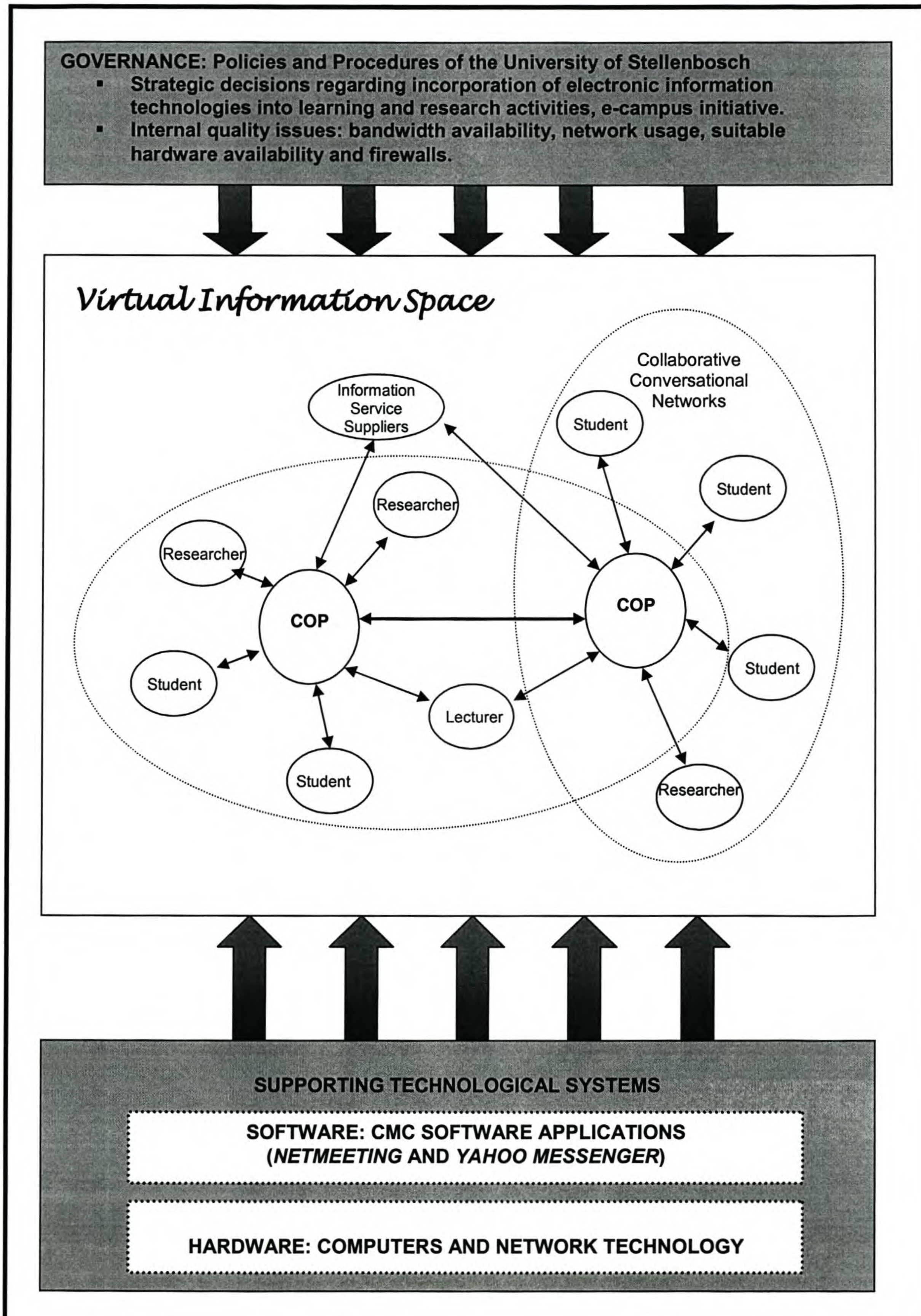


Figure 2.19: A graphical representation of the role of the VIS Environment in promoting KM and COP at the University of Stellenbosch (US)

2.7 CONCLUSION

The focus of this chapter was to explore the issues and challenges related to the creation of an integrative virtual environment through which the researcher, student, lecturer and information service supplier can interact for the purpose of enhanced and improved research, learning and information sharing. The relationship between these role-players is changing rapidly as developments in technology allow them to communicate in various ways. Various virtual learning environments have evolved, with virtual universities and classrooms becoming commonplace. The impact of these changes on higher education institutions were considered and it was established that Internet-based communication and information technologies are rapidly becoming an important part of the teaching and learning strategies of many universities, internationally and locally.

A closer look at the University of Stellenbosch's strategic initiatives regarding global information technology trends revealed that several strategic decisions have been made to maintain national and international competitiveness. The VIS project developed as a research initiative linked to these strategies. This study's focus is on investigation of the synchronous CMC media embedded within *NetMeeting* and *Yahoo Messenger* in terms of usability and feasibility for application within the US technological infrastructure, to facilitate increased virtual information sharing. One of the aims of this chapter was, therefore, to orientate the reader concerning CMC terminology and different CMC media. Video conferencing was discussed in detail with provision of background on the two software applications, namely *NetMeeting* and *Yahoo Messenger*. The literature review revealed that CMC has the potential to support a new educational paradigm, 'knowledge as construction'. It was established that this paradigm shift requires that virtual information sharing and learning should be based on sound constructivist principles.

The researcher maintains that the philosophy underpinning the VIS is based on constructivism. The intent of the VIS is to provide a collaborative online environment where communities of interest can meet to share experience and understanding within the specific context the VIS is utilised for (e.g. research, information sharing, learning). It can, therefore, be described as an online space that incorporates many evolving communities of practice and facilitates flexible learning.

The creation of an effective virtual learning and information-sharing environment is influenced greatly by the usability of the supporting technology systems. The following section will focus on the concept of usability and provide a context-specific view of the usability concept as applied within this study.

CHAPTER 3: USABILITY

3.1 INTRODUCTION

This study has investigated, amongst other elements, the usability of the software applications (*NetMeeting* and *Yahoo Messenger*) to be employed for the creation of an effective collaborative virtual environment. Laister and Kober (2002) emphasise the importance of the usability of the software that is used to create this type of a virtual environment. They maintain that, "...the usability of the software applications is a general requirement of a successful online community as high usability makes it possible for users to interact and perform their tasks easily and intuitively" (Laister & Kober, 2002, p.5).

The purpose of this chapter is to describe the concept of usability. This will be done by providing a thorough theoretical background on key issues pertaining to usability. Firstly, usability is discussed against the background of Ergonomics and Human Computer Interaction. The concept of usability is defined with reference to the determinants of usability and different usability attributes. Lastly, usability evaluation techniques and the usability engineering process are discussed. A context specific view of the concept of usability as applied within the VIS project environment and this study is provided.

3.2 USABILITY IN CONTEXT

3.2.1 Introduction

> "Human performance in the use of computer and information systems will remain a rapidly expending research and development topic in the coming decades. This interdisciplinary journey of discovery combines the experimental methods and intellectual framework of cognitive psychology with the powerful and widely used tools developed from computer science"
>
> (Shneiderman, 1987, p.4).

The discipline of usability lies within the multidisciplinary field of Human computer Interaction (HCI). As Church (1999, p.9) points out, "HCI exists to provide an understanding of usability and of how to design usable computer artefacts." A better understanding of the discipline of usability thus affords a brief look at the field of HCI.

HCI deals with all aspects of the human use of computers, usually in the context of interactive information technology systems (Shackle & Richardson, 1991). HCI research is multidisciplinary. According to Booth (as cited in Church 1999, p.10), "...disciplines that contribute to HCI research include cognitive psychology, software engineering, cognitive science and ergonomics." Shackle and Richardson (1991, p.1) conversely place a stronger emphasis on the role of Ergonomics with relation to HCI when stating that, "HCI is a major part of the larger subject termed Human-System Interaction (HSI) and HSI is a large part of the applied side of the discipline known as Ergonomics." The relationship between the different disciplines is presented in figure 3.1.

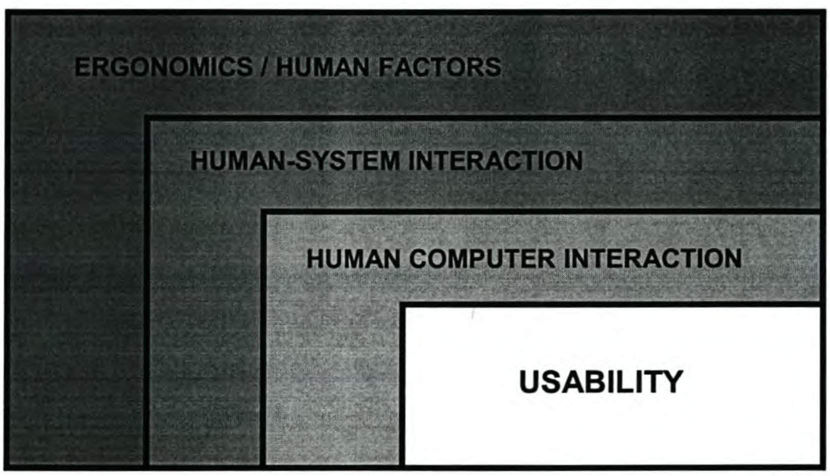


Figure 3.1: Usability in Context (Adapted from Shackel & Richardson, 1991, p. 2.)

3.2.2 Ergonomics

Ergonomics (also known as Human Factors) is defined as the study of the relation between man and his occupation, equipment and environment, and particularly the application of anatomical, physiological and psychological knowledge to the problems arising as result thereof. Ergonomics places a major emphasis upon efficiency in the operation of the equipment as measured by the human performance of actual users. Thus, the aim would be to optimise the human-machine and human-environment combinations by improving the system and the environment (Shackel & Richardson, 1991).

On the relationship between Ergonomics and HCI, Hendricks (1996) states that both internationally as well as in South Africa, the technology of human factors or ergonomics is increasingly being recognised as human-system interface technology. The discipline of human factors can, therefore, be defined as the development and application of human-system interface technology with the aim of improving "...quality of life, including health, safety, *usability* and productivity" (Hendricks, 1996, p.1).

3.2.3 Human-System Interaction (HSI)

HSI is concerned with the methods, media and mechanism for enhancing cooperation between people and systems in an integrative organisational environment. The field is primarily concerned with the study of those aspects of humans, the organisation, the job, the tasks, the machines, and the environment that directly influence the effectiveness and acceptability of systems for the user. These include both the human-machine processes and functions (human-system interaction), as well as the hardware and software components which facilitate these interactions, for example, the human system interface (Shackel & Richardson, 1991).

Part of the results to be gained from the VIS project, and specifically this study, fulfil the purpose of advising the US on the factors in the HSI that could directly influence the effectiveness and acceptability of the implementation of the technologies that support the virtual information sharing process. This will contribute toward providing the US governance with sufficient information to assist in ensuring that implementation of the virtual information sharing technologies (*NetMeeting* and *Yahoo*

Messenger) will enhance the overall competitiveness of the US in the global market. Ultimately, the human and machine (were 'machine' refers to the technologies used to facilitate virtual information sharing) should form a 'socio-technical system', in which these should form complementary components working towards a common goal – that of improved communication and information sharing and thus overall improved productivity.

Cooper, Gencturk and Lindley (1996, p.4) emphasise that, "...an effective new technological system might evolve as an interactive time-dependent process in which technological aspects and social values are played off against one another in the search for a durable overall system design." The VIS project should thus be viewed as the first phase in the process of designing a virtual information space for information sharing at the US.

3.2.4 Human Computer Interaction

3.2.4.1 Background

Human Computer Interaction (HCI) is concerned with the design, evaluation, and implementation of interactive computing systems for human use. The primary focus of HCI is the user. Furthermore, the discipline aims to provide improved explanations of the interactions between the user and his computer (Berg, 2000).

As mentioned earlier, this study aims to provide a better understanding of the dynamics between the user and computer when specific synchronous CMC media is implemented within an educational context to facilitate increased information sharing. The project thus clearly lies within the field of HCI. Carrol (1997), however, provides a somewhat different approach to defining HCI, which the researcher found particularly applicable to the VIS project environment. Although acknowledging that HCI seeks to understand and support human beings interacting with and through technology, he views HCI mostly as a science of design. He explains that,

> "HCI has emerged relatively recently as a highly successful area of computer science research and development and of applied psychology...HCI is not merely applied psychology. It has guided and developed the basic science as much as it has taken direction from it. It illustrates possibilities of psychology as a design science"
>
> (Carrol, 1997, p.62).

3.2.4.2 Areas of Human Computer Interaction research

Booth (cited in Church, 1999, p.9) defines HCI as, "the study of the interaction between humans and computers". He continues to provide five additional definitions that, when considered together, more thoroughly characterise HCI and indicate primary areas of HCI research. These are:

- **Interactional hardware and software.** This area is primarily concerned with the problems of various methods of interaction and how they affect communication at the interface;
- **Matching models**. The main concern here is trying to match the user's model or representation of the task with that of the actual task;
- **The task level.** This area deals with task fit, or with the computer's effectiveness to provide the user with the functions and information that he or she needs. This area is also concerned with determining user needs and ways to do so;
- **Design and development.** Here, the emphasis is on designs that are user-centred. Usability is the main focus area here; and
- **Organisational impact.** This area of HCI research involves evaluating the ways in which computer systems affect not only individual users and groups within an organisation, but also the entire organisation from such standpoints as its structure and function.

Taking into account each of these areas of HCI research, specific applications within this study will briefly be discussed.

- **Research at the task level:** goal number one of this study is to determine and provide a description of the specific needs of the role-players, with regards to the software applications that will facilitate the virtual information sharing process. Research that has been conducted in this area thus falls within the task level classification of research in HCI.
- **Design and development:** the second goal of this study is to empirically examine the usability of the different software applications (*NetMeeting* and *Yahoo Messenger*). This area of research falls within the design and development category of HCI as differentiated by Booth. At this stage, it is important to note that the software applications are evaluated in terms of usability, with the main aim of advising the US about the application that would most likely be the most effective vehicle to meet the university's information sharing needs. The software applications itself are commercial products and the usability thereof, cannot be changed.
- **Organisational impact:** Lastly, the results of this research will be used to advise the US about the technological implications that the implementation of the chosen software applications will most likely result in and is encapsulated in goals number three and four of this study. This, as well as an overview of the potential beneficial capability of the systems, can therefore be considered as research in the organisational impact of the systems from an HCI perspective.

3.4.2.3 Human Computer Interaction in Learning Environments

The understanding of computers as a medium, may be the key to maximising the computer as a powerful tool in learning environments. Gibbons & Fairweather (cited in Berg, 2000, p. 360), identified five attributes that make the computer, as an instructional medium, unique: (a) dynamic display, (b) ability to accept student input, (c) speed, (d) ability to select, and (e) flawless memory. One of the distinct advantages of learning in computer environments may be this ability to maintain a record of learning. Such a record of learning could help students monitor their behaviour, reflect on their progress, and experiment with revisions of their experiences (Berg, 2000).

3.2.5 Human Computer Interface

The human computer interface has been described in various ways. Card, Moran and Newell (cited in Church, 1999, p.8) state that, "...communication between a person and the computer occurs at the human computer interface. The interface is composed of all the parts involved in this communication, thus the physical devices, such as keyboards and displays, as well as the computer's programs for controlling the interaction." According to the Oxford Dictionary (1998, p.422), the term "interface" is defined as, "a surface that forms a common boundary between two bodies, spaces, or phases, a place where independent systems meet and either act on or communicate with each other; or the mechanism by which interaction or communication is brought about at an interface." For the purpose of this study, the human computer interface is defined as the boundary between the human and computer, at which point the two make contact, interact and communicate with each other.

Some have doubted as to whether or not communication at the human computer interface is true communication. The primary reason for this is that the computer is not another intelligent being with which a person can communicate. However, others oppose this view by stating that the computer does have intelligence – that of the designer embedded within the system. Card, Moran and Newell (cited in Church, 1999, p.9), state that communication at this interface, "...can be termed a dialogue because both the computer and the user have access to the stream of symbols flowing back and forth to accomplish the communication."

3.2.6 User-Centred Design

In the early days of HCI, the notion that computer systems and software should be designed and developed with explicit consideration of the needs, abilities, and preferences of their ultimate users was not taken seriously (Carroll, 1997). This has changed. For example, Jordan (1998, p. 49) points out that, "Iterative design and evaluation is fundamental to creating usable products through a user-centred design strategy". According to Rubin (1994), user-centred design represents not only the techniques, processes, methods and procedures for designing usable products and systems, but just as importantly, the philosophy that places the user at the centre of the process.

The 'philosophy' that Rubin refers to is clarified by Gardner (cited in Shackel & Richardson, 1991), as he explains why user-centered design is user-centred. The reasons that are given include:

- All systems exist for human purposes. Advice is needed on how to identify user's purposes and how to represent the information gathered so that it can be acted upon by designers;
- The requirements on which systems are to be judged, are the requirements of those who must use it. Here, usability criteria can be used to establish testable system goals from the point of the users;
- The design team must allow full user involvement in all aspects of system development; and
- The system is to be designed explicitly with the goal to take account of user characteristics, in order to achieve effective performance and acceptability for the users.

The term 'system' refers to more than just the machine (for example, the computer hardware and software). In the VIS project context, the term 'system' should be viewed as referring to all the components (human and machine) involved in establishing the process of virtual learning and information sharing.

According to Rubin (1994), it is essential to understand the basic principles of user-centred design, in order to understand the context for performing usability testing. Usability testing should not be viewed as user-centred design in itself, but rather as one of the several techniques available to ensure and contribute towards a good user-centred design. Gould and Lewis (cited in Rubin, 1994, p. 12) propose three principles of user-centred design. Therefore, in order to design an effective VIS environment, the following principles of user-centred design have been incorporated into the empirical usability testing of the VIS environment.

The principles include:

- **An early focus on users and tasks.** A needs-analysis questionnaire was designed and used by the researcher to establish the needs of the potential users. The questionnaire also assisted the researcher in identifying particular tasks and applications that the software applications could be used for within the VIS;
- **Empirical measurement of product usage.** The empirical measurement was performed by conducting usability experiments and gathering subjective and objective data, with regards to the specified usability criteria, and
- **Iterative design.** Although the specific software packages could not be subjected to an iterative design process, the researcher views the feedback and results of the study as the first step in an iterative design process, with the aim of creating and implementing an integrative virtual information sharing environment for the identified role-players at the US.

3.3 USABILITY

3.3.1 Usability defined

The term usability was coined some 20 years ago in order to replace the term "user-friendly", which by the early 1980s had acquired a host of undesirable vague and subjective connotations (Bevan, Kirawkowski & Maissel, 1991). In practice, the term usability means different things to different people and should be viewed in different ways for different purposes (Bevan & Macleod, 1994). Nielsen and Mack (1994) define usability as a fairly broad concept that basically refers to the ease with which users learn a system, the efficiency with which they can use it once they have learned it, and how pleasant it is to use. Bevan et al. (1991) distinguish between a product-centred, a context-of-use and quality-of-use view of usability. These views are complementary to each other and will all be incorporated into the usability evaluation of this study as they relate to how usability should be measured.

3.3.2 Product-centred view of usability

The usability product-centred view is based on evaluation of the product as derived from the attributes of the product which contribute towards the quality of use. Maddix (cited in Berg, 2000, p.4), provides a product-centred definition of usability when he describes usability as the, "evaluation of the computer system functions such as user interface, dialogue design, cognitive match with the user, quality of documentation, and online help."

Other examples of product attributes that contribute to usability include the style and properties of the interface, the dialogue structure, the nature of the functionality, and any other relevant properties such as system efficiency and reliability (Bevan et al., 1991).

3.3.3 The context-of-use view of usability

The context-of-use view of usability emphasises the fact that the usability depends on the nature of the user, the product, the task, and the surrounding environment (Bevan & Macleod, 1994). Berg (2000, p.4) advocates a context-of-use view by defining usability as the, "…degree to which a computer system is effectively used by its users in the performance of tasks." Usability, therefore, evaluates the degree to which a computer system functions in the manner it was designed and if it fits the design purpose.

Jordan (1998) places a strong emphasis on context by pointing out that an important point to note with regards to the definition of usability, is that usability is a not simply a property of a product in isolation. Likewise, Bevan et al. (1991) agree that it is not meaningful to talk simply about the usability of a product, as usability is a function of the context in which the product is used. Usability is, therefore, a property of the interaction between a product, a user and the task (or set of tasks) that he or she is trying to complete. The characteristics of the context (the users, tasks, and the environment) may be as important in determining usability as the characteristics of the product itself. Usability can, therefore, be better described as a property of the overall system: it is the quality of use in a certain context (Bevan & Macleod, 1994).

The definition of usability coined by the International Standards Organsation (ISO) successfully incorporates all these elements. The ISO (ISO DIS 9241-11 cited in Jordan, 1998, p.37) defines usability as "...the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments."

3.3.4 The quality-of-use view of usability

Defining usability in this way, implies that usability can be regarded as the outcome of human-system interaction and can be measured by the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments (Bevan & Macleod, 1994). Gergle, Brinck and Wood (2002) focus on a quality-of-use view of usability. They define usability as the "...degree to which people (users) can perform a set of required tasks. It is the product of several, sometimes conflicting, design goals, that include efficiency to use, learnability of the product and error tolerance-to name a few" (Gergle et al., 2002, p.55).

In defining quality, traditional approaches to quality have placed emphasis on specified requirements, which are primarily functional. Attempts have been made to broaden the perception of quality. For example, ISO/IEC

9126 categorises quality from a user perspective as functionality, reliability, efficiency, maintainability and portability (Bevan, 1999). The ISO/IEC has recently been revised to include a new quality model which distinguishes between three different approaches to product quality. Each of these will be discussed briefly, as they will impact on the user's evaluation of the usability of the chosen software applications products (*NetMeeting* and *Yahoo Messenger*).

The three approaches to system and or software product quality include (Bevan, 1999):

a. Internal quality, which is measured by the static properties of the code, typically by inspection (such as path length);
b. External quality, which is measured by the dynamic properties of the code when executed (such response time); and
c. Quality of use (usability), which is measured by the extent to which the software meets the needs of the user in the working environment.

A dynamic, interdependent relationship exists between the above-mentioned three elements of quality (see figure 3.2). External quality is a result of the combined behaviour of the software and the computer system, while quality in use (usability) is the effectiveness, productivity and satisfaction of the user when carrying out representative tasks in a realistic working environment. It is important to note the relationship between the different elements. Appropriate internal attributes of the software are a pre-requisite for achieving the required external behaviour and appropriate external behaviour is a pre-requisite for achieving quality in use (Bevan, 1999).

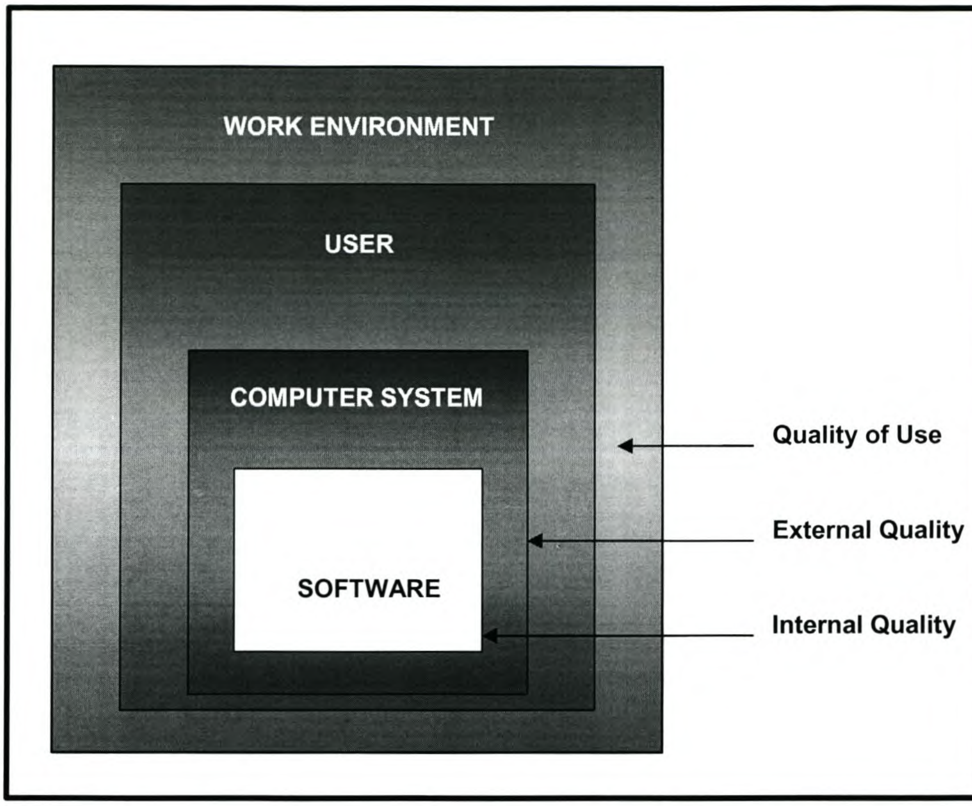


Figure 3.2: The relationship between internal quality, external quality and quality in use (Bevan, 1991, p.3).

For the purpose of this study, the relationship between the external quality, internal quality and quality of use (usability) is of extreme importance, because of the dynamic nature of the software applications that were examined. *NetMeeting* and *Yahoo Messenger* both facilitate real-time synchronous communication. Given the nature of the communication, it is the opinion of the researcher that the attributes of the internal and external quality (quality of audio and video etc.) of the systems cannot be studied in isolation from the quality of use (usability) of the system. To clarify the relationship between the different elements, the model presented in figure 3.3 was developed.

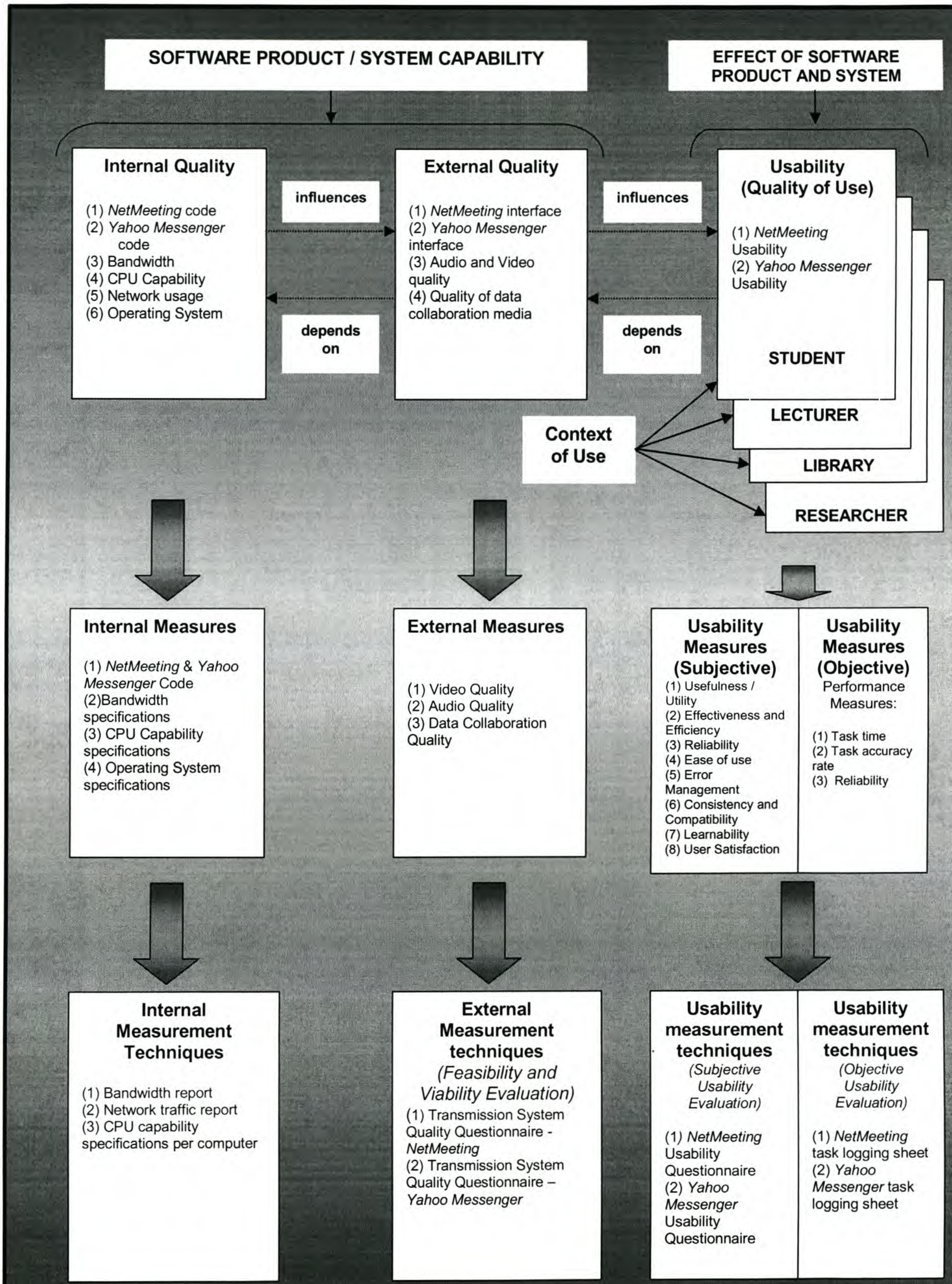


Figure 3.3: Model developed to illustrate the approach taken to measure the usability, feasibility and viability of synchronous CMC media supported by software applications, *NetMeeting* and *Yahoo Messenger,* in this study.

3.3.5 Elements of the proposed model for measurement the usability and feasibility of *NetMeeting* and *Yahoo Messenger*

3.3.5.1 Software product / System capability: Internal Quality

For the purpose of this study, internal quality will refer to system characteristics that entail both the physical hardware and software properties of the computer system that was used. These include the following (terminology used will be explained within the context of this study):

- *NetMeeting* and *Yahoo Messenger* code (versions), where code refers to the manner of representing information on a machine or in some physical form so that the information can be placed on the external data bus in order that it may be read by all devices (A+ Certification Training Kit, 2000);
- The bandwidth available to the specific computer system. Bandwidth is used in several ways to denote the amount of data or load capacity of a medium. In this study, bandwidth will refer to the rate in bits per second (bps) at which data can potentially be sent between two or more network interfaces connected by a Local Area Network (LAN), modem or another communication device (A+ Certification Training Kit, 2000);
- The average network usage for the specified time in which the computer system was used. A network is defined as a group of two or more computers linked together electronically (Palloff & Pratt, 1999). 'Traffic' refers to the amount of actual data being sent over a medium. This is an indication of the amount of users and other networking devices that are engaged in activities over the network, utilising a certain amount of the available bandwidth;
- The central processing unit capability (CPU) of the computer. The central processing unit capability refers to the capability of the CPU to execute commands, and is often measured by its maximum system clock rate in megahertz (MHz), or millions of cycles per second. The clock rate is an indication of how many

commands can be completed in one or two cycles, depending on the specific CPU architecture. Thus, the higher the speed, the more commands can be executed per second, or the faster a single command can be executed (A+ Certification Training Kit, 2000); and

- The operating system loaded onto the computer. The operating system (OS) is a set of instructions that directs a computer to carry out certain tasks and functions. The OS is responsible for the management of software applications, data and hardware involved. The OS is also the basic software component needed for any computer to function (A+ Certification Training Kit, 2000).

It has been established that the above-mentioned system capabilities (internal quality) have a major impact on the external quality of the software product and system performance and thus also the usability of the system (Bevan, 1991). The hardware and software configuration (internal quality) of the computers used for this study, are specified in appendix A. A bandwidth report will be used as a technique to establish the internal capability of the system for the specified time of the experiments.

3.3.5.2 Software product / System capability: External Quality

In the context of this study, external quality refers to the following characteristics of the software product or system: the interface that is displayed, the audio and video quality, as well as the quality of the data collaboration media. The external quality depends on the internal quality system characteristics. In order to measure the external quality, a questionnaire (Transmission System Quality Questionnaire – appendix B) was designed. It focussed on the video and audio quality, as well as the quality of the data collaboration media embedded in the software applications.

3.3.5.3 Effect of the software product and system

While the internal and external quality of the software product or system will be used to establish the technical feasibility of the system, these elements will definitely also influence the quality of use (the usability) of the system.

Based on the literature survey, the following dimensions will be included in the operational usability definition for this study:

- General usefulness/utility;
- Effectiveness and efficiency;
- Reliability;
- Ease of use;
- Error management;
- Consistency and compatibility;
- Learnability; and
- User satisfaction.

A subjective evaluation of these dimensions was conducted by administering the usability questionnaire (appendix C) designed specifically for this purpose. Objective measures for establishing the usability of the system included performance measures such as task time, task accuracy rate and reliability.

3.3.6 Integrated definition of usability for the VIS project

The position taken by the researcher is that a comprehensive definition of usability should encompass all of the above-mentioned views and elements. The following definition of usability successfully incorporates the product-centered, context-of-use, and quality-of-use views of usability, and will be used to define usability within this study.

> "The usability of a system or equipment can be defined as the capability in human functional terms to be used easily (to a specified level of subjective assessment) and effectively (to a specified level of performance) 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"

(Shackel & Richardson, 1991, p.24).

The researcher would like to point out at this stage that the usability study cannot be separated from the technological feasibility study, as the above-mentioned model clearly highlights the interdependent relationship between the two. Although this study will focus mainly on the usability of the software applications, *NetMeeting* and *Yahoo Messenger*, the feasibility and viability of these systems when applied within the technological infrastructure of the US, will also be considered. In order to achieve this purpose the concepts of feasibility and viability should be defined.

A system is feasible when it demonstrates a capability of working successfully, in a practical, easy and convenient manner (Oxford dictionary, 1998). The viability of a system, on the other hand, refers to the extent to which the system works successfully under specific circumstances. Viability, furthermore, could also encapsulate relevant cost factors which could influence the implementation and/or effective utilisation of a system. For the purpose of this study, the feasibility and viability of the supporting technological systems to the virtual information sharing process is, therefore, defined as the extent to which the software application or system is capable of working successfully at an acceptable cost level, given the current technological infrastructure of the US, within which the system has to function.

3.3.7 Usability Paradigm within the VIS project environment

Shackel and Richardson (1991) point out that when users make decisions about systems, their decisions usually not only depend on the usability (in the terms that have been defined above), but also upon an assessment of balancing factors (for example, financial, personal and organisational costs).

It is important to note, however, that potential implementation of the systems, *NetMeeting* and *Yahoo Messenger*, within the information sharing and communication infrastructure of the US should still be subjected to the trade-off paradigm (usability versus other balancing factors), as proposed by Shackel and Richardson (1991) (see figure 3.4). In doing this, the US governance will succeed in placing usability in its balanced position with functionality, deriving a decision on the acceptability of the software applications from the interplay between usability and various cost factors.

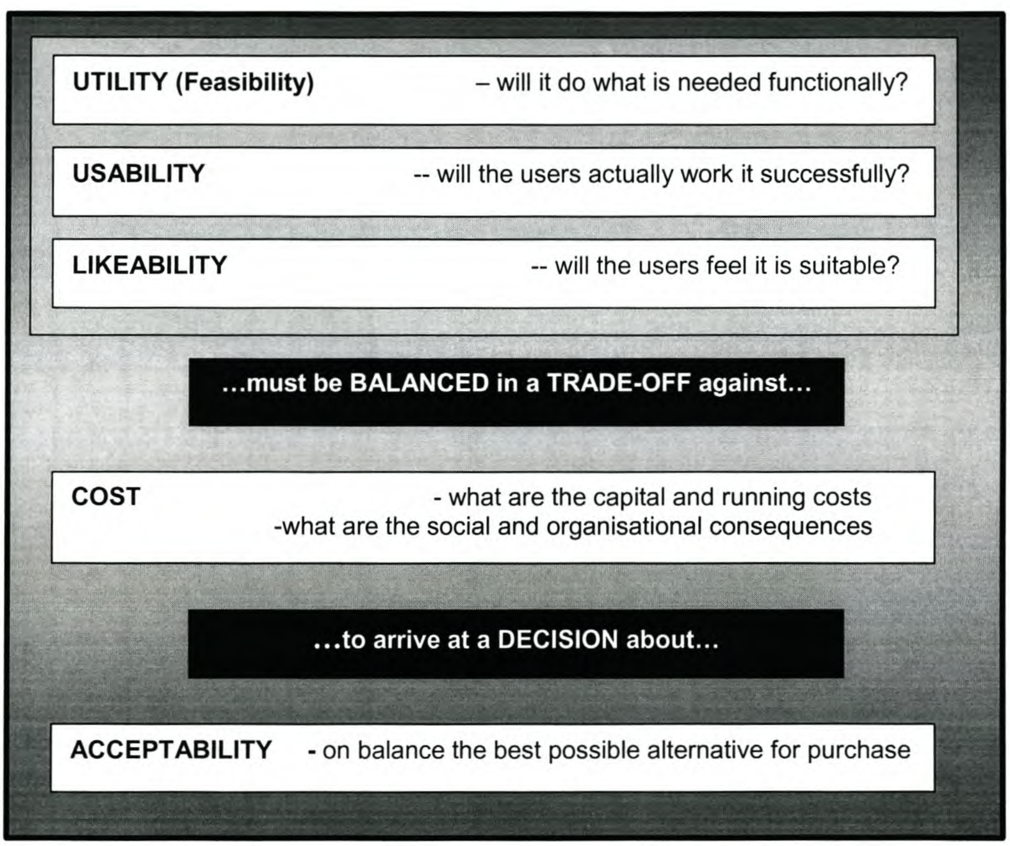


Figure 3.4: The paradigm of usability and related concepts (Shackel & Richardson, 1991, p. 22).

3.4 THE COMPONENTS / DETERMINANTS OF USABILITY

According to Shackel & Richardson (1991), usability mainly depends upon the design of the tool in relation to the users, the task, and the environments. Bevan and Macleod (1994) also identify the users, task, equipment and environment as the context-of-use components of usability. Furthermore, the attributes required for a product to be considered usable, is influenced by variables such as the nature of the user, the task it is intended to be used for, and the environment within which it will be used. Each of these components will be discussed shortly.

3.4.1 The User

One problem with understanding users is that an agreed definition on who or what constitutes a 'user' is lacking (Webb, 1996). Shackel and Richardson (1991, p.134) defines users as, "...all the people that will use the specified system." In this sense, users are seen as components within the system and knowing the user thus becomes one of the most basic of all usability guidelines. For the purpose of the VIS project environment, users will be defined as all the people that will use the different systems (*NetMeeting* and *Yahoo Messenger*). Four different categories of users have been identified within the VIS project environment. These include lecturers, researchers, information service suppliers and students.

Individual user characteristics, the user's current task and variability in task have a sizeable impact on usability (De Jager, 2002). A product that is usable for one person will not necessarily be usable for another. Designing for usability, therefore, implies designing for those who will use the product in question. For this reason, it is vital to gather as much information about the users as is possible, prior to the design of a product or system, and to thus have a thorough understanding of those for whom the product is intended.

A number of user characteristics that could predict how easy to use a product will be for a specific user, exists. Previous experience with the product itself is likely to affect just how easy or difficult it is to complete a particular task for a particular user. Experience with other similar products will also affect how usable a new product is for a user. The user's domain knowledge is another important characteristic that can significantly influence the user's performance with a product. Domain refers to the knowledge relating to a task that is independent of the product being used to complete that task. Personal attributes like the cultural background of a user as well as physical limitations and capabilities can also influence how he or she interacts with a product. Age and gender as such, but also attitudes that people may be more likely to hold according to their age and gender, can also play a role here (Jordan, 1998; Bevan & Macleod, 1994).

Shackel (1984) points out that the user's motivation and attitudes can also have an impact on usability. With regards to motivation, it has been established that highly attractive tasks and strong goal orientation can create user involvement and overcome poor usability. Research has shown that attitudes, on the other hand, are probably only indirectly related to usability, except when attitudinal measures directly investigate the user's opinions with regards to the ease of use of the system.

3.4.2 The Task

Considering the relationship between the user and the task, Hix and Hartson (1993, p.123) point out that, "understanding users means understanding how they will use the system, and consequently the tasks that are to be performed with the system, within their work context." The task can be defined as the, "sequence of steps a user will follow to achieve a specific goal" (Gergle et al., 2002, p.54).

In the breakdown of the context for usability measurement, Bevan and Macleod (1994) suggest that certain task characteristics should be specified. These include task frequency, duration, flexibility, physical and mental demands, as well as task output.

In order to attain detailed information about the task, a task analysis should be executed. A task analysis provides a complete description of the tasks, subtasks, and methods involved in using the system, as well as identifying resources necessary for users and the system to cooperatively perform the tasks (Hix & Hartson, 1993). A number of 'standard' task analysis methods, for application within usability evaluation, have been developed. Amongst the most commonly used, are the Keystroke Model and GOMS (goals, operators, methods and selections rules) (Jordan, 1998).

3.4.3 The Environment

The environment is a very broad category, comprising physical, psychological and social aspects (Shackel, 1984). Bevan and Macleod (1994) divide the environment into three categories: the organisational, the technical and the physical.

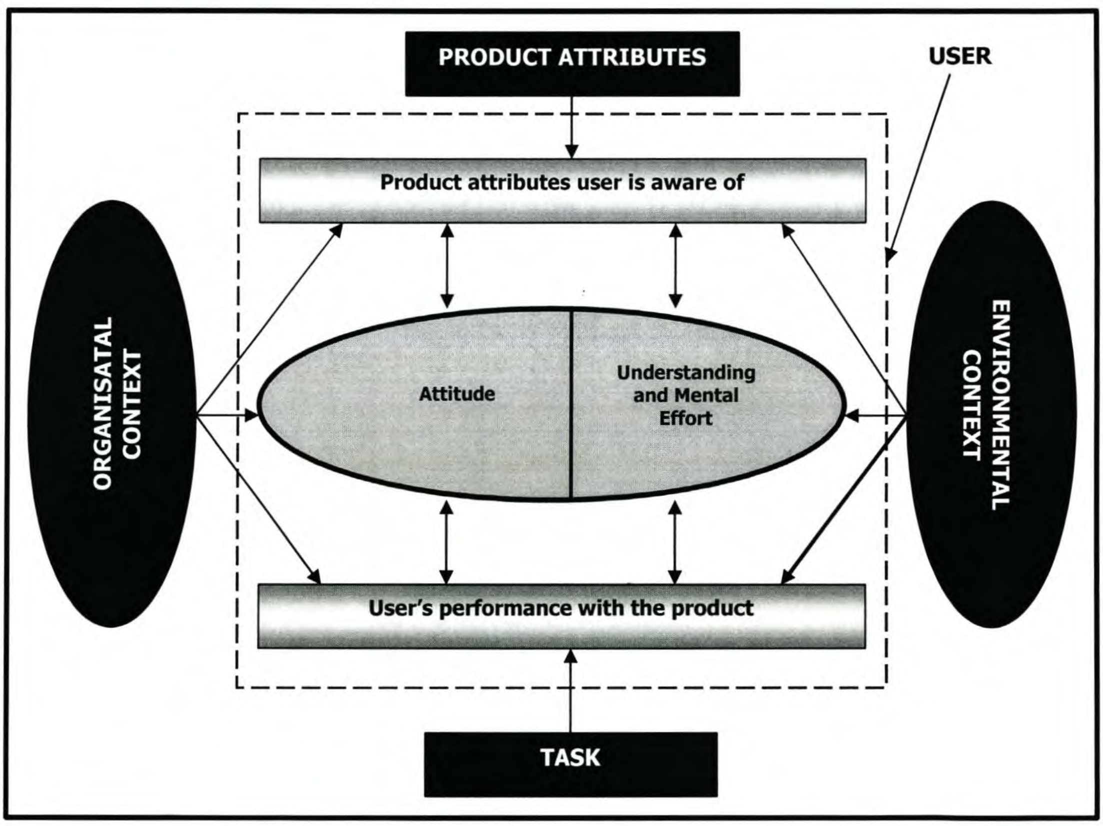


Figure 3.5: The determinants of Usability (adapted from Bevan et al., 1991, p.3).

The organisational environment includes organisational structure, attitudes and culture and job design. The technical environment includes technical configuration elements, such as the hardware and software being used by the user. Lastly, the physical environment includes factors such as workplace design, conditions and safety. The dynamic relationship between the user, task and environment as the context of use components that determine usability, is shown in figure 3.5.

3.5 USABILITY ATTRIBUTES

Usability has many attributes by which it is defined. Bevan et al. (1991), state that a product in itself is not usable or unusable, but rather has attributes which will determine the usability for a particular user, task and environment. These attributes include not only the specifically ergonomic characteristics but also all the characteristics of the product that will impinge on usage, including those aspects of software quality (such as efficiency and reliability), which affect ease of use. Usability attributes thus outline the features and characteristics of the product that influence the learnability, effectiveness, efficiency and satisfaction with which users can achieve specified goals in a particular environment (De Jager, 2002).

The following usability attributes have been cited most frequently in usability literature.

- **Functionality:** functionality refers to the capability of the software to provide functions that meet stated and implied needs when the software is used under specified conditions (ISO/IEC 9126-1, cited in Bevan, 1999; Gergle et al., 2002).
- **Efficiency:** efficiency can be a measure of the time or actions required to perform a task, thus the amount of effort required to accomplish a goal. Measures of efficiency relate to the level of effectiveness achieved weighed up against the expenditure of resources (Bevan & Macleod, 1994; Gergle et al., 2002; ISO/IEC 9126-1 cited in Bevan, 1999; Jordan, 1998; Rengger & Turner, 1988).
- **Effectiveness:** effectiveness refers to the extent to which a goal or task is achieved. Measures of effectiveness relate the goals or sub-goals of using the system to the accuracy and completeness with which these goals can be achieved (Bevan & Macleod, 1994; JISC Technology Applications Programme, 1998; Jordan, 1998; Rubin, 1994).
- **Satisfaction / likeability / subjectively pleasing:** these attributes refer to the level of comfort that the users experience when using a product and the

level of acceptability of the product to users as a means of achieving their goals. Likeability thus refers to the user's perceptions, feelings and opinions on the product (Bevan & Macleod, 1994; Gergle et al., 2002; Jordan, 1998; Rubin, 1994; Shneiderman, 1987).

- **Learnability / easy to learn:** 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 (Gergle et al., 2002; Rubin, 1994; Shneiderman, 1987).

Other attributes of usability that were also cited in literature are listed below.

- **Task Efficiency:** the task efficiency metric is designed to measure the efficiency with which a user can achieve the objective of a task. The metric is based on task performance and speed. It depends on measuring how accurately and quickly an expert can accomplish a task and then relating this to a specific user's performance and speed. The actual metric is defined as:

$$\text{Task Efficiency} = \frac{\text{Task Success}}{\text{Task Time Ratio}}$$

  Task success refers to the percentage of the task that the user successfully completes, compared to the performance of the expert. The time task ratio is the ratio between the time taken by the user and the time taken by the expert for the task. An expert in this context is defined as someone who has access to the facilities of the system being evaluated, who can therefore carry out the task without consulting any source of help (Rengger & Turner, 1988).

- **User efficiency:** user efficiency is a measure of the time component involved in achieving a given level of effectiveness and is expressed in the equation below.

$$\text{User efficiency} = \frac{\text{Effectiveness}}{\text{Task time}}$$

This measure can be used comparatively to provide comparative user efficiency between different conditions (JTAP, 1998).

- **Problem analysis / Error tolerance / Error rate:** the number of problems that arise, the ease with which they can be overcome, and their ranked order, are all important parameters that affect the usability of the system. In this context, a problem is defined as any situation in which the computer system functions in a manner that the user does not expect. Problems arise as a result of three main causes:
    - User error. A user is defined as performing an error when the action or response of the user is inappropriate for the current state of the system;
    - System errors. A system is defined as performing an error when its reaction to an appropriate action or response from a user is inconsistent with its designed behaviour; and
    - User difficulties. A user is defined as experiencing difficulty when the system's behaviour is not fully understood by the user even though an error has not been made.

  Errors, as defined above, are cases of illogical interaction between the computer and the user (Gergle et al., 2002; Rengger & Turner, 1988).
- **Activity Problem Rate:** it is very rare for a computer system to be used without some difficulties being encountered by users. Nevertheless, the more problems that are encountered by users, the more difficult is it for them to successfully complete a task. A system-independent metric that can be used to quantify this difficulty, is the ratio of the number of problems encountered, to the number of activities carried out. This ratio is called the activity problem rate (Rengger & Turner, 1988).
- **Task Accuracy:** task accuracy is an indication of correct performance. The task accuracy rate can be calculated in three ways:
    - Percentage of participants performing successfully within the time benchmark:
    - Percentage of participants performing successfully, regardless of the time benchmark: and
    - Percentage of participants performing successfully, regardless of the time benchmark, including those who required assistance.

The last measure is the most inclusive measure. It includes every participant who completed the task successfully, whether before or after the maximum time allocated and whether or not they required assistance. If this number is very low, it indicates very serious problems with the product, because participants could not execute the task successfully, even with assistance and extra time (Rubin, 1994).

- **Usefulness:** usefulness concerns the degree to which a product enables a user to achieve his or her goals, and is an assessment of the user's motivation for using the product. Usefulness, therefore, refers to the value, worth and helpfulness of the system (Nielsen, 1993; Rubin, 1994).
- **Utility:** utility refers to the functionality of the system to the user, thus the power to satisfy human wants (Shackel & Richardson, 1991; Shackel, cited in Bennet, Case, Sandelin & Smith, 1984).
- **Task completion rate:** the most basic measure of the effectiveness of a product for a particular task, is the user's capability to complete the task with the product. With more complex systems, it is possible that a user completes a task with only partial success (Jordan, 1998).
- **Time on task:** along with error rate, this is probably the most widely used measure of usability. Clearly, the quicker a user can complete a task using a product, the more efficient that product is for the task (Jordan, 1998).
- **Mental workload/ Cognitive workload:** mental workload is a measure of efficiency that has been widely used in assessing the usability of products, where the time in which to carry out tasks is fixed and error rates are low. There are a number of ways in which mental workload can be measured. McCormick and Sanders (cited in Jordan, 1998) mention heart rate variability, brain rhythm analysis, pupil dilation and body fluid analysis as being amongst the techniques that various analysts have used. Bevan and Macleod (1994) identify objective and subjective measures of cognitive workload. Objective measures include heart rate, blood pressure and temperature regulation. Subjective measures include questionnaires, such as the Subjective Mental Effort Questionnaire (SMEQ) and the Task Load Index (TLX).
- **Reliability:** reliability refers to the dependability of the system and the repeatability (without failure) of tasks when using the system (De Jager, 2002).

- **Compatibility:** compatibility refers to the degree to which the system's method of operation conforms to the user's expectations (Jordan, 1998).
- **Consistency and Controllability:** consistency and controllability refers to the ability of the system to respond to user inputs in a consistent way and to perform similar tasks in similar ways (Jordan, 1998).

3.6 USABILITY MEASUREMENT / EVALUATION

"Usability is quantifiable it is not something that is merely subjective"

(Gabbard, Swan, Hix, Lanzagorta, Livingston, Brown & Julier, 2002, p.2).

3.6.1 Types of measurement

Usability measurement or testing refers to a process that employs participants who are representative of the target population in order to evaluate the degree to which a product meets specified usability criteria (Rubin, 1994). Bevan et al. (1991) point out that the usability of a product for a user carrying out a particular task, in a particular environment, can be measured with a combination of performance measures as well as an assessment of the internal state of the user (including acceptability).

Shackel and Richardson (1991) identify three general types of measurement criteria available for evaluation: dimension, performance and attitude. The performance and attitude criteria for measurement are mostly applicable for the usability evaluation of software applications, *NetMeeting* and *Yahoo Messenger*, and will therefore be discussed shortly.

- **Performance criteria for usability measurement:** performance measures, such as time spent on task and error rate, are perhaps the 'traditional' metrics by which usability has most often been measured (Jordan, 1998). Performance criteria involve an objective statement of some achievement, often in terms of time and errors, against which human performance can then be measured. Although the interpretation of performance criteria is often also seen in terms of a pass or fail, the measurements obtained for comparison with the criterion give some indication of the degree of usability achieved (Rubin, 1994; Shackel & Richardson, 1991).

- **Attitude criteria for usability measurement:** attitude criteria, or preference data, consist of the more subjective data that measures a participant's feelings or opinions of the product (Rubin, 1994). Shackel and Richardson (1991, p.35) state that, "...attitude criteria can be defined with the same precision and operational form as performance criteria, since there has been much research done in psychology on controlled methods of gathering subjective data from humans." Jordan (1998) holds that for attitude data to be meaningful, it is necessary to quantify attitude, so that reactions to a particular product can be assessed in relation to the criteria set. In this way, quantitative criterion can be a way of getting user attitude accepted as product quality indicator in the same way as technical and performance aspects.

3.6.2 Choosing usability measures

With regards to the relative importance of different measures, Bevan and Macleod (1994) state that the choice of appropriate measures and the level of detail is dependent upon those characteristics of the context of use that may influence usability, as well as the objectives of the parties involved in the measurement. Performance measures will assess the operational capability that can be achieved by the human user, but will of course not assess the cost or difficulty in achieving the performance. The attitude measures assess the user's view of the cost and relative difficulty in achieving the performance. For this reason, performance measures cannot be the sole criterion, because the individual involved may readily achieve a given performance, but still not prefer to do the task or to use the tool, because it is very inconvenient and awkward (Shackel & Richardson, 1991). The view that attitude measure should be a part of usability evaluation, is supported by Chapanis (cited in Shackel & Richardson, 1991, p. 367) as he states that, "...evaluations of usability should take into account how users feel".

3.6.3 Methods for Usability Evaluation

3.6.3.1 Background

The concept of evaluation dates back to the beginning of system analysis and human factors. Usability evaluation stretches back to virtually the beginning of human-computer interaction (HCI) and usability evaluation methods go back more than a decade (Hartson, Andre & Williges, 2000). Evaluation helps to ensure that the user-centered design is on track to satisfy the goals of the design. Evaluation may include usability evaluation, client review of the design, quality assurance, or technical feasibility (Gergle et al., 2002).

Various types of usability evaluations can be performed. Different types of evaluations will often be used for the same product, but at different points in the development cycle (Fath, Mann & Holzman, 1994). Choosing a usability inspection method will thus require consideration of several methodology issues, beginning with the objectives of the inspection (Nielsen & Mack, 1994). Karat (cited in Nielsen & Mack, 1994) states that there is a "tool kit" of usability evaluation methods available and that the users of these methods need to be able to select a method that meets their needs or tailors a method to the requirements of the situation. Each method has a series of properties, which gives the method certain advantages and disadvantages. Sufficient knowledge on the different methods should thus ensure correct application by researchers.

In conducting a usability study, both empirical and non-empirical methods can be used. Many of the methods have their root in psychology (for example, experiments, questionnaires and interviews), some have been adapted from other disciplines (for example focus groups or workshops), whilst other have been developed specifically for usability evaluation (for example co-discovery or cognitive walkthroughs) (Jordan, 1998).

Generally, there are three types of usability evaluation methods that can be differentiated. The three types include (Mayhew, 1999):

- **Usability testing:** in the usability testing approach, empirical data is collected while representative users work on typical tasks using the system or prototype. Evaluators then use the results to see how the user interface supports the users in performing their tasks;
- **Usability inspection:** here the usability specialists (sometimes other professionals or software developers) examine usability related aspects of a user interface; and
- **Usability inquiry:** the general aim of a usability inquiry is to obtain information about user's likes, dislikes, needs, and understanding of the system by way of discussing these issues with them, observing them using the system, or letting by them answer questions either verbally or in a written form.

Some of the major techniques and methods of usability evaluation, as categorised in Mayhew's taxonomy, are listed in table 3.1. Each of the methods that appeared most frequently in usability literature will be discussed shortly.

Table 3.1: Usability Evaluation Methods categorised into Mayhew's taxonomy (Mayhew, 1999).

Usability Testing	Usability Inspection	Usability Inquiry
1.Co-discovery Learning 2.Performance Measurement (Formative and Summative evaluation) 3.Thinking Aloud Protocol	1.Cognitive Walkthroughs 2.Heuristic Evaluation 3.Pluralistic Walkthroughs 4.Expert Evaluation 5.Usability Audit/ Standard inspection 6.Checklist	1.Field Observation 2.Focus Groups 3.Interviews 4.Logging Actual Use 5.Questionnaires

3.6.3.2 Usability Inquiry

a. Field studies

Field observation involves watching users in the environment in which they would normally use a product. Typically conducted very late in the development cycle, the information is rarely used to make significant changes, although the data can be extremely valuable when used for future releases. Field studies sacrifice some of the control of the formal laboratory, however, to gain greater ecological validity (Fath et al., 1994; Jordan, 1998; Nielsen, 1993; Nielsen & Mack, 1994; Rubin, 1994).

b. Focus Groups

A focus group is a group of people gathered together to discuss a particular issue. Focus group research is typically employed during the early stages of a project. A focus group could, for example, cover user' experiences of using a particular product, their requirements for a new product, or usability problems that are associated with using a product. The strength of the focus group is its ability to explore a few people's judgements and feelings in great depth and in doing so, will acquire knowledge of how end-users think and feel (Gergle et al., 2002; Jordan, 1998; Nielsen, 1993; Nielsen & Mack, 1994; Rubin, 1994).

c. Interviews

Interviews can be conducted in conjunction with other techniques, to uncover the thought processes behind the user's actions. The investigator compiles a series of questions, which are then posed directly to participants. As with questionnaires, questions can be formulated for investigating users' attitudes towards prototypes or finished products (Gergle et al., 2002; Jordan, 1998; Nielsen, 1993).

d. **Logging Actual Use**

Logging involves having the computer automatically collect statistics about the detailed use of the system. The outcome of using such a device is the acquisition of information explaining the extent to which a user has interacted with a particular aspect of the system or product (Jordan, 1998). Nielsen (1993, p.218) points out that, "...since the logging data shows what the users did but not why they did it, it would be better to combine logging with other methods such as interviews, where users are shown data about their own use of the system and asked to explain their activities."

e. **User Survey Questionnaires**

Surveys are employed in order to understand the preferences of a broad base of users with regards to an existing or potential product. Surveys can be used at any time in the life cycle, but are mostly used in the early stages in order to better understand the potential user. Answering a questionnaire focuses the respondent's mind on a particular topic. The advantage of a usability questionnaire is that it gives feedback, from the perspective of the user (Jordan, 1998, Rubin, 1994).

3.6.3.3 Usability Inspection

a. **Walkthroughs**

A walkthrough is an informal evaluation that combines aspects of a product demonstration with an assessment of user reactions to the interface. Walkthroughs can be used with either paper mock-ups, prototypes, or live code (Fath et al., 1994; Rubin, 1994). Different types of walkthroughs exist. Three will be discussed shortly.

- **Pluralistic walkthroughs:** pluralistic walkthroughs are meetings where representative users, product developers, and human factors professionals step through a scenario, discussing usability issues associated with dialogue elements involved in the scenario steps (Bias, cited in Nielsen & Mack, 1994).
- **Cognitive walkthroughs:** cognitive walkthroughs use a detailed procedure in order to simulate the user's problem-solving processes at each step in the human-computer dialogue, checking to see if the user's goals and memory for actions can be assumed to lead to the next correct action. The cognitive walkthrough is a usability inspection method that focuses on evaluating a design for ease of learning, particularly through exploration. This focus is motivated by the observation that many users prefer to learn software by way of exploration (Jordan, 1998; Wharton, Rieman, Lewis & Polson, cited in Nielsen & Mack 1994).
- **Customer walkthroughs:** this type of evaluation helps to assess the intuitiveness of a product for a group of potential users in the design process. The evaluators frequently work as a group along with the evaluation team. The group assesses the product's usability and recommends design alternatives. Many of the most severe usability problems can be quickly discovered through customer walkthroughs (Fath et al., 1994).

b. Heuristic evaluation

Heuristic evaluation is a usability engineering method with the aim of finding the usability problems in a user interface design, so that they can be attended to as an integral part of an iterative design process. Heuristic evaluation involves a small set of evaluators that examine the interface and judge its compliance with recognised usability principles (the "heuristics") (Nielsen, cited in Nielsen & Mack, 1994).

c. **Expert Evaluations**

In this case, a product is evaluated on the basis of whether an expert or experts regard it as being designed in such a way that it will be usable. The specialist performs a review according to accepted usability principles from the body of research and human factors literature. An expert, in this context, is an investigator whose education, professional training and experience allow him or her to derive an informed judgement on usability issues, with regards to the product under investigation (Bevan et al., 1991; Jordan, 1998; Rubin, 1994).

d. **Usability Audit / Standard inspection**

In a usability audit, the product or system is evaluated by comparing its design against checklists of standards. Also called standards inspections, an expert on some interface standard will inspect the interface for compliance with the specified standard (Nielsen & Mack, 1994; Rubin, 1994).

e. **Checklists**

Property checklists list a series of design properties which, according to accepted human factors knowledge, will ensure that a product is usable. Users can then complete detailed checklists with regards to the acceptability of various aspects of the interface, thus highlighting particular problems. Usability specialists can also evaluate the usability of the system for pre-defined tasks, by assessing whether it meets the detailed requirements that are identified in checklists (Bevan et al., 1991; Jordan, 1998).

3.6.3.4 Usability Testing

a. **Co-discovery**

This method involves two users working together to explore a product and to discover how particular tasks are performed. The investigator will then proceed to analyse the participants' verbalisations, and in this way gain an understanding of the usability issues associated with the product (Jordan, 1998; Nielsen, 1993).

b. **Formative evaluation**

Formative evaluation (also named formal usability testing, controlled experiments and user performance tests), constitute methods that are used to collect empirical data, while observing representative end users that are using the product to perform representative tasks. Formal usability testing is usually performed in a usability laboratory. The experiment is a formally designed evaluation with considerably tight controls and balances. The aim would be to remove as much 'noise' as possible from the data, in order to isolate the effects of performance with the product as cleanly as possible (Hix & Hartson, 1993; Jordan, 1998; Nielsen & Mack, 1994; Rubin, 1994; Shackel, 1981).

Fath et al., (1994) identify the following types of tests that are used in the IBM Atlanta usability laboratory:

- **Prototype and live code formal tests:** these evaluations are performed at any given time during the development cycle and are designed to provide answers to specific usability issues (for example, navigation terminology, and on-line help).
- **Quick tests:** these tests are performed when a specific design alternative must be chosen in a short span of

time and design alternatives can be simply and easily presented to evaluators by way of a prototype or live code.

- **Benchmark tests:** these tests are performed to determine the length of time it takes a person to learn or to perform a set of tasks in a given set of circumstances. The test may help to determine how quickly and easily either a novice, an expert, or an average user can learn to perform the tasks.

c. Summative Evaluation

A summative evaluation is a statistical comparison of two or more configurations of user interface designs or user interface components. As with a formative evaluation, representative users perform task scenarios, as evaluators collect both qualitative and quantitative data (Hartson et al., 2001; Hix & Hartson, 1993).

d. Think-Aloud Protocol

In the think-aloud protocol users, are asked to verbalise their thoughts while using the system, explaining their actions as they perform their tasks. This approach to usability evaluation is, in general, helpful in determining why users behave in the manner observed. It is especially helpful when users have unexpected responses (Gergle et al., 2002; Jordan, 1998; Nielsen, cited in Nielsen & Mack, 1994).

3.6.4 User-centred design and usability evaluation methods

A usability method is any technique that is used to create a design from a user centered perspective (Gergle et al., 2002). Interactive systems are usually designed through an iterative process involving design, evaluation and redesign. The formative usability evaluation method focuses on usability problems that need to be solved during the prototype design stage, before a final design can be accepted for release. Summative evaluation is then conducted in order to evaluate the effectiveness of the final design or to compare competing design alternatives, in terms of usability. As shown in figure 3.6, most of the usability evaluation methods that were discussed, are used primarily for formative evaluations during the prototype design stage.

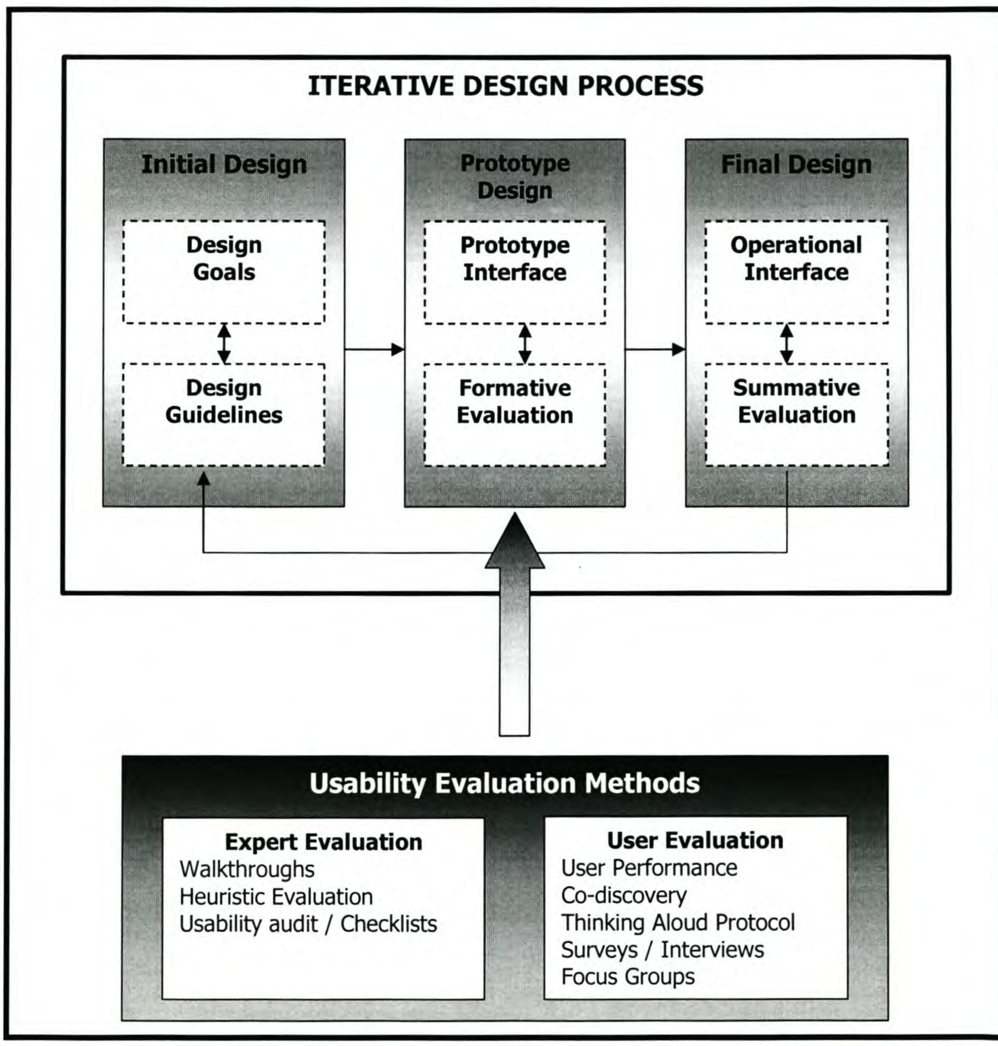


Figure 3.6: Usability Evaluation Methods used in Formative Usability Evaluation (adapted from Hartson et al., 2000).

These formative evaluations are focused on efficient and effective techniques that will determine usability problems that need to be eliminated through redesign. A combination of expert- and user-based inspection methods have evolved in order to facilitate the formative evaluation process (Hartson et al., 2000).

3.6.5 Classification of Virtual Environments Usability Evaluation Methods: Application for the VIS Environment

The following classification model (figure 3.7) provides a structured means for comparing usability evaluation methods according to three key characteristics: involvement of users, context of evaluation, and types of results produced (Bowman, Gabbard & Hix, 2002). In this classification model, the first characteristic (user involvement) discriminates between those methods that require the participation of users (to provide design or use-based experiences and options), and those methods that do not (methods not requiring users still require a usability expert).

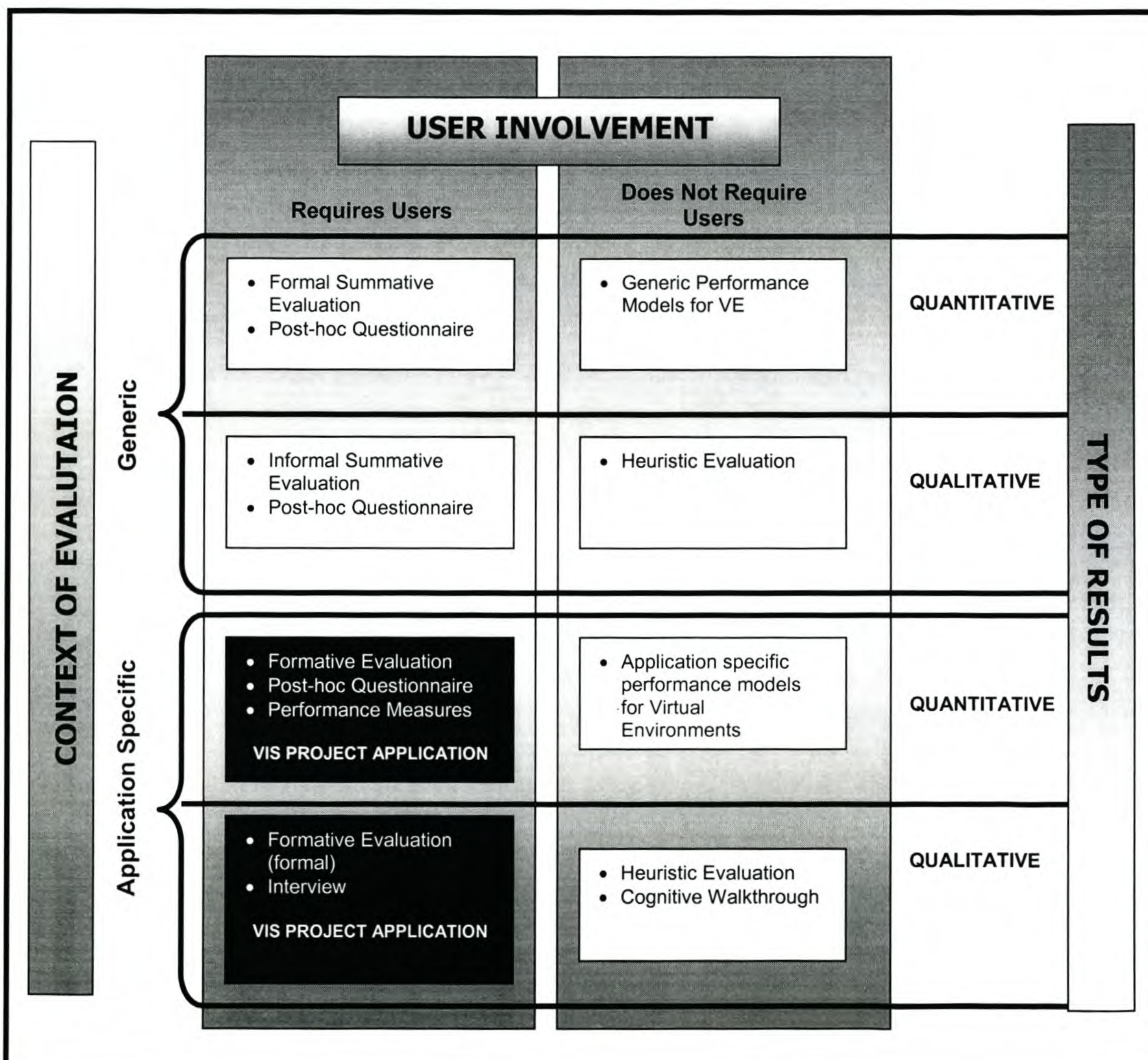


Figure 3.7: A classification of usability evaluation methods for virtual environments (adapted from Bowman et al., 2002).

The second characteristic describes the type of context in which the evaluation takes place. In particular, this characteristic identifies those methods that are applied in a generic context and those that are applied in an application-specific context. The results of evaluations conducted in a generic context can typically be applied more broadly (i.e., to more types of interfaces) than results of an applications-specific evaluation method, which may be best-suited for applications that are similar in nature. The third characteristic identifies whether a given usability evaluation method produces (primarily) qualitative or quantitative results (Bowman et al., 2002).

In choosing appropriate usability evaluation methods for this study, the three above-mentioned characteristics (user involvement, context of evaluation and type of results) together with the VIS project goals, as well as budgetary and time constraints, were taken into account. Due to these factors, it was the researcher's decision to conduct a formative evaluation, gathering qualitative and quantitative data through questionnaires, interview feedback and observers. Refer to figure 3.7 for the VIS project application within the Bowman et al. classification.

3.7 POTENTIAL BENEFITS OF USABILITY

Quality in use, and thus usability, should be the major design objective for an interactive product, ensuring that the product can be used for its intended purpose. Increased quality in use brings significant benefits which have been widely documented, and include:

- **Increased efficiency:** a system incorporating good ergonomics design and tailored to the preferred way of working, will allow the user to operate effectively and efficiently rather than lose vital time struggling with a poorly designed user interface and system functionality.
- **Improved productivity:** a good interface to a well designed product will allow the user to concentrate on the task rather than the tool which, if designed inappropriately, can extend rather than reduce the time to do a task,

as well as directly affecting other aspects of performance or quality. Difficult to learn software also increases the cost of training and subsequent support.

- **Reduced errors:** a significant proportion of so-called "human error" can be attributed to a product with a poorly designed interface to functionality which is not closely matched to the user's task needs. Avoiding inconsistencies, ambiguities or other interface design faults reduces user error.
- **Reduced training:** a poorly designed user interface and dialogue can prove a barrier to an otherwise technically sound system. A well-designed system, designed with a focus on the end-user can reinforce learning, thus reducing training time and effort, as well as costs related to training and retraining.
- **Improved acceptance:** this is particularly important where usage is discretionary. Users would rather use and would more likely trust a well-designed system, which gives access to functionalities which makes information easy to find, and provides the information in a format which is easy to assimilate and use (Bevan & Macleod, 1994; Karat, cited in Bevan, 1999;).

3.8 USABILITY ENGINEERING

3.8.1 Introduction

System usability is not something that happens by accident or good luck; it must be engineered into a product from the beginning of the development process. Usability engineering is a cost-effective, user-centered development process that ensures a high level of usability in an interactive system (Gabbard et al., 2002). Likewise, Hix and Hartson (1993) defines usability engineering as a process through which usability characteristics are specified, and measured throughout the process of product design and development.

According to Nielsen (1993), usability engineering is a set of activities that take place throughout the life cycle of the product; with significant activities happening at the early stages before the user interfaces have even been designed. Usability engineering ensures a high level of usability by involving users formally, early, and continually in the development lifecycle. The main objective of usability engineering being to provide principles, methods, and tools for supporting quality user interface and maximising usability (De Jager, 2002).

Gabbard et al. (2002) state that producing a usable interactive system requires complementary and parallel application of systems engineering, software engineering and usability engineering, as is shown in figure 3.8.

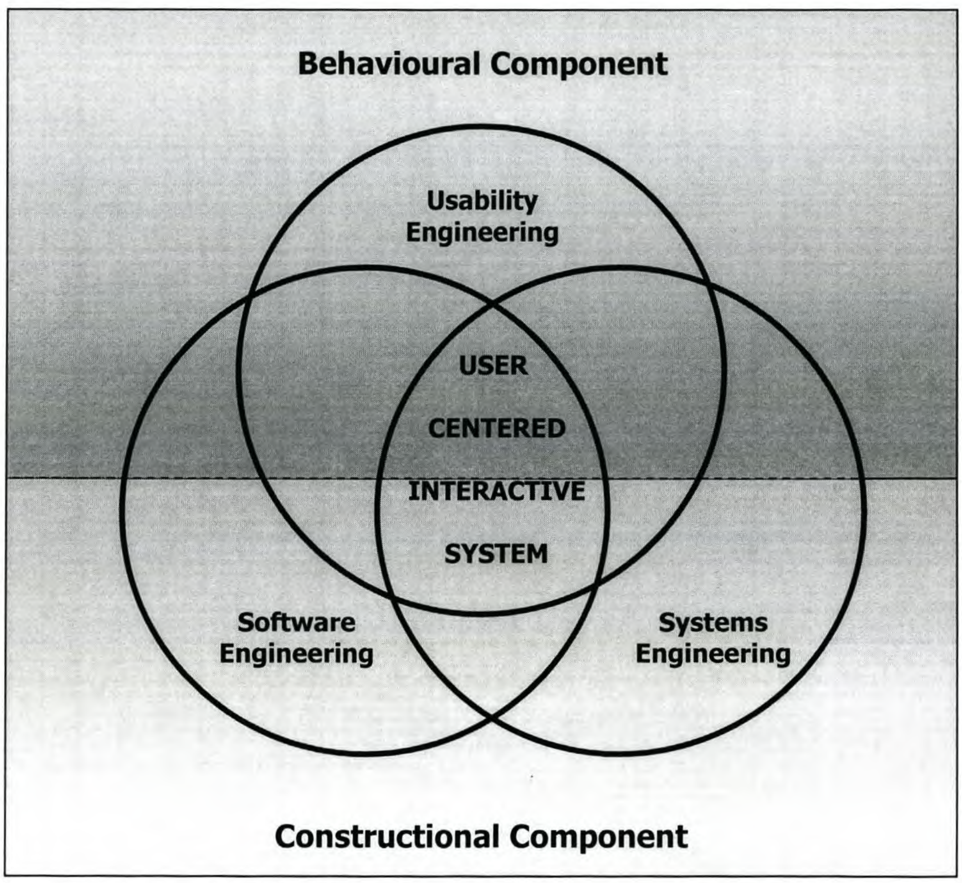


Figure 3.8: The engineering efforts required to produce a user-centred interactive system (adapted from Gabbard et al., 2002, p. 2).

In the behavioral component, usability engineering supports development of user interaction — the look, feel and behavior as a user interacts with an application. User interaction components include all icons, text, graphics, audio, video, and devices through which a user communicates with an interactive system, as well as navigation, layout and content. In the constructional component, software engineering and systems engineering support development of software, including that for both the user interface and the rest of the application (i.e., the non-user-interface, purely computational software), as well as other non-user-interface elements such as hardware. Both the behavioral and the constructional components are necessary for producing any interactive system, but the component that ensures usability, and in which usability engineering is applied, is the behavioral component (Gabbard et al., 2002).

3.8.2 A Usability Engineering Process

The usability engineering process described below (figure 3.9) is applicable to development of any human-computer interface. The left pointing arrows indicate that each activity can iterate with the activity that precedes it. However, research has shown that almost any activity can be followed by any other activity – the boxes depicting the process, should thus be considered as completely connected. To this end, Hix and Hartson (1993) has developed the star life cycle (figure 3.10) of user interaction development. The activities in the star life cycle correspond to a high degree to the activities in the Usability Engineering Process from Gabbard et al. (2002). The various activities are highly connected (as in the model below), however, through the usability evaluation process that resides in the centre of the engineering process. Thus, the star life cycle is evaluation-centred as results of each activity are evaluated before moving on to the next activity.

Each of the activities in the proposed usability engineering process will be discussed shortly.

- **Domain analysis:** the goal of conducting a domain analysis is to answer two critical questions regarding the specific system domain: who are the users, and what tasks will they perform? The most important result of this phase is that the usability engineers gain a thorough understanding of the user's point of view.
- **User-centred requirements and metrics:** these requirements and metrics and quantitative ways of specifying and measuring user

interaction and user performance with the system. The metrics allows usability engineers to assess the usability of the system.

- **Conceptual and detailed user interaction design:** these activities encompass designing a particular set of user interactions, based on the tasks and users of those tasks.
- **Rapid prototyping:** this is a quick and temporary way of implementing detailed user interaction designs for the system.
- **Usability evaluation:** here the usability of the system is assessed and measured.

Figures 3.9 and 3.10 should be viewed as generic process models for usability engineering that could easily be adapted to any situation involving a product and its users. An adapted model for the usability engineering process within this study and the VIS project environment (incorporating most of the above-mentioned activities), is presented in chapter four (figure 4.3) and will therefore not be discussed here.

3.9 CONCLUSION

The purpose of this chapter was to describe the concept of usability through presenting a thorough theoretical background on important issues pertaining to usability. The importance of the usability of the supporting software used to create virtual collaborative learning environments has been emphasised by Laister and Kober (2002). They maintain that, "...the usability of the software applications is a general requirement of a successful online community as high usability makes it possible for users to interact and perform their tasks easily and intuitively" (Laister & Kober, 2002, p.5). Furthermore, De Jager (2002, p.40) points out that, "...it has become increasingly apparent that technology must have high usability in order to increase user effectiveness and acceptance." The importance of usability in the creation of the VIS is therefore indisputable.

It has been established from the literature survey that a connection exists between high usability of a system and user acceptance and satisfaction. Characteristics of usability include, amongst others, the degree to which a system is easy to use, easily learnable and optimised from the user's perspective.

This chapter aimed to define and explain concepts related to usability whilst a context specific view of the topic was presented. The literature of chapters two and three provides a background for this study, and furthermore supports the contents of the subsequent chapter. In chapter four a description will be provided concerning the research methodology of this study.

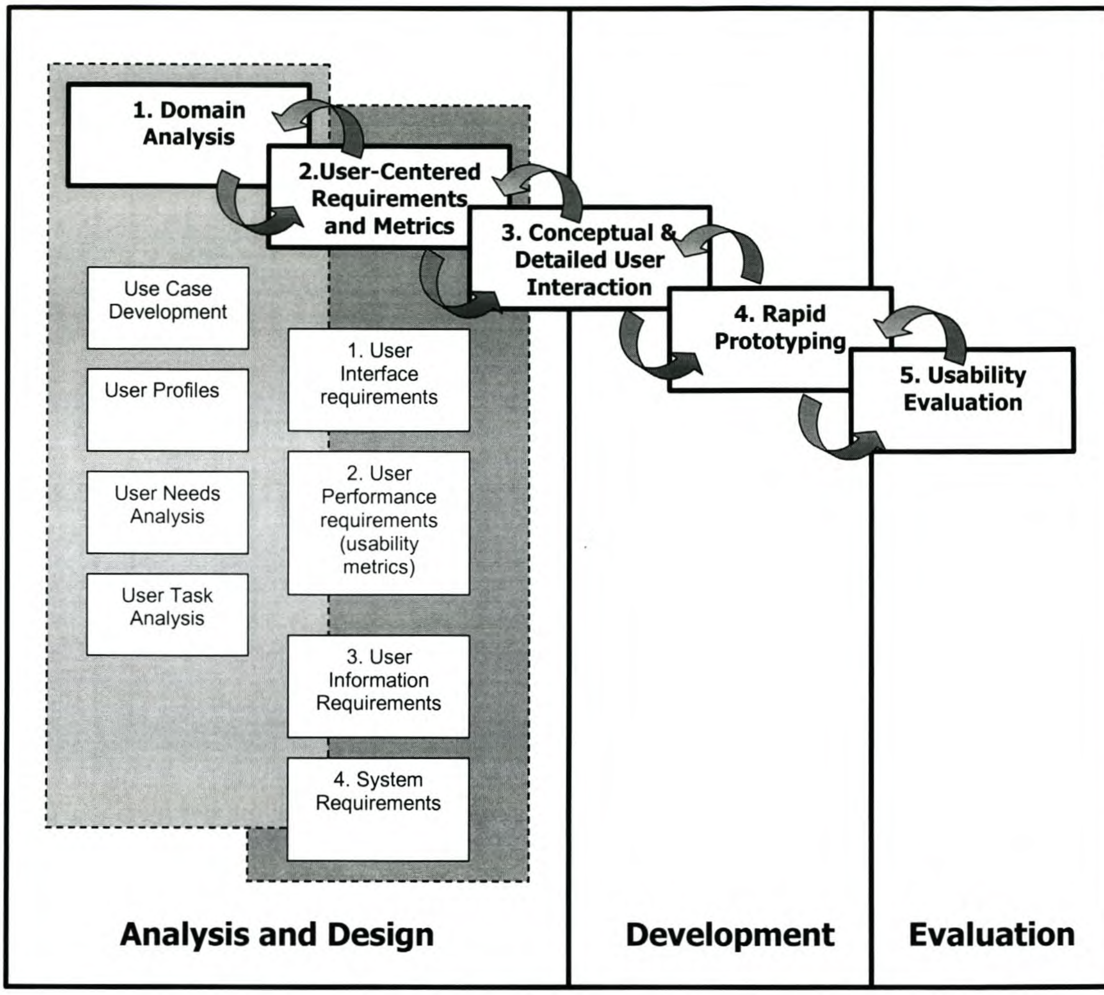


Figure 3.9: A usability engineering process and the associated activities (Gabbard et al., 2002, p. 7).

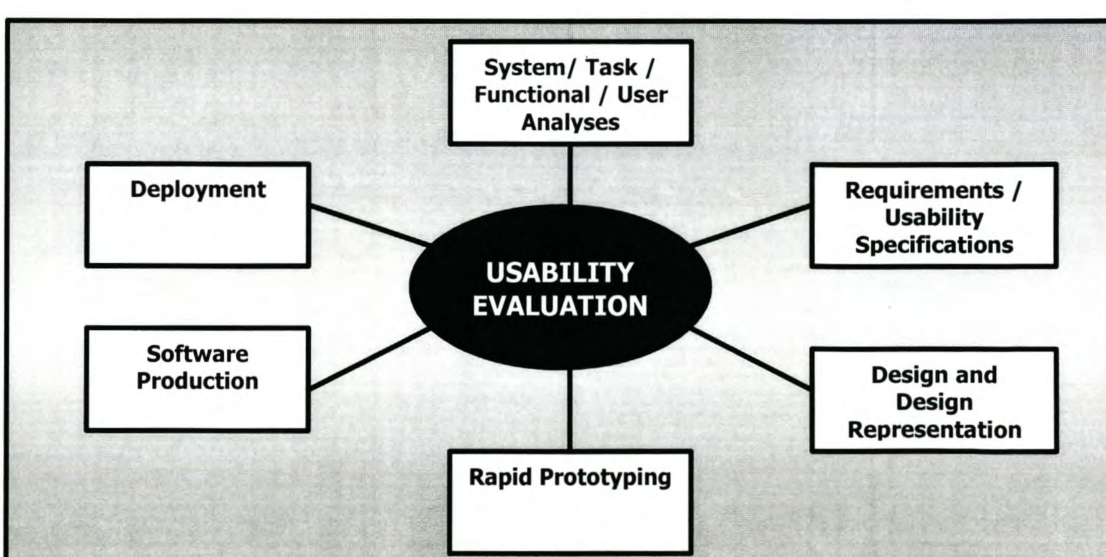


Figure 3.10: The star life cycle for user interaction development (Hix & Hartson, 1993, p. 102).

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The aim of this research was to conduct an exploratory study through the use of empirical research and prototyping, by the quantification of the usability of synchronous CMC media, for application in the South-African on and off-campus tertiary education environment (focused on post graduate level), in order to enhance information sharing between inter alia, information service suppliers, lecturers, students and researchers.

This chapter provides a brief overview of the VIS Project that constitutes the framework within which this study was conducted. The research problem as well as the aim, goals and objectives that were formulated for this study are discussed. Together with each objective, the strategy that was followed to attain the objective is described. Furthermore, the research design and methodology employed for this research is discussed. The focus here is on the process that was followed to conduct the usability study. The chapter includes a description of the measuring instruments, the sample used in this study, the sampling method and the statistical approach applied to analyse the data obtained.

4.2 BACKGROUND

4.2.1 Rational of the VIS Project

The Virtual Information Space (VIS) project for optimal information sharing developed as a reaction to a need that was directly linked to the e-campus initiative of the US. This need was centred on the strategic decisions and actions that were identified in order to facilitate a 'quantum leap' in the development of the university's e-campus. In terms of point 5.13 of the proposal for the '*Quantum leap towards an integrative virtual environment at the US*', a decision was made that both "synchronous and asynchronous electronic communication possibilities will be increased" (US, 2001). As a result of this strategic decision, the need thus arose to investigate the different synchronous and asynchronous CMC media possibilities, as well as platforms (software applications) within which these media could be made available.

Based on the identified need, the rationale of the VIS Project was to investigate the challenges related to the creation of a shared virtual space through the use of synchronous and asynchronous CMC technologies, in order to enhance information sharing and knowledge creation at the US. The project focused on the tertiary education environment and, more specifically, on post graduate level. The main purpose of the project was thus to investigate opportunities for enhanced learning and information sharing between role-players (students, lecturers, researchers and information service suppliers) by suggesting usable products that would truly enhance and support the learning and information sharing processes between role-players. This ties in with the objectives of the US that relates to the extension of the synchronous and asynchronous communication possibilities as set out in the proposal for the 'quantum leap' towards the e-campus at the US. Objectives include: "...to establish interactive communication between lecturers and students, as well as between students, and the utilisation of the communication possibilities (media) within the context of research to promote collaboration in team context, as well as individuals, at the US and between the US and other universities – locally or internationally" (US, 2001, p.22).

4.2.2 Description of the VIS Project

The VIS project centres on the processes within a virtual learning and information sharing environment, where role-players can communicate and share information (refer to figure 4.1). The 'processes' refers to the creation of numerous collaborative conversational networks through which role-players can collaborate, thus forming numerous communities of practice (COP) for different subjects, learning or research interests. With sufficient inputs from the parties involved, these processes will culminate in certain outcomes, such as improved learning and information sharing. It is recognized that the skills of thinking critically and reflectively, both using and creating new knowledge structures and networks is pivotal to effective research and learning processes – especially at post-graduate level. Therefore, opportunities should be created for the development of these skills.

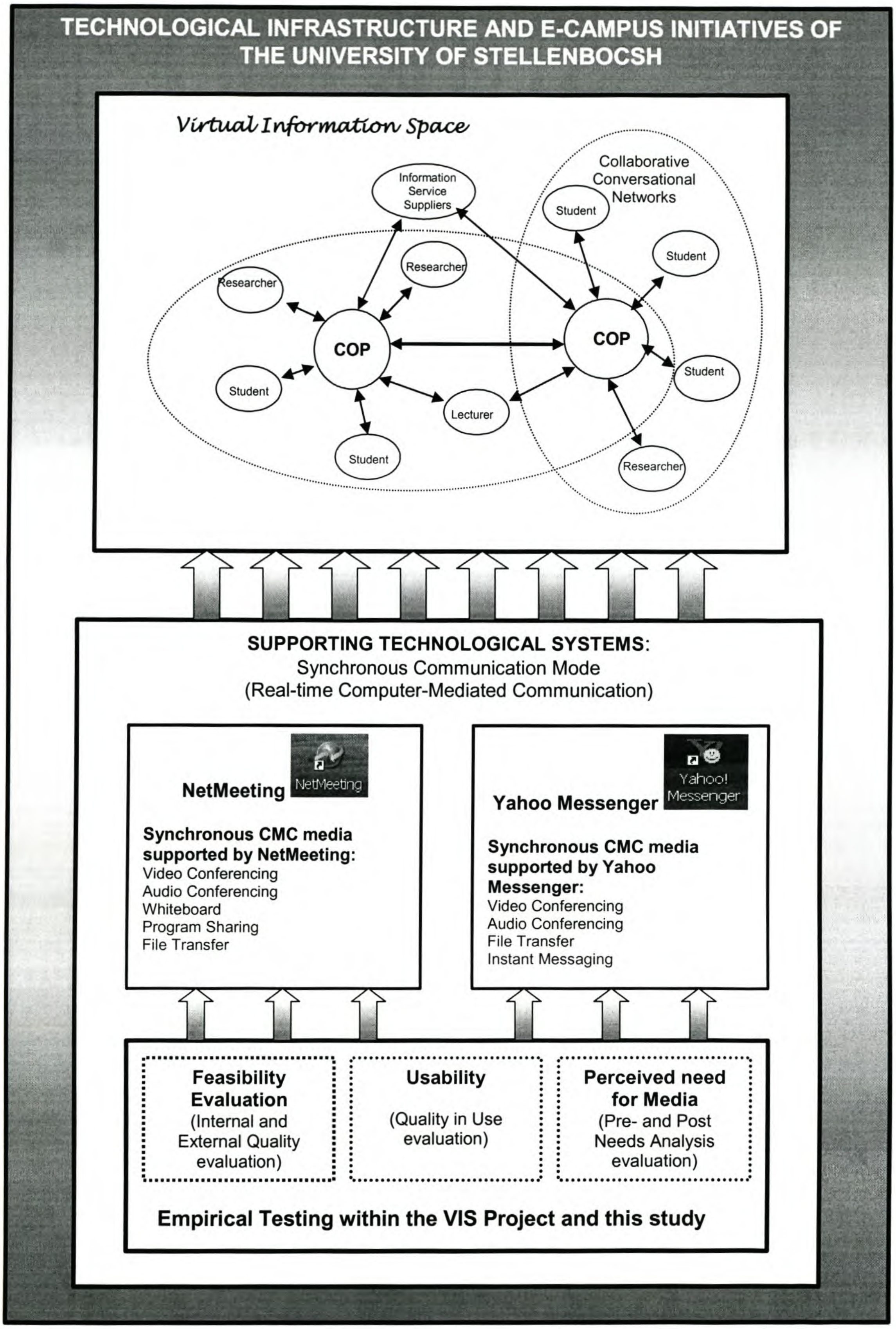


Figure 4.1: Overview of the elements influencing the VIS environment that formed the focus of the research in this study (COP refers to Communities of Practice).

According to Romiszowski (cited in Khan, 1997, p.34), the known effective learning strategies for the development of such skills involve intensive interaction, not only with content that is structured into knowledge networks, but also with other people who have an interest in the specific knowledge domain. This is where the VIS for optimal information sharing comes into play, as it creates an opportunity for the role-players to engage in relevant conversational networks (irrespective of their dispersed geographical locations), as well as allowing them access to and interaction with available content resources. In order to fully achieve desired outcomes of improved information sharing and learning, the processes rest and draw from underlying supporting systems (see figure 4.1). These systems (or computer networks) should be viewed as the technological devices that will link human beings together on the network. A vital part of any human computer system is, however, the software application that is used to perform tasks, in this instance communicating and sharing information. The software applications chosen for evaluation within the VIS environment were selected in accordance with the department of Information Technology at the US, the decision based mainly upon relevant cost and availability factors.

The chosen software applications included *NetMeeting* and *Yahoo Messeng*er (both desktop-based video conferencing systems, accommodating synchronous media), *WebCT* (asynchronous course management system) and *Windows Producer* for video streaming (asynchronous video streaming system). Various synchronous and asynchronous web-based computer-mediated communication media is embedded within each of these software applications systems. Each of these systems was examined with focus on their individual characteristics.

This particular study focused on the synchronous CMC media embedded within *NetMeeting* and *Yahoo Messenger*, with the goals of testing the usability and feasibility (see figure 4.1) of the software applications, within the scope of the interaction between the role-players, as set out in the following range of scenarios (see figure 4.2), also referred to as role-player combination groups.

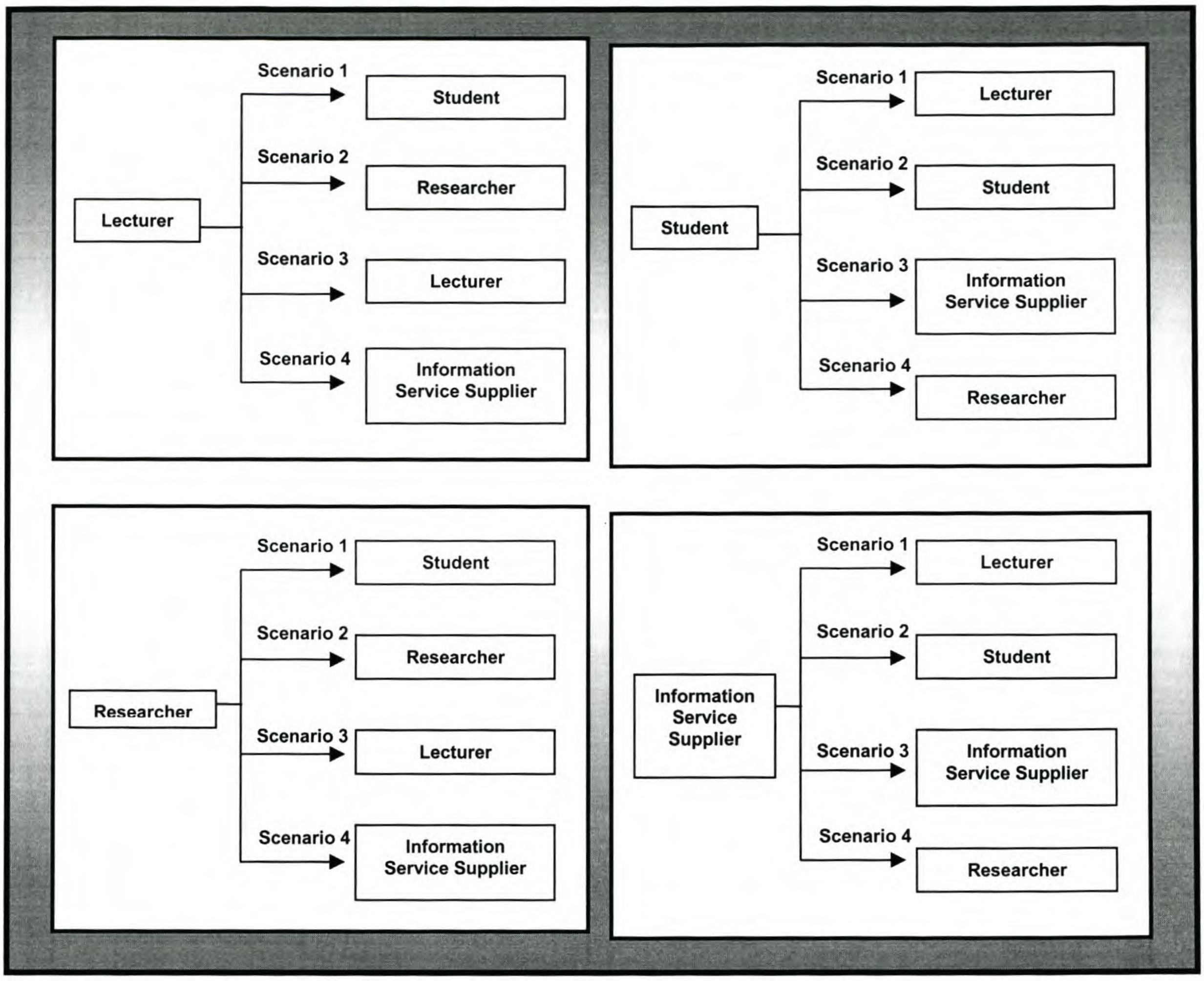


Figure 4.2: Graphical representation of the various interaction / communication 'scenarios' that each role-player group experience on a daily basis.

Although lecturers and researchers are viewed as two separate role-player groups, it is true that all lecturers are also regularly involved in some level of research. Due to time and other constraints, the lecturer and research role-player groups were, therefore, grouped together in the experimental usability testing sessions.

It is important to note that the processes of information sharing and communication are also influenced by governance, i.e. the rules and regulations of the larger organisation, in this case the US. These rules and regulations will impact the processes and thus the outcomes achieved by the information sharing process. Rules and regulations could pertain to all levels of information sharing, as well as other elements in the VIS. Examples of governance, in terms of information sharing, could include restrictions on knowledge sharing due to intellectual property rights and copyright issues determined by university governance. Examples of governance in terms of technological issues may possibly pertain to firewall policies and regulations that could restrict user access to the supporting technological systems (for example, *NetMeeting)*.

4.3 THE RESEARCH PROBLEM

The use of technology for the enhancement of education and information sharing, needs to be well tested, easy to implement, reliable and proven to having added value to the specific application scenario (Lindsay & Grant, 1998). Limited research has been conducted in this domain.

The VIS environment and subsequently the whole process, technologies and outcomes that surround this environment, is a new development in the world of virtual education and information sharing. To date, no similar studies, with a specific focus on the tertiary education environment have been conducted in South Africa.

The aim of this research is to conduct an exploratory study through the use of empirical research and prototyping, by the quantification of the usability of synchronous CMC media, for application in the South-African on and off-campus tertiary education environment (focused on post graduate level), in order to enhance information sharing between inter alia, information service suppliers, lecturers, students and researchers.

The research problem can thus be stated as follows: It is anticipated that the CMC media that support the synchronous communication mode will enhance learning and information sharing between role-players. The degree to which the CMC media adds value to the learning and information sharing process will, however, be influenced by the usability of the media and the perceived need of the role-players for this specific media. The question therefore arises: are the feasibility, viability and usability, together with the need for the media, instrumental to ensure effective utilisation and implementation of these technologies for the various role-players, within the technological parameters of the US? Empirical tests will therefore be conducted in order to examine the feasibility and viability of the communication media in terms of specific usability criteria, together with the determination of the need for the media, with a specific focus on the various role-players.

4.4 THE RESEARCH AIM

As was mentioned earlier, the aim of this study is to conduct an exploratory study through the use of empirical research and prototyping, by the quantification of the usability of synchronous CMC media, for application in the South-African on and off-campus tertiary education environment (focused on post graduate level), in order to enhance information sharing between inter alia, information service suppliers, lecturers, students and researchers.

Three of the most common and useful purposes of social research are: exploration, description and explanation (Babbie, 1998). The goal of exploratory research is usually to formulate increasingly precise questions that can be answered by future research. Exploratory research may thus be the first stage in a series of studies. A researcher may need to conduct an exploratory study in order to obtain enough knowledge to design and execute a second, more systematic and extensive study (Neuman, 1997).

In short, the goals of exploratory research can be described as follows (Neuman, 1997, p. 20):

- Become familiar with the basic facts, people, and concerns involved;
- Develop a well-grounded mental picture of what is taking place;
- Generate ideas and develop tentative theories and conjectures;
- Determine the feasibility of doing additional research;
- Formulate questions and refine issues for more systematic inquiry; and
- Develop techniques and a sense of direction for future research.

Descriptive research, on the other hand, presents a picture of the specific details of a situation, social setting, or relationship. The outcome of a descriptive study is a detailed picture of the subject. Schweigert (1998) points out that descriptive research plays an important role in science, by identifying and describing certain phenomena.

The goals of descriptive research can be described as follows (Neuman, 1997, p. 20):

- Provide an accurate profile of a group;

- Describe a process, mechanism, or relationship;
- Give a verbal or numerical picture;
- Find information to stimulate new explanations;
- Present basic background information on a context; and
- Create a set of categories or classify types.

Although this study mainly portrays characteristics of an exploratory study, a few elements of descriptive research will also be found. This is not unusual. Neuman (1997) points out that descriptive and exploratory research have many similarities and often blur together in practice. Babbie (1998) supports this view by stating that it is possible – and is often the case in practice – that a given study displays the characteristics of more than one of these research purposes.

4.5 THE RESEARCH GOALS

The research problem, as stated above, creates a frame of reference within which the goals of this study are formulated. The following section describes the research goals of this study.

4.5.1 VIS Project Goals

Within the VIS Project environment, several project goals were identified. The project goals were divided into four specific categories. These categories focussed mainly on the different role-players and their needs, the software applications and testing the usability thereof, identifying technological aspects that influence the VIS environment, as well as the potential of the VIS to add value to communication and learning processes within the US.

The above-mentioned goals were developed for the total VIS Project, with a focus on both the synchronous and asynchronous communication media, as supported by the four selected software applications (*NetMeeting*, *Yahoo Messenger*, *WebCT* and *Windows Producer*). This study, however, focuses specifically on the synchronous communication media supported by the software applications *NetMeeting* and *Yahoo Messenger*. Due to the synchronous nature of the communication facilitated by the two software applications, the project goals (hereafter referred to as research goals) were suitably adapted.

4.5.2 Research Goals

Given the specific nature of this study, the following research goals were formulated. Four goals are described, which pertain to the four areas of research that this study has focussed on, i.e. needs analysis, usability, feasibility and viability, as well as the value of the VIS environment. Within each goal, specific objectives are outlined. Where applicable, the strategy that was employed for reaching the goal will also be discussed.

4.5.2.1 Goal one: Conduct a Needs Analysis

a. Background

Palloff and Pratt (1999, p.23) highlight the importance of a needs analysis when they state that, "…in a virtual or electronic community, educators must realise that the way the medium or technology is used depends largely on human needs, meeting the needs of both faculty and students, and that these needs are the prime reason that electronic communities are formed."

The needs analysis formed a fundamental aspect of this study, since the needs of the role-players are viewed to remain relatively constant, whilst the software applications are most likely subject to change as new products become available. The needs analysis was thus conducted in order to establish the intended/potential frequency of use of the CMC media (for example, whiteboard or chat) by role-players, should it readily be available to them. Within the scope of the VIS Project; lecturers, researchers, postgraduate students and information service suppliers were identified as the main role-players in the creation of a virtual information space for the US

b. Objective 1: To describe the specific needs of the role-players (students and lecturers) regarding the synchronous CMC media, before and after usability testing.

Sub-objectives:

- Objective 1(a): To describe the specific needs of the lecturer role-player group regarding the synchronous CMC media, before and after usability testing.
- Objective 1(b): To describe the specific needs of the student role-player group regarding the synchronous CMC media, before and after usability testing.

Strategy

In order to gain a description of the perceived needs of the role-players regarding the CMC media, two needs analysis questionnaires (one for students and one for lecturers) were designed. No participants from the information service supplier role-player group were, however, in a position to take part in the needs analysis survey and therefore no questionnaire was designed or administered for this role-player group.

Although most of the lecturers are also regularly involved in research activities, the sample was not big enough not conduct a needs analysis for both lecturers and researchers. The researcher, however, felt that it would not be appropriate to combine these two groups for the needs analysis survey, due to the fact that there will definitely be a difference in their needs regarding the CMC media. It was therefore decided to not design a needs analysis questionnaire for the researcher role-player group, but rather focus on the needs of the lecturer role-player group.

The aim of the needs analysis questionnaires was to acquire a quantitative description of the perceived needs of the different role-players (lecturers and students) in terms of the media, before and after usability testing. The main indicator in determining the needs of the different role-players, with regards to the media that was used, was the 'frequency of use' indicator.

The questionnaires were divided into four sections, describing the four different scenarios that would form the context of use for the media, for the specific role-player group (see figure 4.2). For example, scenario one of the student needs-analysis questionnaire recorded the perceived frequency of use when the media is employed for enabling interaction and information sharing with lecturers. The data that was obtained from the questionnaires was interpreted to provide a description of the needs of the role-players in terms of the different media.

c. **Objective 2: To prioritise the needs of the different role-player groups.**

Sub-objectives:

- Objective 2(a): To prioritise the needs of the lecturer role-player group.
- Objective 2(b): To prioritise the needs of the student role-player group.

Strategy

In order to prioritise the needs of the role-players, the data that was obtained from the needs analysis questionnaire was ranked (in terms of frequency of use). This ranking was used to provide a profile of the importance of the different media (e.g. whiteboard), for the different role-players, in terms of the different interaction scenarios (e.g. student to lecturer).

4.5.2.2 Goal two: Evaluate the usability of the software applications.

a. Background

The main focus of this study centres on empirically quantifying the usability of the synchronous CMC media embedded in the software applications, *NetMeeting* and *Yahoo Messenger*. With this in mind, the following objectives regarding the usability of the software applications, *NetMeeting* and *Yahoo Messenger*, were identified.

b. Objective 3: To describe the software applications, *NetMeeting* and *Yahoo Messenger*.

Sub-objectives:

- Objective 3(a): To describe the software application, *NetMeeting*.
- Objective 3(b): To describe the software application, *Yahoo Messenger*.

Strategy

NetMeeting and *Yahoo Messenger* were chosen for a usability evaluation. This decision was based mainly on the availability of technological solutions for the creation of the VIS, as specified by Department of Information Technology of the US. Cost effectiveness, in terms of monetary (purchasing of software applications) and support elements (man-hours for the technical support aspects), were taken into account.

NetMeeting and *Yahoo Messenger* are desktop-based video-conferencing facilities that support the synchronous communication mode, by housing mainly synchronous CMC media (e.g. chat and whiteboard). For a comprehensive overview of the nature of the software applications, *NetMeeting* and *Yahoo Messenger*, refer to chapter two (section 2.5.5.4).

c. **Objective 4: To define the concept of usability within the VIS Project environment in operational terms.**

Strategy

Nielsen and Mack (1994) define usability as a fairly broad concept that basically refers to the ease with which users learn to manage a system, the efficiency with which they can use, and how pleasant it is to use. A comprehensive overview of the concept of usability has been reported in chapter three of this thesis. Throughout the chapter, the researcher has placed usability within the context of this study, and highlighted the important aspects that pertain to this study.

d. **Objective 5: To evaluate the usability of *NetMeeting* and *Yahoo Messenger,* by conducting formal usability testing in a controlled experimental environment, in order to obtain subjective data through a subjective measurement technique (usability questionnaire).**

Sub-objectives:

- Objective 5 (a): To evaluate the usability of *NetMeeting* by conducting formal usability testing in a controlled experimental environment, in order to obtain subjective data through a subjective measurement technique (usability questionnaire).
- Objective 5 (b): To evaluate the usability of *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, in order to

obtain subjective data through a subjective measurement technique (usability questionnaire).

Strategy

In order to conduct the formal usability testing of *NetMeeting* and *Yahoo Messenger*, activities listed below were performed. Activities related to data capturing included:

- The development of the usability questionnaire (subjective data) (refer to appendix C).

Activities related to preparation of the controlled experimental environment included:

- The development of training manuals for the *NetMeeting* and *Yahoo Messenger* training sessions.
- The development of the task protocol sheets for the respective experiments (see appendix D).

Data analysis (subjective data): The research hypotheses

A hypothesis is a proposition that is to be tested or the tentative statement of a relationship between two variables (Neuman, 1997). According to Heiman (1999), there are two general types of hypotheses. A causal hypothesis tentatively identifies a particular cause for, or influence on, a behaviour. In keeping with the goal of describing behaviour, a descriptive hypothesis tentatively describes a behaviour in terms of its characteristics or the situation in which it occurs.

Descriptive hypotheses are tested by utilising descriptive methods, in which the researcher only measures – without manipulation – a behaviour and its possible influences (Heiman, 1999). In view of the fact that descriptive research methods are used for this part of the study, the following descriptive hypotheses have been formulated, in accordance with the proposed statements about the usability concepts contained within the literature and research problem. The hypotheses are the same for both the software applications (*NetMeeting* and *Yahoo Messenger*), due to the fact that the same usability questionnaire was used in both cases. The data is, however, analysed separately.

HYPOTHESIS ONE

(a) A positive perception exists regarding the general usefulness / utility of *NetMeeting*.

(b) A positive perception exists regarding the general usefulness / utility of *Yahoo Messenger*.

HYPOTHESIS TWO

(a) A positive perception exists that the utilisation of *NetMeeting* will lead to improved effectiveness and efficiency.

(b) A positive perception exists that the utilisation of *Yahoo Messenger* will lead to improved effectiveness and efficiency.

HYPOTHESIS THREE

(a) A positive perception exists regarding the reliability of the *NetMeeting*.

(b) A positive perception exists regarding the reliability of *Yahoo Messenger*.

HYPOTHESIS FOUR

(a) A positive perception exists concerning the ease of use of *NetMeeting*.

(b) A positive perception exists concerning the ease of use of *Yahoo Messenger*.

HYPOTHESIS FIVE

(a) A positive perception exists concerning the error management capabilities of *NetMeeting*.

(b) A positive perception exists concerning the error management capabilities of *Yahoo Messenger*.

HYPOTHESIS SIX

(a) A positive perception exists concerning the consistency and compatibility of *NetMeeting*.

(b) A positive perception exists concerning the consistency and compatibility of *Yahoo Messenger*.

HYPOTHESIS SEVEN

(a) A positive perception exists concerning the learnability of *NetMeeting*.

(b) A positive perception exists concerning the learnability of *Yahoo Messenger*.

HYPOTHESIS EIGHT

(a) A high level of satisfaction exists regarding the use of *NetMeeting*.

(b) A high level of satisfaction exists regarding the use of *Yahoo Messenger*.

e. Objective 6: To evaluate the usability of *NetMeeting* and *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, to obtain objective data through an objective measurement technique (human performance measurement).

Sub-objectives:

- Objective 6 (a): To evaluate the usability of *NetMeeting* by conducting formal usability testing in a controlled experimental environment, in order to obtain objective data through an objective measurement technique (human performance measurement).

- Objective 6 (b): To evaluate the usability of *Yahoo Messenger* by conducting formal usability testing in a controlled experimental environment, in order to obtain objective data through an objective measurement technique (human performance measurement).

Strategy

In order to conduct the formal usability testing of *NetMeeting* and *Yahoo Messenger*, the activities listed below were performed. Activities relating to data capturing included:

- The developing of the task logging sheet for the capturing of the objective data by the observer (see appendix E).

Activities relating to preparation of the controlled experimental environment included:

- The development of the training manuals for the *NetMeeting* and *Yahoo Messenger* training sessions; and
- The development of the task protocol sheets for the different experiments (see appendix D).

Data analysis: objective data

To address this goal, the data analysis focussed on the performance measurement data and the description thereof. Descriptive summaries of the performance measurement results, as gathered from the task logging sheets, are thus presented. Performance measurement criteria used, included task time, task accuracy rate and a measure of the reliability of the system, for each of the tasks participants performed with the system.

4.5.2.3 Goal three: Investigation into the feasibility and viability of the software applications

a. Background

The feasibility and viability of the software applications when applied within the technological infrastructure of the US, was considered to be a vital element for the success of the creation of an effective VIS. A system is feasible when it demonstrates a capability of working successfully in a practical, easy and convenient manner. The viability of a system, on the other hand, refers to the extent to which the system works successfully under specific circumstances. Viability, furthermore, could also encapsulate relevant cost factors which could influence the implementation and/or effective utilisation of a system.

For the purpose of this study, the feasibility and viability of the supporting technological systems to the virtual information sharing process is, therefore, defined as the extent to which the software application or system is capable of working successfully at an acceptable cost level, given the technological infrastructure of the US, within which the system has to function.

b. Objective 7: Conducting prototype experiments with *NetMeeting* and *Yahoo Messenger*.

Sub-objectives:

- Objective 7(a): Conducting prototype experiments with *NetMeeting*.
- Objective 7(b): Conducting prototype experiments with *Yahoo Messenger*.

Strategy

The first phase in determining the feasibility and viability of the software applications *NetMeeting* and

Yahoo Messenger was to conduct prototype experiments. These experiments were conducted in a controlled experimental environment that simulated the actual experimental conditions. The main purpose of the prototype experiments was to gain information about the feasibility and viability of the software applications, when applied within the technological infrastructure of the US, considering certain network, bandwidth and firewall constraints.

The goals of the prototype experiments conducted with *NetMeeting* and *Yahoo Messenger* therefore included:

a. To explore the technological constraints of the software applications when utilised within the technological infrastructure of the US, by emphasising the following:
   - Feasibility and viability testing: the prototype experiments were conducted to establish which of the media functions in the different software applications are not supported by Intranet-to-Intranet and Intranet-to-Internet (modem) connections; and
   - Exploring firewall constraints.

b. To establish benchmarks of performance for the different tasks to be performed with the respective software applications.

The researcher anticipated that the prototype experiments would provide information on the above-mentioned criteria, to such an extent that it would have been reasonable to omit the testing of certain communication types (for example, group video conferencing in *NetMeeting*) when used over different connections, due to the limiting technological constraints of the systems. The results of the prototype experiments are reported in chapter five.

c. **Objective 8: To acquire information about the internal quality of the technological infrastructure of the US, such as its bandwidth capabilities and average network usage.**

Strategy

In order to acquire the necessary information, the researcher liaised with relevant parties at the department of Information Technology at the US. A specific bandwidth report was generated, providing an indication of the average amount of network usage during the time that the experiments were conducted. An investigation was conducted to establish the amount of potential bandwidth available for utilisation over the Local Area Network (LAN) connection (the US network).

This information was acquired in order to determine the rate at which information can be transmitted across the network, measured in bits per second (bps). A high amount of potential bandwidth (such as 10 Mbps that a LAN connection supports) will allow for better and quicker information transfer, whereas as low amount of bandwidth (such as 48kbps available when a modem connection is used) will hamper quick and efficient information transfer processes.

c. **Objective 9: To acquire information about the external quality (audio, video and data collaboration quality) of software applications *NetMeeting* and *Yahoo Messenger,* when utilised within the technological infrastructure parameters of the US.**

Sub-objectives:

- Objective 9 (a): To acquire information about the external quality (audio, video and data collaboration quality) of *NetMeeting*, when utilised within the technological infrastructure parameters of the US.

- Objective 9 (b): To acquire information about the external quality (audio and video quality) of *Yahoo Messenger*, when utilised within the technological infrastructure parameters of the US.

Strategy

In order to address this objective, the Transmission System Quality questionnaires were developed. The purpose of these questionnaires was to gather information on the perceptions of the participants, as it relate to the external quality of the software applications. For the purpose of this study, the external quality of the system was referred to as the result of the combined behaviour of the software application (e.g. *NetMeeting*) and the computer system (hardware, e.g. microphones, speaker, etc.). In the case of *NetMeeting,* the questionnaire focussed on the quality of the video, audio and data collaboration media (whiteboard, file transfer and program sharing media). In the case of *Yahoo Messenger*, only information about the video and audio quality was gathered, as *Yahoo Messenger* only supports one type of data collaboration media (file transfer).

e. Objective 10: To document findings regarding general limitations of the respective software applications when utilised within the current technological infrastructure of the US.

Sub-objectives:

- Objective 10 (a): To document findings regarding the general limitations of the *NetMeeting* when utilised within the current technological infrastructure of the US.

- Objective 10 (b): To document findings regarding the general limitations of the *Yahoo Messenger* when utilised within the current technological infrastructure of the US.

Strategy

The data obtained during the formal usability testing phase was used to document results of a usability problem analysis for each of the software applications. General trends regarding certain limitations of the systems have, therefore, been highlighted and where applicable, recommendations and comments were made.

4.5.2.4 Goal 4: Investigation into the value of the VIS environment.

a. Background

In the survey of literature as reported in section 2.6 of chapter two, it was proposed that the value of the VIS is mainly embedded in its capacity to provide a collaborative online environment, where different role-players can meet to share experience and understanding, within the specific context for which the VIS is utilised (e.g. research, information sharing and learning). The VIS, can, therefore be described as an online 'space' that incorporates many evolving communities of practice and thus facilitates flexible learning.

In terms of flexible learning, the VIS aims to provide students with the opportunity to take greater responsibility for their learning and to be engaged in learning, information sharing, research activities and opportunities that meet their own individual needs – fostering the student-centred learning ethos. For lecturers, the VIS aims to create new opportunities that they may embrace the paradigm shift towards constructivism, by allowing for new and innovative ways of both delivering teaching and of conducting research. Increased efficient information sharing with other researchers and subject experts will also be facilitated by the supporting technological systems.

For the information service suppliers role-player group, expected outcomes (that relate to functioning within in the VIS) could translate into increased relevance in the services that are supplied, more cost-effective delivery and dissemination of relevant information and a overall quicker and a more efficient service that is being provided to the relevant role-player groups.

The VIS project research results (both synchronous and asynchronous) should thus aid the creation of these opportunities and outcomes, by making recommendations regarding the supporting technological systems that will facilitate the process of flexible learning - a process that is being increasingly acknowledged as pivotal with regards to the global competitiveness of the US.

b. Objective 11: To conceptualise the value added to information sharing and knowledge creation through the use of the software applications *NetMeeting* and *Yahoo Messenger* within the information sharing context of the US.

Strategy

An extensive literature study was conducted to conceptually demonstrate the value of the VIS environment within the context of the US. The results of the literature review are documented in detail and contained in chapter two.

4.6 RESEARCH PROCESS AND DESIGN

Research is a procedure by which the researcher systematically attempts to find the answers to a question or the resolution of a problem (Merriam & Simpson, 1984). A research design expresses both the structure of the research problem and the investigation plan that is used to obtain the empirical evidence on the relations of the problem (Kerlinger & Lee, 2000).

In essence, this study is a usability study. Due to this fact, the nature of the research process and design primarily displays the characteristics of a usability study. The process followed in order to conduct the usability study is depicted in figure 4.3. Each of the phases of the process will be discussed briefly.

4.6.1 Phase 1: Scope and methodology of VIS Project

During this phase, the need for the VIS project was identified and the relevant parties were involved in formalisation of the research in terms of university procedures. It was established that the proposed scope of the project would entail the empirical evaluation of the perceived need of the role-players for the media, as well as the usability and feasibility and viability of synchronous and asynchronous CMC media, embedded within four different software applications.

The decision was made, that both objective and subjective measures would be used in order to obtain the necessary usability information. The information would be obtained during a series of formative usability evaluations (controlled experiments) conducted within an environment that replicates a usability laboratory. The following sources of data were obtained during the formative usability evaluations:

a. **Performance measurements.** An observer obtained quantitative data about participants' performance (recorded on a task logging sheet), while the participants completed a range of tasks with a specific software application during the formative evaluation session (experiment). Performance measures include the task

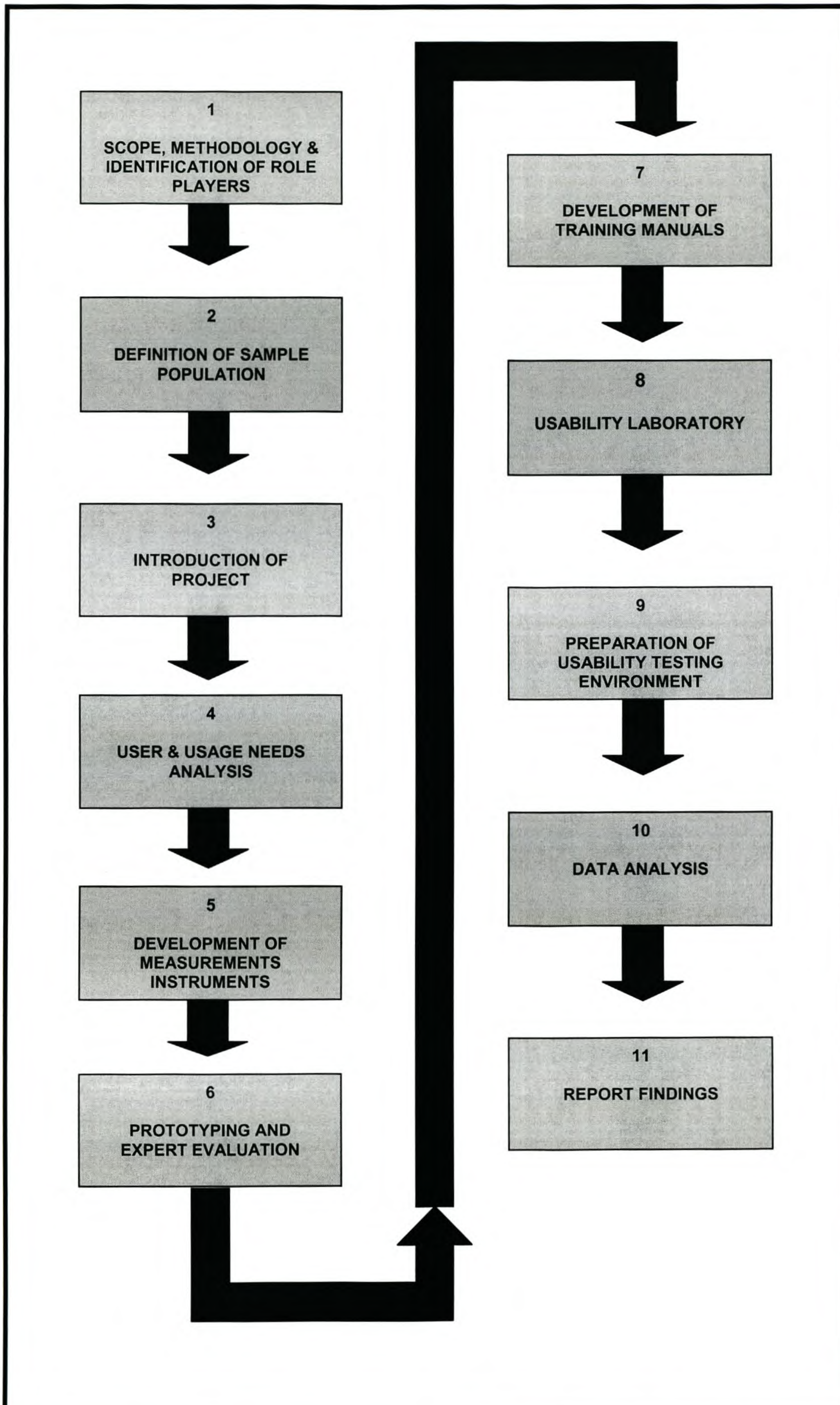


Figure 4.3: Phases in the research process for conducting a usability study.

time, the task rate as well an indicator of the reliability of system.

b. **Subjective measurements.** Three questionnaires were used in this study in order to obtain subjective measurements. A questionnaire, according to Schnetler, Stoker, Dixon, Herbst & Geldenhuys (1989), is a structured data collection instrument through which information is elicited, collected and recorded.

Jordan (1998) holds that the main advantage of usability questionnaires is that they provide feedback from the user's perspective. In this study, there were two sets of three questionnaires for each software application. Each set of three questionnaires included:

- **The usability questionnaire** (appendix C). Each respondent filled out a usability questionnaire after completing a range of tasks with the specific software application. Only questions relating to the usability issues, that were identified to be pertinent to this study, were included in the questionnaire;
- **The needs analysis questionnaire** (appendix F). This questionnaire was developed with the aim of gaining a quantitative description of the perceived needs of the different role-players (students and lecturers), in terms of the synchronous and asynchronous CMC media, before and after usability testing;
- **The transmission system quality questionnaire** (appendix B). This questionnaire was developed to provide information on user's perceptions of the external quality (e.g. audio and video quality) of the software application, after being exposed to the system.

4.6.2 Phase 2: Determining the sample population

The population refers to all the organisms that the researcher wishes to be able to generalise the research results about (Schweigert, 1998). The population is usually defined more precisely in terms of the target population and thus the specific pool of cases that the researcher wants to study (Neuman, 1997). For the VIS Project, and therefore for this study, it was decided that the target population should comprise all lecturers, researchers, students and information service suppliers, hereafter referred to as the four role-player groups, at the US. A decision was made to limit the student population to post graduate level students and their interaction with the previously mentioned role players.

Samples that are based on nonprobability theory are often used because of a lack of time or in special situations (Neuman, 1997). This was the case with the VIS Project and therefore, the nonprobability sampling technique of convenience sampling, was used to obtain the sample of respondents (from the different role-player groups) for inclusion in this study. Although the convenience sampling technique was used, several measures were taken to ensure that role-players from various disciplines have been included into the sample population. These included:

- During the identification of lecturers and researchers for inclusion into the sample, prominent lecturers and researchers (Sub-committee A & NRF grand holders), were identified through lists obtained from various faculties and the research institute of the University;
- Representatives of the information service suppliers' role-player group (library personnel) were identified with the help of a senior member of the US library management staff; and
- Participating lecturers were asked to identify students within their own postgraduate courses for inclusion into the sample. Other methods of identification of student participants included introductory sessions and a marketing campaign via e-mail, to inform students about the project.

Considering that the VIS Project consists of two research projects (the testing of both synchronous and asynchronous CMC media) the identified sample had to be divided into two groups. For this particular study, a sample consisting of 35 participants (for *NetMeeting*) and 33 participants (for *Yahoo Messenger*) was secured. Each of these participants was exposed to *NetMeeting* and *Yahoo Messenger* in a formal experimental setting. Due to a number of constraints (including time), only 18 of the respondents participated in the needs analysis survey, completing a needs analysis questionnaire before and after the formative usability testing.

Although the sample was relatively small, it represented the full extent of the possible population that could have been tested, since only 35 and 33 subjects were exposed to the *NetMeeting* and *Yahoo Messenger* systems, respectively. Therefore, only their perception of the usability of the systems could be assessed. Virzi (cited in De Jager, 2002, p.56) conducted a series of experiments in order to determine how many subjects would be necessary when identifying usability problems. The findings indicated that the first few subjects detected the majority of problems, as well as the more severe problems. Virzi concluded that in most situations, as few as five subjects would be able to detect 80% of the most important usability problems in a test session. It can, therefore, be assumed in the light of these findings, that the sample size that was used in this study was sufficient to identify the most critical usability problems during the experimental sessions as part of the research.

4.6.3 Phase 3 and 4: Introduction of the project to the sample population and distribution of the needs analysis questionnaire

Four separate introductory sessions were held to introduce lecturers, library personnel and researchers to the project, the relevant synchronous and asynchronous media and the software applications. The introductory sessions also provided a manner of distributing the needs analysis questionnaire to the various participants and thereby to gain the pre-needs analysis data. On another two separate occasions, introductory sessions were held to introduce the students to the project, as well as to distribute the needs analysis questionnaire and secure experimental times and dates with the participants.

4.6.4 Phase 5: Development of measurement instruments

4.6.4.1 Background

Measurement is one of the key building blocks for research (Kerlinger & Lee, 2000). Due to a lack of appropriate measurement instruments suited to the specific nature of this study, appropriate instruments had to be developed. Two types of measurement instruments were used in this study, namely user survey questionnaires (the usability and needs analysis questionnaires, recording subjective data) as well as the task-logging sheet. The task logging sheet was completed by a trained observer recording certain aspects of a user's performance in relation to the system providing the objective data. The following section will provide a brief description of the measurement instruments.

According to Neuman (1997), survey research produces quantitative information about the social world and describes features of people or the social world. Consequently, a survey is used to ask respondents about their beliefs, opinions, characteristics and present or past behaviour. The researcher's interest with this study was to establish a measurement of the subjective perceptions of the sample, concerning the usability of the software applications, *NetMeeting* and *Yahoo Messenger*. The subjective perceptions of the perceived need of the respondents with regards to the synchronous media embedded within *NetMeeting* and *Yahoo Messenger*, was also determined. Since it cannot be assumed that people think in certain ways without asking them what they think, academic surveys play an important role when attitudes are of interest and thus emphasise the explanation of attitudes (Nachmias & Nachmias, 1981). Survey research, was therefore, employed in this study as it was found to be best suited to the nature of this study.

According to Schweigert (1998), several types of surveys exist, and there are, therefore, numerous methods by which survey research can be executed. For the purposes of this study, the survey questionnaire was employed. The survey questionnaire is an example of a structured data collection instrument through which information is extracted, collected and recorded (Kerlinger & Lee, 2000). Answering a questionnaire focuses the respondent's mind on a particular topic, which in the case of this study, is the usability of *NetMeeting* and *Yahoo Messenger*, as well as the perceived need for the synchronous communication media that is embedded within each of the systems.

The decision to make use of the questionnaire survey method in order to find answers to the research problem as defined in this study, was motivated by the advantages of this method. Heiman (1999) and Kerlinger and Lee (2000) point out that survey research (usually in the form of a questionnaire), has the following advantages:

- With a questionnaire, the interaction between the researcher and the participant is minimal, so there is less risk of biasing participants with experimenter expectations;
- Questionnaires provide increased efficiency in the collection of data because many people can be tested at one time;
- Anonymity is ensured since there is no interviewer present to identify the respondent. This was an important consideration as respondents are often more inclined to answer questions honestly when they remain anonymous; and
- The questionnaire may be completed at the respondent's convenience, allowing them the opportunity to spend more time on their answers. In the case of this study, the questionnaires were made available in electronic format on the computer that was utilised for the experiment and the participant could complete it by accessing the programme and merely clicking on the appropriate answer box.

Coupled with the advantages mentioned above, are the inevitable weaknesses and disadvantages of the survey research method. Heiman (1999), Kerlinger and Lee (2000) and Schweigert (1998) maintain that this method has the following shortcomings:

- The major disadvantage of the questionnaire survey method is the low response rate. Respondents who do not return questionnaires often have some definite opinions on the subject. Therefore, bias may be introduced into the data because of the poor response rate. This problem was not encountered in this study, as all the respondents within the sample completed the questionnaire after the experiment;

- The information obtained is limited to the degree of the inflexibility of the questions presented;
- Participants may not complete the questionnaires as instructed; and
- Personal interpretation may occur due to the fact that questions are interpreted from the respondent's frame of reference, often making it impossible for researchers to clarify the interpretations.

According to Kerlinger and Lee (2000) survey research requires a good deal of research knowledge and sophistication. Bradburn and Sudman (cited in Neuman, 1997, p.228), highlight that, "...surveys, like other scientific and technical tools, can be well made or poorly made and can be used in appropriate or inappropriate ways."

Thus far, several usability questionnaires have been developed to assess users' perceptions of different systems. Chin, Diehl and Norman (cited in De Jager, 2002, p.50) have found several weaknesses in many of the subjective evaluation measurement tools. Problems range from a lack of validation, to low reliability. Furthermore, an extended debate about the use of open-ended versus closed-ended questions in questionnaires exists (Neuman, 1997). Closed-ended questions are, according to Heiman (1999), also called 'objective questions', and that is their overwhelming strength – a response can be assigned a score objectively and reliably, with a minimum of subjective interpretation or error on the researcher's part. The major disadvantage of closed-ended questions is that they may yield limited information. Conversely, open-ended questions allow people to provide a wide range of responses, so that researchers may discover new relevant variables. Scoring each response may, however, require subjective interpretation by the researcher, resulting in scores that may not be reliable.

4.6.4.2 The usability questionnaire

This research utilised a usability questionnaire designed by the VIS Project researchers, after careful investigation into all of the issues concerned. Several other questionnaires were also examined prior to questionnaire design. The following collection of usability questionnaires was examined:

- Loughborough University Virtual Reality Usability Questionnaire (Kalawsky, undated);
- Usability Evaluation Questionnaire for a C2 Digital Battlefield System (De Jager, 2002);
- The Software Usability Measurement Inventory (SUMI) (Lind, 1998); and
- Nielsen's Attributes of Usability (Nielsen, 1993).

The usability questionnaire designed for this study (refer to appendix C) employs rating scales. A rating scale is a measuring instrument that requires the respondent to assign the rated object to categories that have numerals assigned to each of them (Kerlinger & Lee, 2000). The items on the rating scales provide participants with concrete adjectives to facilitate evaluation, in the form of statements with a Likert-type response. Likert scales usually ask respondents to indicate whether they agree or disagree with a statement (as is the case with this questionnaire) and are, therefore, also called additive scales, as a person's score on the scale is computed by adding up the number of responses that the person gives (Neuman, 1997). In this questionnaire, open-ended questions were also included in order to afford participants the opportunity to make suggestions or comments that may not otherwise have been addressed by the questionnaire.

The usability questionnaire consists of four sections:

a. **Section A:** This section is composed of questions aimed at eliciting general biographical information and consisted of four broad sections.
   - The first segment gave an indication of the general background of the participants. Questions related to the candidate's gender, preferred language and user group.
   - The second portion consisted of questions relating to the respondents' level of technology-related knowledge and ability. These questions related to computer literacy, exposure, experience and frequency of computer usage.
   - The third section related to the candidates level of exposure to the software applications, *NetMeeting* and *Yahoo Messenger*.
   - The fourth section covered issues related to the *NetMeeting / Yahoo Messenger* experiment. These questions had to do with the training received and tasks completed by the participants.

b. **Section B:** This section consists of statements related to general usability issues. Only statements relating to the usability issues that were identified to be pertinent with regards to this study were included in the questionnaire design. The following attributes of usability (discussed in chapter three of this thesis) that were relevant to measuring usability, include:
   - **General usefulness / utility:** Usefulness concerns the degree to which a product enables a user to achieve his or her goals and is an assessment of the users motivation for using the product at all. Utility refers to the functionality (the value, worth and helpfulness) of the system;
   - **General effectiveness and efficiency:** Effectiveness refers to the extent to which the system enables tasks to be completed accurately and goals to be achieved.

Efficiency refers to the degree to which the system enables tasks to be completed in a timely, competent and economical fashion;

- **Reliability:** Reliability refers to the dependability of the system and the repeatability without failure of tasks using the system;
- **Ease of use:** Ease of use refers to the effortlessness and user-friendliness of the system;
- **Error Management:** Error management refers to the degree to which the system/software application allows the user to effectively identify, diagnose and rectify errors;
- **Consistency and compatibility:** Consistency refers to the ability of the system to respond to user inputs in a consistent way and to perform similar tasks in similar ways. Compatibility refers to the degree to which the system's method of operation matches with the user's expectations;
- **Learnability:** Learnability refers to the time and effort required to reach a specified level of user performance.
- **User satisfaction:** Satisfaction refers to the user's level of comfort with the system, feelings towards, and acceptability of the system to the user; and
- **Error rate:** Error rate refers to the degree of accuracy of the work carried out to complete specified tasks.

c. **Section C:** This section consists of items related to the user's general reaction to the software application. The user was required to rate his or her reaction to the system on a semantic differential scale. This scale uses bi-polar opposite adjectives to create a rating measure or scale, and thus captures the connotations associated with that which is being evaluated, indirectly measuring it.

d. **Section D:** The last section contains open-ended questions. The researcher has coded the open-ended questions, in order to simplify statistical analysis. This has been done through content analysis, which allows responses to be classified into categories. The different categories of responses subsequently calculated according to their frequency of occurrence. The advantage of open-ended questions is that it allows participants the chance to make suggestions or comments that may not otherwise have been addressed by the questionnaire.

4.6.4.3 The needs analysis questionnaire

In order to gain a description of the perceived needs of the role-players with regards to the CMC media, a needs analysis questionnaire was developed (appendix F) by the VIS Project researchers. The aim of the questionnaire was to gain a quantitative description of the perceived needs of the different role-players, in terms of the CMC media, both before and after usability testing. One of the key indicators, in determining the needs of the different role-players with regards to the media that were used, was the 'frequency of use' indicator. Participants were thus asked to anticipate and indicate the frequency (in response categories 'never', 'sometimes' or 'frequently') with which they would use the specific media if it were readily available to them. The questionnaire is divided into four sections, describing the four different scenarios that would form the context of use for the media (see figure 4.2). For example, scenario one of the student needs analysis, recorded the perceived frequency of use when the media is used for enabling interaction and information-sharing with lecturers.

The needs analysis questionnaire was designed with the following four goals in mind:

- To present the role-players with a detailed description of each of the media functions (e. g. whiteboard) supported by the different software applications (e.g. *NetMeeting*);
- To provide the participant with a range of options (3-point scale) when indicating their perceived need, regarding the specific media function;

- To gather this data within the four specific application scenarios for each of the role-player groups; and
- To create an opportunity for the participant to indicate to the researcher any context specific application of the media function, as it would pertain to their field of study or research.

The six synchronous media types that were assessed by the questionnaire included video and audio conferencing, whiteboard, interactive text chat, file transfer, program sharing and instant messaging. The Internet directory was also included in the questionnaire, but the researcher refrained from analysing the data obtained for this medium, as it was not identified as a synchronous CMC media to be investigated by this study. Furthermore, a limitation of this study is that, due to various practical constraints only the student and lecturer needs-analysis questionnaire were administered as no respondents from the information service suppliers and researcher role-player group could be involved in the needs analysis survey.

4.6.4.4 The transmission system quality questionnaire

No suitable existing questionnaire could be located to gather the information related to the quality of the audio, video and data collaboration media of the different software applications, when employed within the technological infrastructure of the US. Therefore, the researcher developed the transmission system quality questionnaire (refer to appendix B) through a process of design by comparison. Two similar questionnaires were consulted in the development of the questionnaire. These included:

- The Questionnaire for Communication Effectiveness (Kies, 1997); and
- The EURESCOM Multimedia Communication Quality Questionnaire (Bonaventura, Baldi, Alfano, Mirabelli, Antkowiak & Dehnel, 1999).

The *NetMeeting* version of the transmission system quality questionnaire incorporates three dimensions, namely video quality, audio quality, as well as the quality of the data collaboration media (whiteboard, program sharing and real-time file transfer). The *Yahoo Messenger* version of the questionnaire, however, only includes two dimensions (the quality of the video and audio), due to the fact that *Yahoo Messenger* only contains one data collaboration media function (file transfer).

A seven-point rating scale, similar to the scale used in the usability questionnaire, was employed in the transmission system quality questionnaire. At the end of each section, the user had to indicate his or her overall evaluation of the particular feature of the system (e.g. audio quality) on a five-point scale.

4.6.4.5 The task logging sheet

The researcher developed a task-logging sheet (also referred to as a 'data logger') for the recording of objective usability performance measurement data during the experiments (see appendix E). The purpose of such data collection instruments (data loggers), according to Rubin (1994), is to expedite the collection of all data significant to the test objectives. The objective is to collect data during the test as simply, concisely and reliably as possible.

In order to develop the task-logging sheet, a detailed task analysis was performed. The task analysis technique categorises the methods for performing tasks with a product into a series of steps (Jordan, 1998). The results of the task analysis were used to develop a task protocol sheet (see appendix D). The task protocol sheet contributed towards standardisation of the experiments, by providing all participants with the same instructions with regards to the tasks to be performed. Due to the dynamic nature of the software applications tested, two different task protocol sheets had to be developed for each experiment. The two task protocol sheets (A and B) differed in that the participants were each provided with a chance to be either the sender or receiver, for different media functions. Each sheet consisted of a different combination of sending and receiving activities that were completed by the different participants.

During the experimental phase of the usability testing, a trained observer performed manual data collection. The observer used the customised task-logging sheet for the collection of quantitative data, to document the performance of the participant in terms of specified usability performance measurement criteria.

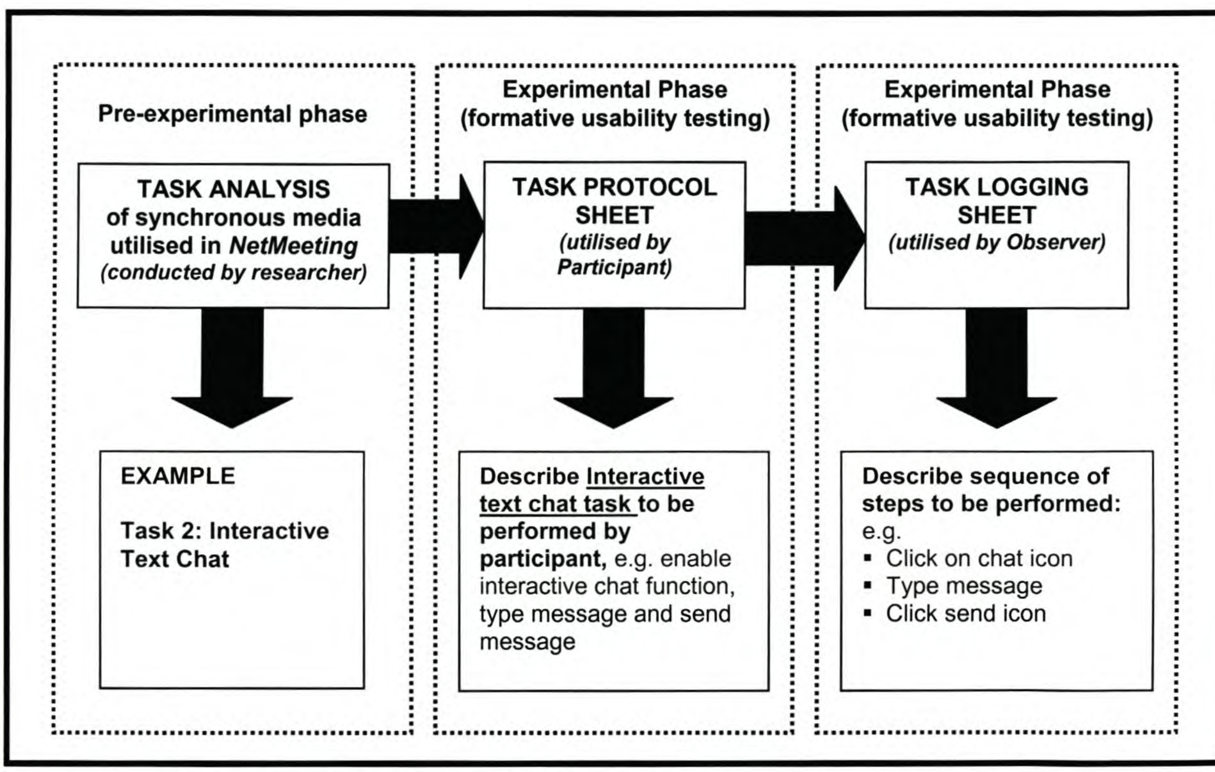


Figure 4.4: Description of objective data collection materials

4.6.4.6 Reliability

Neuman (1997) states that reliability and validity are central issues in all scientific measurement. Therefore, before a measuring instrument is developed and administered to a group of subjects, the issues concerning reliability and validity should be addressed. If the reliability and validity of the measuring instrument is unknown, very little trust can be placed in the results obtained and conclusions drawn.

Kerlinger and Lee (2000) state that reliability is the accuracy or precision of a measuring instrument. Synonyms for reliability include dependability, stability, consistency and predictability. It can be defined as the relative absence of errors of measurement in a measuring instrument. Neuman (1997) states that reliability means that the information provided by indicators (e.g. a questionnaire) does not vary as a result of characteristics of the indicator, instrument, or measurement device itself.

Kerlinger and Lee (2000) maintain that the measuring instrument is unreliable to the extent that errors of measurement are present in that instrument. The amount of error of measurement can be ascertained by determining the variance. Systematic variance occurs when errors are constant or biased (in other words, all scores lean to one direction and they are either all high or all low). With random or error variance, the scores tend to lean in any direction. Errors are random, due to the fact that a condition (such as fatigue), experienced at a particular time, may temporarily affect the subject or the measuring instrument.

To be interpretable, a test must be reliable. However, Kerlinger and Lee (2000) affirm that reliability is a necessary, but not always sufficient, condition of the value of research results and the interpretation thereof. In this study, Cronbach's Alpha, which is an estimate of reliability based on the average intercorrelation among question items, was used as the measure of reliability. The reliability measured by the alpha coefficients is summarised in table 4.1 and table 4.2.

Table 4.1: Alpha Coefficients for the dimensions of usability as were measured for the *NetMeeting* and *Yahoo Messenger* Usability Questionnaires.

Dimension	NetMeeting		Yahoo Messenger	
	Alpha	Number of items	Alpha	Number of items
General Usefulness / Utility	.7934	14	.9101	14
Effectiveness and Efficiency	.8973	8	.9100	8
Reliability	.2845	3	.6643	3
Ease of Use	.7766	11	.9200	11
Error Management	.6584	5	.7239	5
Consistency & Compatibility	.7630	9	.8861	9
Learnability	.7588	7	.8572	7
User satisfaction	.8704	8	.8983	8

Table 4.2: Alpha Coefficients for the dimensions of external quality as were measured for the *NetMeeting* and *Yahoo Messenger* Transmission System Quality Questionnaires.

Dimension	NetMeeting		Yahoo Messenger	
	Alpha	Number of items	Alpha	Number of items
Video Quality	.8006	4	.8049	4
Audio Quality	.7948	4	.5261	4
Quality of Data collaboration media	.3523	3	n/a	n/a

Nunnally (cited in Pallant, 2001, p.6) recommends a minimum level of .7 for the Cronbach alpha values. Almost all of the dimensions (except for reliability, error management and the quality of the data collaboration media) achieved a reliability coefficient of .7 and above. No alpha coefficient was calculated for the 'error rate' dimension (included in the usability questionnaire), due to a different measurement scale that was used for this dimension. As a result of constraints faced by the researcher, the dimensions of effectiveness and efficiency were combined together in one dimension. The same was done with the two dimensions, consistency and compatibility. One alpha coefficient was thus calculated for each these dimensions (consisting of two sub-dimensions).

4.6.4.7 Validity

Validity can be described, according to Heiman (1999) as the extent to which a measuring instrument measures that which it intends to measure. Hence, at the core of measurement validity is the degree of fit between a construct and the indicators thereof (Neuman, 1997). Types of validity include content, criterion related, and construct validity (Kerlinger & Lee, 2000). Content validity is the degree to which measurements actually reflect the variable of interest (Heiman, 1999). It is virtually impossible to draw large collections of items from a universe of content. Therefore, content validity is often a matter of judgement. The items of a measuring instrument must be studied, each item being weighed for its presumed representativeness of the property being measured (Kerlinger & Lee, 2000). Within this study, questions were chosen from previous research that specifically investigated similar usability issues.

Criterion validity is studied by comparing test or scale scores with one or more external variables, or criteria that are known or believed to measure the attributes under study (Kerlinger & Lee, 2000). To confirm criterion validity, it is important to determine whether the wording of the questions is understandable. It is furthermore important, to determine the elements that should be included or excluded, in order to provide answers to specific aspects of the research (De Jager, 2002). Validity is often assessed during the pilot testing of the questionnaires. Due to the constraints faced in completing this study, it was not possible to pre-test the usability questionnaire. As an alternative method of validation, the questionnaire was therefore presented to a usability expert and other non-experts to determine whether the questions were clearly worded and easily understood. This is especially important when measuring subjective concepts, such as attitudes. This procedure was also followed with the needs analysis and transmission system quality questionnaires to ensure the validity of these measurement instruments.

4.6.5 Phase 6: Prototyping and expert evaluation

The first phase in determining the feasibility of the software applications *NetMeeting* and *Yahoo Messenger,* was to conduct prototype experiments within a controlled experimental environment that simulated the actual experimental conditions. The purpose of the prototype experiments was to gain information about the feasibility of the software applications, when applied within the current technological infrastructure of the US (refer back to objective seven of goal three in section 4.5.2.3 (b) for more detail). The results of the prototype experiments are documented in sections 5.5.1.2 (*NetMeeting* prototype experiments) and 5.7.1.2 (*Yahoo Messenger* prototype experiments) of this thesis and will therefore not be discussed here.

4.6.6 Phase 7: Development of training manuals

Prerequisite training as part of the usability testing, as was the case with this study, refers to training provided for participants prior to the actual usability test, raising their skill level to some pre-established criterion. Such training could range from a simple 10-minute description of the product, to a comprehensive two-day workshop (Rubin, 1994). In order for the researcher to provide prerequisite training as part of the usability testing, two training manuals had to be developed, one for *NetMeeting* and one for *Yahoo Messenger*. The aim was to provide a brief introduction on the software applications and the media embedded within them. Each usability test session (experiment) was started with a 20-minute training session, providing the participants with a brief background and introduction to the two software applications.

Hereafter, with the commencement of the usability test, the users started to complete the tasks (as set out in the task protocol sheet) and the training manual was removed. Rubin (1994, p.189) states that, "removing the training manuals is an important requirement, since the training represents a very pointed, structured, and condensed document or package users often do not receive. Therefore, the user would not normally have access to them."

4.6.7 Phase 8: Prepare usability testing environment

The choice of method for a usability evaluation may be affected by the facilities and resources available to the investigator (Jordan, 1998). A facility that is increasingly common in industry is the on-site usability laboratory (Nielsen, 1993). Usability laboratories allow developers and researchers (usability team) to test their product by bringing their product and its potential users (evaluators) together in a controlled environment (Blatt, Jacobson & Miller, 1994). Rubin (1994, p.50), however, points out that, "...usability testing has often become synonymous with a high-powered, well-appointed, well-equipped, expensive laboratory. Having succumbed to the misperception that equates the laboratory with a successful usability testing process itself, numerous organisations have discovered only too late that usability testing is much more that a collection of cameras and recorders." Furthermore, Jordan (1998) proposes that although usability laboratories provide ideal surroundings for controlled experiments, they may be open to the criticism of being too far removed from the real environment of product use, and thus may lack in ecological validity. One could, therefore, assert that an expensive usability laboratory, is by no means, a pre-requisite for successful usability testing and results.

Due to financial constraints it was not possible to gain access to an appropriate usability laboratory and suitable technologically advanced video cameras (to record the actions of the participants on screen) for the usability test sessions of this study. Hence, the researcher utilised the available resources and undertook the necessary precautions during the usability experimental sessions, in order to create an authentic experimental environment, simulating a formal usability testing session in a usability laboratory.

Precautions included:

- Only allowing one participant per room for each experiment (with one observer);
- Ensuring that no disruptions took place during the course of the experiment; and

- Informing participants that the observer would only provide help and assistance when it is requested, after which, assistance provided would be recorded by the observer on the task-logging sheet.

4.6.8 Phase 9: Usability testing

The protocol for the usability test sessions that was executed during each experiment in this study, corresponds with the usability testing procedure described by Rubin (1994). The following phases of the experiments, as it was conducted, can be distinguished:

- Provide prerequisite training (20 minute introductory session);
- Distribute the task protocol sheet to the participant and instruct them to start completing the tasks;
- Observe the participant and collect all critical data (25 minutes);
- Have the participant complete all post-test questionnaires (15 minutes);
- Repeat the process for the second software application; and
- Thank the participant.

The overall experimental time was two hours, within which the respondents would have been trained in, worked with and evaluated both the software applications, *NetMeeting* and *Yahoo Messenger*.

4.6.9 Phase 10: Data analysis and report findings

The data obtained from the different measurement instruments was analysed utilising the Statistical Package for Social Science (SPSS) program. The analysis consisted of descriptive statistics, as this was deemed the most important objective of the research. Chapter five of this thesis is dedicated to providing a detailed description of the data and the subsequent findings of this study.

4.7 CONCLUSION

In this chapter, the research design and methodology that was employed during this study was reviewed. A clear description of the research problem and objectives has been provided. Furthermore, a concise description of the

VIS Project that provided the operational framework for the execution of this study, was also discussed.

Due to the fact that this was a usability study, the different phases in a usability research project, were also discussed. This research utilised numerous measurement instruments. The development of these instruments was discussed, as well as the concerted effort that was invested to investigate and verify the reliability and validity of the measuring instruments to ensure that the research results are viable.

CHAPTER 5: DISCUSSION OF FINDINGS AND RECOMMENDATIONS

5.1 INTRODUCTION

In exploratory research, the goal of the investigation is to produce a thorough and descriptive explanation of a specific phenomenon. The purpose of this chapter is to describe all research findings of the usability and feasibility of *NetMeeting* and *Yahoo Messenger* research as applied within the context of the technological infrastructure of the US, for purposes of virtual information sharing.

A brief description of the needs analysis data, obtained from the lecturer and student role-player groups, is presented. The chapter is structured to provide a logical exposition of the research goals and the attainment thereof, as it was presented in chapter four (section 4.5.2).

5.2 THE RESEARCH FINDINGS: LECTURER NEEDS ANALYSIS

The following section presents an overview of the research results that address the goal of conducting a needs analysis. The specific objectives that will be addressed by this section include:

- Objective 1 (a): To describe the specific needs of the lecturer role-player group, regarding the synchronous CMC media, before and after usability testing.
- Objective 2 (a): To prioritise the needs of the lecturer role-player group.

5.2.1 Introduction

The purpose of this section is to provide a description of the data obtained from the lecturer needs analysis questionnaire. At this stage the researcher would like to point out that the needs analysis questionnaire (appendix F) was originally designed to gather information on all synchronous and asynchronous CMC media that the VIS project investigated. This study focuses on the synchronous CMC media, therefore, only the data from the appropriate parts of the needs analysis questionnaire (those that focus on the synchronous CMC media) was analysed.

Seven respondents filled out the questionnaire on two respective occasions. The findings are represented in two segments. The first segment provides a brief description of the sample, in terms of biographical information. In the paragraphs to follow, the pre-and post needs analysis data findings are presented as analysed in terms of the different interaction scenarios for lecturers.

5.2.2 Results: descriptive statistics concerning the lecturer needs analysis biographical information

5.2.2.1 Background

The general biographical information segment of the needs analysis questionnaire for the lecturers, consists of two broad sections:

- The first segment gave an indication of the general background of the participants. These questions are related to the faculty candidates are from, the time that is spent on lecturing versus research activities, as well as an indication of the average time per week that the respondent spends on the Internet; and
- The second portion consists of questions relating to the respondents' previous exposure to software applications, *NetMeeting* and *Yahoo Messenger*.

5.2.2.2 Biographical results

- Seven respondents completed the questionnaire on two occasions.
- The highest percentage of respondents (43%) came from the faculty of science, whilst 20%, 14% and 14% of the respondents came from the arts, education and business management faculties, respectively (see figure 5.1).
- The mean time of lecturing activities for the seven lecturers was calculated at 49.3%, while the mean time for research activities was calculated at 50.7% (figure 5.2).
- Two of the respondents (28.6%) have previously used *Yahoo Messenger* (table 5.1). Both of the respondents indicated that the time of exposure to *Yahoo Messenger* did not exceed one year (table 5.3).

- Only one of the respondents (14.3%) has had previous exposure to *NetMeeting* (table 5.2). The respondent indicated that the time of exposure did not exceed one year (table 5.4).

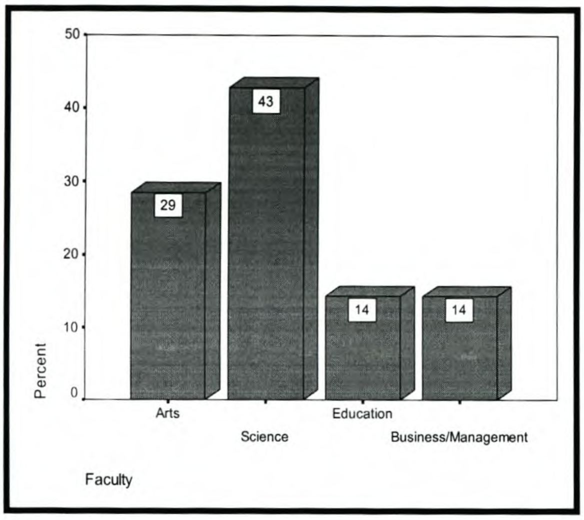


Figure 5.1: Faculties of lecturers

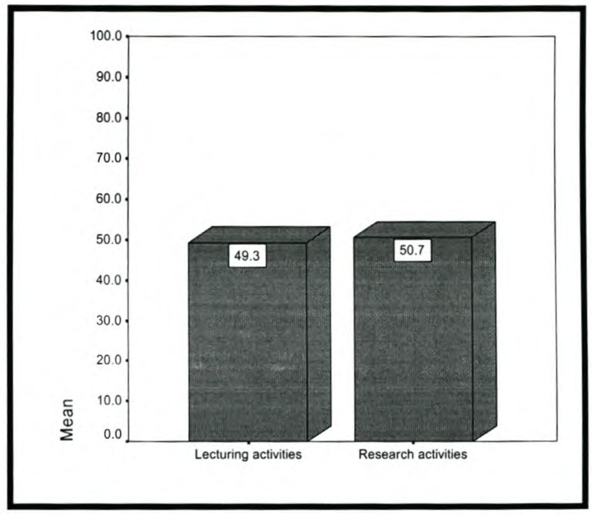


Figure 5.2: Lecturing vs. research activities of lecturers

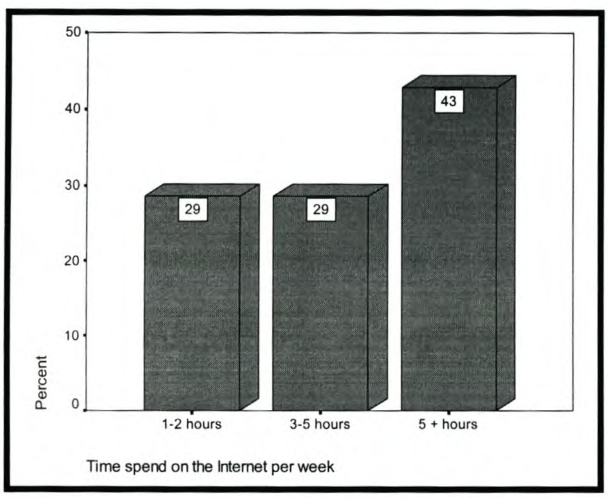


Figure 5.3: Average amount of time spent on the Internet by lecturers

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

Table 5.1: *Yahoo Messenger* use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	28.6	28.6	28.6
	No	5	71.4	71.4	100.0
	Total	7	100.0	100.0	

Table 5.2: ***NetMeeting* use**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	14.3	14.3	14.3
	No	6	85.7	85.7	100.0
	Total	7	100.0	100.0	

Table 5.3: ***Yahoo Messenger* years**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	71.4	71.4	71.4
	1	2	28.6	28.6	100.0
	Total	7	100.0	100.0	

Table 5.4: ***NetMeeting* years**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	6	85.7	85.7	85.7
	1	1	14.3	14.3	100.0
	Total	7	100.0	100.0	

5.2.3 Results: Descriptive statistics concerning the results of the lecturer pre- and post needs analysis

The following section is focused on the provision of a concise description of the needs of the lecturer role-player group, as it pertains to the different synchronous CMC media that were tested in this study. Four different scenarios of interaction were specified in the questionnaire for the lecturer role-player group. These include: lecturer-to-student interaction, lecturer-to-researcher interaction, lecturer-to-lecturer interaction and lecturer-to-information service supplier interaction.

The results of the questionnaire were analysed per scenario and are presented in tables 5.5-5.8. The percentage that is categorised in relation to each medium represents the grouped responses of the participants' assessment. This percentage, therefore, indicates the total amount of participants that observe a specific level of frequency of use (never, sometimes or frequently) for that specific medium, within the specified scenario (such as student to lecturer) – both before and after exposure to the medium. The subsequent interpretations of the data will focus primarily on the post-needs analysis results in the 'frequent' category of usage.

5.2.3.1 Interaction Scenario One

Table 5.5 represents the results obtained for interaction scenario one, lecturer-to-student interaction. The following incidence of perceived needs can be reported:

- Slightly more than half (57%) of the lecturers reported that they would frequently use video and audio conferencing when interacting with students. This percentage increased significantly (with 53%) after exposure to the systems;
- 71% of the respondents suspect that they would use the file transfer function frequently, whereas 29% believe that they would use it sometimes, when interacting with students;
- None of the respondents perceive that they would use the instant messaging function frequently when interacting with students, while 86% of the respondents suspect that they would never use the medium when interacting with students;
- 71% of the respondents observe that they would sometimes use the whiteboard in their interaction with students.

Table 5.5: Results of the lecturer pre- and post needs-analysis for interaction scenario one (lecturer-to-student interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing					6	86%	3	43%	1	4%	4	57%
Whiteboard					6	86%	5	71%	1	14%	2	29%
Interactive text chat	1	14%	1	14%	6	86%	4	57%			2	29%
Real time file transfer	1	14%			2	29%	2	29%	4	57%	5	71%
Program sharing	1	14%			6	86%	4	57%			3	43%
Instant messaging			6	86%	5	71%	1	14%	2	29%		

Based upon the results in table 5.5, the following hierarchy of the perceived needs, in terms of frequent anticipated use for the specific media (for lecturer-to-student interaction) is, therefore, presented:

1. Real-time file transfer (71%);

2. Video and audio conferencing (57%);
3. Program sharing (43%); and
4. Whiteboard and Interactive text chat (both 29%).

5.2.3.2 Interaction Scenario Two

Table 5.6 represents the results obtained for interaction scenario two, lecturer-to-researcher interaction. The following incidence of perceived needs can be reported:

- A vast majority (86%) of the respondents suspect that they would frequently use the program sharing function in their interaction with other researchers;
- More than two thirds of the respondents (71%) believe that they would use the file transfer and interactive text chat functions frequently when collaborating with other researchers;
- 43% of the respondents observe that they would use the video and audio conferencing functions frequently when collaborating with other researchers;

Based upon the results presented in table 5.6, the following hierarchy of the perceived needs, in terms of frequent anticipated use, (for lecturer-to-student interaction), is therefore presented:

1. Program sharing (86%);
2. Interactive text chat and real-time file transfer (both 71%);
3. Whiteboard (57%);
4. Video and audio conferencing and instant messaging (both 43%).

A possible interpretation of the ranking presented above could be attributed to the potential that lecturers perceive for the use of the program sharing and file transfer media when collaborating with other lecturers, over dispersed geographical boundaries. In this application scenario, the program sharing and file transfer media would provide suitable opportunities for collaborative editing of articles (or research results) before publication. These media functions would, furthermore, enable lecturers to collaborate with other subject matter experts in their field of study, obtaining the most recent information about developments in their fields, in order to efficiently update their course material.

Table 5.6: Results of the lecturer pre- and post needs-analysis for interaction scenario two (lecturer-to- researcher interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing					6	86%	4	57%	1	14%	3	43%
Whiteboard	1	14%			4	57%	3	43%	2	29%	4	57%
Interactive text chat	1	14%	2	29%	5	71%			1	14%	5	71%
Real time file transfer					3	43%	2	29%	4	57%	5	71%
Program sharing	1	14%			5	71%	1	14%	1	14%	6	86%
Instant messaging			1	14%	5	71%	3	43%	2	29%	3	43%

5.2.3.3 Interaction Scenario Three

Table 5.7 represents the results obtained for interaction scenario three, lecturer-to-lecturer interaction. The following incidence of perceived needs can be reported:

- Slightly more than half of the respondents (57%) suspect that they would never use the program sharing, whiteboard and interactive text chat media to interact with fellow lecturers;
- 29% of the respondents perceive that they would never use video and audio conferencing in this context of interaction, whilst 57% of the respondents suspect that they would sometimes use these media in their interaction with other lecturers;
- A mere 14% of the respondents perceive that they would frequently use video and audio conferencing media, the whiteboard, file transfer and program sharing media, should it be available to facilitate communication and information sharing with fellow lecturers; and

- Only 29% of the respondents suspect that they would frequently use the instant messaging and interactive text chat functions within this interaction context.

It is evident, based on the results of table 5.7, that the respondents generally assess the specified synchronous media to not be particularly suitable for facilitating communication with other lecturers. Consequently, the researcher will refrain from prioritising needs with regards to the media.

A possible interpretation of these results could be attributed to the fact that the level of previous exposure to both the software applications was relatively low. It should, however, be the case that with more exposure to the products the users will start to explore new applications for the use of the product. The researcher therefore suspects that as lecturers familiarise themselves with the software applications and become comfortable with it, new applications (e.g. liasing with lecturers at similar institutions of tertiary education over geographical boundaries) will be discovered.

Table 5.7: Results of the lecturer pre- and post needs-analysis for interaction scenario three (lecturer-to-lecturer interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing	4	57%	2	29%	3	43%	4	57%			1	14%
Whiteboard	4	57%	4	57%	3	43%	2	29%			1	14%
Interactive text chat	4	57%	4	57%	3	43%	1	14%			2	29%
Real time file transfer	3	43%	2	29%	4	57%	4	57%			1	14%
Program sharing	6	86%	4	57%	1	14%	2	29%			1	14%
Instant messaging	3	43%	3	43%	4	57%	2	29%			2	29%

5.2.3.4 Interaction Scenario Four

Table 5.8 represents the results obtained for interaction scenario four, lecturer-to-information service supplier interaction. The following incidence of perceived needs can be reported:

- More than half of the respondents (57%) predict frequent usage of the program sharing and real-time file transfer media when interacting and sharing information with information service suppliers;
- 43% of the respondents perceive frequent use of the whiteboard, whilst 57% of the respondents suspect that they would sometimes use the whiteboard for collaboration with information service suppliers; and
- Only 29% of the respondents perceive that they would utilise the video and audio conferencing, interactive text chat and instant messaging media frequently within this interaction scenario.

Based upon the results presented in table 5.8, the following hierarchy of the perceived needs, in terms of frequent anticipated use of the specified media, is presented:

1. Program sharing and file transfer (both 57%);
2. Whiteboard (43%);
3. Video and audio conferencing and interactive text chat (both 29%); and
4. Instant messaging (14%).

It is evident, from the ranking presented above, that the data collaboration media are perceived by lecturers as most applicable for the support role that the information service suppliers presently fulfil (mainly the dissemination of information). It is anticipated, however, that a paradigm shift will take place as the value of communities of practice and knowledge management are realised (by all role-players) and specifically the role that the information service suppliers (through the utilisation of instant messaging, chat and conferencing media) could possibly fulfil in these communities.

Table 5.8: Results of the lecturer pre- and post needs-analysis for interaction scenario four (lecturer-to-information service supplier interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing	2	29%			5	71%	5	71%			2	29%
The Whiteboard	1	14%			6	86%	4	57%			3	43%
Interactive text chat	3	43%	2	29%	4	57%	3	43%			2	29%
Real time file transfer			1	14%	6	86%	2	29%	1	14%	4	57%
Program sharing	1	14%			6	86%	3	43%			4	57%
Instant messaging	1	14%	2	29%	5	71%	4	57%	1	14%	1	14%

Table 5.9: Overview of the rankings of the needs analysis data for the post-test 'frequent' category for each of the scenarios.

	Scenario 1: Lecturer-to-Student Interaction	Scenario 2: Lecturer-to-Researcher Interaction	Scenario 3: Lecturer-to-Lecturer Interaction	Scenario 4: Lecturer-to-Information Service Supplier Interaction
Video & Audio conferencing	2	4	n/a	3
Whiteboard	4	3	n/a	2
Interactive text chat	4	2	n/a	3
Real time file transfer	1	2	n/a	1
Program sharing	3	1	n/a	1
Instant messaging	5	4	n/a	4

5.2.4 Interpretations of the findings for the lecturer needs analysis

The following interpretations regarding the need for the different media, across all interaction scenarios can be reported (table 5.9):

- Across all scenarios, there seems to be the highest need for the real-time file transfer medium (having achieved the first ranking twice and second ranking once);
- The second highest need exists for the program sharing medium (having achieved a first ranking twice and a third ranking once);
- The third highest need exists for the video and audio conferencing, whiteboard and interactive chat media (all having achieved the second ranking once, the third ranking once and the fourth ranking once); and
- The fourth highest need exists for the instant messaging medium (having achieved the fourth ranking twice, and the fifth ranking once).

Based on the results provided above, the identification of a common denominator underlying the ranking of the needs was identified. It is evident that the current need for the media is focused on the functionality of the data collaboration media (real-time file transfer and program sharing) and the opportunities that it would create for increased efficient information sharing. From the experimental sessions, however, it became evident that the effective utilisation of the program sharing medium needs to be accompanied with interaction assisted by the audio conferencing medium. It is, therefore, anticipated that such increased exposure to the use of the audio and video conferencing media, will facilitate a process by which lecturers will become aware of the potential of the media and the numerous application possibilities that it hold for increased information sharing and learning processes in the VIS.

5.3 THE RESEARCH FINDINGS: STUDENT NEEDS ANALYSIS

The following section presents an overview of the research results that address the goal of conducting a needs analysis (goal one). The specific objectives that will be addressed by this section include:

- Objective 1 (b): To describe the specific needs of the student role-player group, regarding the synchronous CMC media, before and after usability testing.
- Objective 2 (b): To prioritise the needs of the student role-player group.

5.3.1 Introduction

The purpose of this section is to provide a description of the data obtained from the student needs analysis questionnaires. Eleven respondents filled out the questionnaire on two occasions. The findings are represented in two segments. The first segment will provide a brief description of the sample, in terms of biographical information. Hereafter, the pre-and post needs analysis data findings are presented, as analysed, in terms of the different interaction scenarios for students.

5.3.2 Results: Descriptive statistics concerning the student needs analysis biographical information

5.3.2.1 Background

The general biographical information segment of the needs analysis questionnaire for the students, consists of two broad sections:

- The first segment gave an indication of the general background of the participants. These questions were related to the degree and faculty of the candidates; and
- The second portion consists of questions relating to the respondents' exposure to the software applications, *NetMeeting* and *Yahoo Messenger,* as well as the average amount of time spent on the Internet per week.

5.3.2.2 Biographical results

- Eleven respondents completed the questionnaire on two occasions.
- Due to constraints, 45% of the respondents were not post-graduate students, but rather final year undergraduate students (figure 5.4). Although this study primarily targeted students on postgraduate level, the researcher had no other choice but to include final-year students in order to secure a reasonable sample size.
- As is evident from figure 5.5, 55% of the respondents were from the arts faculty, 27% from the science faculty, 9% from the education faculty and 9% from the business and management faculty.
- 36% of the respondents indicated that they spend an average of three to five hours per week on the Internet, whereas 27% spend between one to two hours a week on the Internet. 27% of the respondents indicated that they spend more than five hours per week on the Internet (figure 5.6).
- Almost half of the respondents (45.5%) have previously used *Yahoo Messenger* (table 5.10). Of the five respondents that have previously been exposed to *Yahoo*

Messenger, four indicated that the time of exposure did not exceed two years (table 5.12) and one respondent indicated up to four years of exposure.

- Only one of the respondents (9.1%) has had previous exposure to *NetMeeting* (table 5.11). The respondent indicated that the time of exposure did not exceed more than one year (table 5.13).

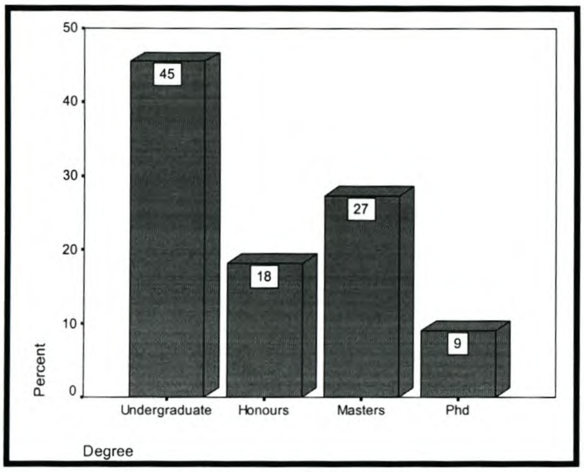


Figure 5.4: Degree of respondents that are studying

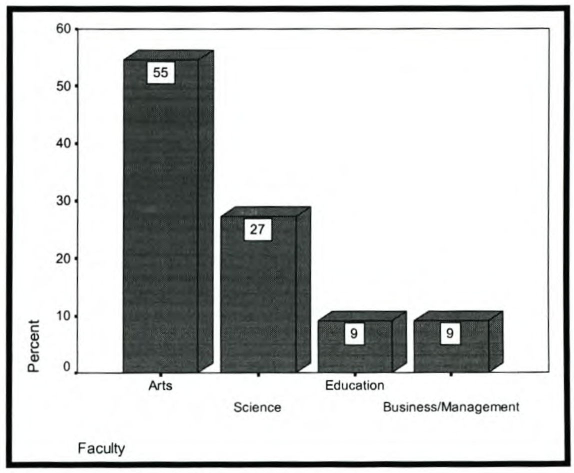


Figure 5.5: Faculty of respondents

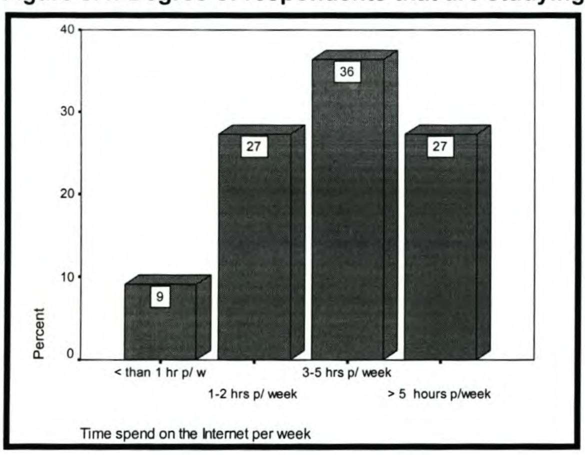


Figure 5.6: Average amount of time spent on the Internet by students

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

Table 5.10: *Yahoo Messenger* use / experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	45.5	45.5	45.5
	No	6	54.5	54.5	100.0
	Total	11	100.0	100.0	

Table 5.11: *NetMeeting* use / experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	9.1	9.1	9.1
	No	10	90.9	90.9	100.0
	Total	11	100.0	100.0	

Table 5.12: Yahoo Messenger years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	6	55.0	55.0	55.0
	2	4	36.0	36.0	91.0
	4	1	9.0	9.0	100.0
	Total	11	100.0	100.0	

Table 5.13: *NetMeeting* years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	10	90.9	90.9	90.9
	1	1	9.1	9.1	100.0
	Total	11	100.0	100.0	

The very low previous exposure of the respondents to *NetMeeting* and the relatively low previous exposure to *Yahoo Messenger* are most likely as a result of its limited availability on the US campus. Although both of these software applications can be downloaded from the Internet, certain hardware requirements must be met (webcam, microphone and speakers). A solution to encourage increased use of these systems would be to provide access to *Yahoo Messenger* and *NetMeeting* at selected points on the campus, that is suitably equipped for this purpose.

5.3.3 Results: Descriptive statistics concerning the results of the student pre- and post needs analysis

The following section focuses on providing a concise description of the needs of the student role-player group, as it pertains to the different synchronous CMC media that was tested in this study.

Four different scenarios of interaction were specified for this role-player group. These include: student-to-lecturer interaction, student-to-student interaction, student-to-information service supplier interaction and student-to-researcher interaction. The results of the questionnaire were analysed per scenario and are presented in tables

5.14 – 5.17. The percentage that is categorised opposite each medium, represents the grouped responses of the participants' assessment. This percentage thus depicts the total amount of participants that observed a specific level of frequency of use (never, sometimes or frequently) for that specific medium, within the specified scenario (e.g. student to lecturer) – both before and after exposure to the medium. The subsequent interpretations of the data will focus primarily on the post-needs analysis results in the 'frequent' category of usage.

5.3.3.1 Interaction Scenario One

Table 5.14 represents the results obtained for interaction scenario one, student-to-lecturer interaction. The following observations can be reported:

- Almost two thirds of the respondents (64%) suspect that they would frequently use the interactive text chat and instant messaging media, when sharing information with lecturers;
- Slightly more than half of the respondents (55%) perceive that they would frequently use the real-time file transfer medium when interacting with lecturers; and
- 45% of the respondents perceive that they would utilise the video and audio conferencing, whiteboard and program sharing media frequently for sharing information and collaborating with lecturers.

Based upon the results, the following hierarchy of the perceived needs, in terms of frequent anticipated use of the media, is presented:

1. Interactive text chat and instant messaging (both 64%);
2. Real-time file transfer (55%);
3. Video and audio conferencing, whiteboard and program sharing (all 45%).

Table 5.14: Results of the student pre- and post needs-analysis for interaction scenario one (student-to-lecturer interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing	1	9%			5	45%	6	55%	5	45%	5	45%
The Whiteboard	2	18%	1	9%	5	45%	5	45%	4	36%	5	45%
Interactive text chat			1	9%	6	55%	3	27%	5	45%	7	64%
Real time file transfer	2	18%			5	45%	5	45%	4	36%	6	55%
Program sharing	1	9%	1	9%	6	55%	5	45%	4	36%	5	45%
Instant messaging			2	18%	2	18%	2	18%	9	82%	7	64%

For student interaction with lecturers, the interactive text chat and instant messaging media could be utilised in situations were students would want to acquire course related information. These media will also facilitate more effective interaction between students and lecturers. The file transfer function could be used for the quick and efficient transfer of documents (seminars, projects or theses) that would normally not be transferable by e-mail (as a result of the relative small size that attachments to e-mail are limited to).

5.3.3.2 Interaction Scenario Two

Table 5.15 represents the results for interaction scenario two, thus student-to-student interaction. The following observations can be reported:

- Almost three quarters (73%) of the respondents suspect that they would use the interactive text chat medium frequently, when interacting with fellow students;
- 64% of the respondents perceive that they would utilise the video and audio conferencing media frequently, whilst the remaining 36% or the respondents suspect that they would use it sometimes when communicating with fellow students;
- 55% of the respondents perceive, concerning the instant messaging medium that they would use it frequently, whilst 45% suspect that they would use it sometimes when interacting with fellow students; and

- 45% of the respondents suspect that they would utilise the whiteboard and real-time file transfer media frequently, when interacting with fellow students.

Table 5.15: Results of the student pre- and post needs analysis for interaction scenario two (student-to-student interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing	1	9%			5	45%	4	36%	5	45%	7	64%
Whiteboard	2	18%	1	9%	3	27%	5	45%	6	55%	5	45%
Interactive text chat	2	18%			3	27%	3	27%	6	55%	8	73%
Real time file transfer					8	73%	6	55%	3	27%	5	45%
Program sharing	1	9%			6	55%	7	64%	4	36%	4	36%
Instant messaging							5	45%	11	100%	6	55%

Based upon the results in table 5.15, the following hierarchy of the perceived needs in terms of frequent anticipated use of the media, is presented:

1. Interactive text chat (73%);
2. Video and audio conferencing (64%);
3. Instant messaging (55%);
4. Whiteboard and real-time file transfer (both 45%) and program sharing (36%).

A possible interpretation of these results could point towards the potential that students observe in utilising the media for group work. Students would most probably use the interactive text chat and instant messaging media to collaborate on various topics related to the specified task. This will increase the effectiveness of group work, whilst documents can easily be dispersed between group members by utilisation of the file transfer medium. A group member could also present his/her work to other members by sharing the document with the program sharing media. This presents an opportunity for the collaborative editing of the document to ensure that all members are satisfied with the content and presentation thereof. Consequently, these application possibilities, in essence, reflect the fundamental acceptance of COP principles and will therefore increase knowledge sharing and creation based on constructivist principles.

5.3.3.3 Interaction Scenario Three

Table 5.16 represents the results obtained for interaction scenario three, student-to-information service suppliers. The following observations can be reported:

- Almost half of the respondents (45%) suspect that they would never use the video and audio conferencing, whiteboard and program sharing media when interacting with information service suppliers;
- 27% of the respondents perceive that they would never use the interactive text chat function within this context, whereas 45% suspect that they would use frequently;
- Slightly more than half of the respondents (55%), suspect that they would utilise the real-time file transfer function frequently in their interaction with information service suppliers; and
- 27% of the respondents perceive that they would use the instant messaging function frequently when communicating with information service suppliers.

Table 5.16: Results of the student pre- and post needs-analysis for interaction scenario three (student-to-information service supplier interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing	2	18%	5	45%	7	64%	4	36%	2	18%	2	18%
Whiteboard	2	18%	5	45%	6	55%	4	36%	3	27%	2	18%
Interactive text chat	2	18%	3	27%	3	27%	3	27%	6	55%	5	45%
Real time file transfer	3	27%	1	9%	4	36%	4	36%	4	36%	6	55%
Program sharing	2	18%	5	45%	6	55%	4	36%	3	27%	2	18%
Instant messaging	1	9%	1	9%	3	27%	7	64%	7	64%	3	27%

Based upon the results in table 5.16, the following hierarchy of the perceived needs, in terms of frequent anticipated use of the media, is presented:

1. Real-time file transfer (55%);
2. Interactive text chat (45%);
3. Instant messaging (27%); and
4. Whiteboard, video and audio conferencing and program sharing (all 18%).

Specific applications for the use of the real-time file transfer medium in the student-to-information service supplier interaction scenario would most likely pertain to the dissemination of electronic references, journal articles and other sources of information. Enquiries regarding requested information could furthermore be facilitated by the interactive text chat and instant messaging media. This will most probably improve the accuracy and speed at which the information is requested and provided.

5.3.3.4 Interaction Scenario Four

Table 5.17 represents the results obtained for interaction scenario four, student-to-researcher interaction. The following observations can be reported:

- Almost two thirds of the respondents (64%), suspect that they would use the real-time file transfer medium frequently in their interaction with researchers. A further 36% of the respondents perceive that they would sometimes use this medium within this interaction scenario;
- 55% of the respondents suspect that they would frequently utilise the interactive text chat medium when communicating with researchers, whilst 9% believe that they would never use this medium within this interaction context;
- 45% of the respondents suspect that they would utilise the video and audio conferencing media frequently, whilst 36% perceive they would use it sometimes in their interaction with researchers; and

- Slightly more than a third of the respondents (36%), suspect that they would frequently use the whiteboard and instant messaging media when communicating with researchers.

Table 5.17: Results of the student pre- and post needs-analysis for interaction scenario four (student-to-researcher interaction)

Synchronous CMC media	NEVER				SOMETIMES				FREQUENTLY			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Video & Audio conferencing			2	18%	5	45%	4	36%	6	55%	5	45%
Whiteboard	1	9%			4	36%	7	64%	6	55%	4	36%
Interactive text chat	1	9%	1	9%	4	36%	4	36%	6	55%	6	55%
Real time file transfer	2	18%			2	18%	4	36%	7	64%	7	64%
Program sharing	1	9%			6	55%	6	55%	4	36%	5	45%
Instant messaging			2	18%	2	18%	5	45%	9	82%	4	36%

Based upon the results in table 5.17, the following hierarchy of the perceived needs, in terms of frequent anticipated use of the media, is presented:

1. Real-time file transfer (64%);
2. Interactive text chat (55%);
3. Program sharing and video and audio conferencing (both 45%);
4. Whiteboard and instant messaging (both 36%).

5.3.4 Interpretations of the findings for the student needs analysis

The following interpretations regarding the needs for the different media, across all interaction scenarios can be reported (table 5.18):

- Across all of the scenarios there seems be the highest need for the interactive text chat medium (having achieved both the first and second ranking twice);
- The second highest need exists for the file transfer function (having achieved the first ranking twice and the second ranking once);

- The third highest need exists for the instant messaging medium (having achieved the first ranking once and the third ranking twice);
- The fourth highest need exists for the video and audio conferencing media (having achieved the second ranking once, and the third ranking twice);
- The fifth highest need exists for the program sharing medium (having achieved the third ranking three times and the fourth ranking once); and
- The sixth highest need exists for the whiteboard (having achieved the fourth ranking four times).

It is evident from the results was the greatest need was for the interactive text chat media, followed by the file transfer function, instant messaging media, video and audio conferencing, program sharing and lastly, the whiteboard media. The common denominator underlying the higher ranking needs here, is clearly not only the media that provides quick and easy data collaboration opportunities (as was the case with the lecturers). Conversely, it rather seems that the students found the opportunities for CMC, that allow for a higher level of interaction between all the relevant role-players, as more important.

Table 5.18: Overview of the rankings of the needs analysis data for the post-test 'frequent' category for each of the scenarios

	Scenario 1: Student-to-Lecturer Interaction	Scenario 2: Student-to-Student Interaction	Scenario 3: Student-to-Information Service Supplier Interaction	Scenario 4: Student-to-Researcher Interaction
Video & Audio conferencing	3	4	2	3
Whiteboard	4	4	4	4
Interactive text chat	2	2	1	1
Real time file transfer	1	1	4	2
Program sharing	3	4	4	4
Instant messaging	4	3	3	1

5.3.5 Summary of lecturer and student needs analysis results

Table 5.19 provides a summary of the post needs analysis data from the 'frequent' category of usage, for both the student and lecturer role-players groups. The percentage categorised opposite each medium represents the grouped responses of the participants' assessment. The percentage thus depicts the total amount of participants that observed 'frequent' usage for that specific medium, within the specified scenario.

The following observations can be reported (table 5.19):

- There is a large difference in terms of the instant messaging (64%) and interactive chat media (35%) with relation to the student-to-lecturer and lecturer to student interaction scenarios. In both cases more students indicated a need for the two media functions (both 64%), whilst only 29% and 0% of the lecturers perceived a need for the interactive text chat and instant messaging media, respectively. The reason for the students' reaction could possibly be due to the fact that they perceive these media functions as a convenient and easy way to interact with lecturers. Lecturers, however, might feel that they would rather refrain from interacting with students through utilising these media functions, as it might take up a lot of time to respond to every individual enquiry from different students.
- In terms of these two role-players groups' interaction with the information service suppliers, was it observed that more students once again indicated a need for the interactive text chat medium (45% versus 29% of the lecturers). More lecturers, however, indicated a need for the data collaboration media (program sharing and whiteboard) than students.
- A significant difference can be noted with regards to the use of the program sharing medium in the student-to-researcher and lecturer-to-researcher interaction scenarios. 86% of the lecturers indicated that they would use the program sharing medium in this interaction scenario, whilst only 45% of students indicated a need for frequent use of this medium in this particular interaction scenario. Lecturers are, however, significantly more involved in research than students and the application of the program sharing medium for certain research activities (e.g. collaborative editing of a article) could most probably be the reason for this incidence.
- In terms of interaction with the similar role-player group (student-to-student and lecturer-to-lecturer) can it be reported that in all of the media functions students did indicated a higher frequency (in relation to the lecturers) of usage with their peers. This could

indicate that the students are more open to the use of the media for increased information sharing and would most probably more eagerly accept and adapt to the use of these technologies when applied within the tertiary education environment.

Table 5.19: Summary of lecturer and student post-needs analysis results

Synchronous CMC media	INTERACTION SCENARIO: STUDENT-to				INTERACTION SCENARIO: LECTURER-to			
	Lecturer	Student	Information Service Supplier	Researcher	Student	Researcher	Lecturer	Information Service Supplier
Video & Audio conferencing	45%	64%	18%	45%	57%	43%	14%	29%
Whiteboard	45%	45%	18%	36%	29%	57%	14%	43%
Interactive text chat	64%	73%	45%	55%	29%	71%	29%	29%
Real time file transfer	55%	45%	55%	64%	71%	71%	14%	57%
Program sharing	45%	36%	18%	45%	43%	86%	14%	57%
Instant messaging	64%	55%	27%	36%	0%	43%	29%	14%

5.4 THE RESEARCH FINDINGS: *NETMEETING* USABILITY (SUBJECTIVE DATA)

The following section presents an overview of the research results related to the goal of evaluating the usability of the software application, *NetMeeting*. Objectives 3 (a and b) and 4 as stated in paragraph 4.5.2.2 (a) and (b) of chapter four have already been addressed in chapter two, section 2.5.5.4 and chapter three, respectively.

Therefore, this section will focus on addressing objective 5 (a), which was specified as: to evaluate the usability of *NetMeeting* through conducting formal usability testing in a controlled experimental environment, to obtain subjective data through the utilisation of a subjective measurement technique (usability questionnaire). Section 5.5 of this thesis will address objective 6 (a) that also relates to the goal of evaluating the usability of *NetMeeting* through objective measurement.

5.4.1 Introduction

The purpose of this section is to present the research findings as it pertains to the participants' subjective evaluation of the usability of the software application, *NetMeeting*. The findings in this section are represented in two segments. The first segment will provide a brief description of the sample in terms of the biographical information. Hereafter the usability results (of the usability questionnaire) are presented, as analysed, in terms of the stated hypotheses.

5.4.2 Results: Descriptive statistics concerning biographical information

5.4.2.1 Background

The general biographical information segment of the usability questionnaire consists of four broad sections:

- The first segment gave an indication of the general background of the participants. These questions related to the candidates gender, their preferred language and user group;
- The second portion consisted of questions relating to the respondents' level of technology-related knowledge and ability. These questions related to computer literacy, exposure, experience and frequency of computer usage;
- The third section related to the candidates level of exposure to the software application, *NetMeeting*; and
- The fourth section covered issues regarding the *NetMeeting* experiment. These questions covered the training received and tasks completed.

5.4.2.2 Biographical results

- The questionnaire was issued to 35 individuals.
- Almost all of the respondents (91 %) were categorised into the lecturer & researcher or student user groups (figure 5.7).
- Most of the respondents (71.5%) indicated that Afrikaans was their first language (table 5.21).
- The gender dispersion was almost equal, with 40% of the respondents being female and 60% of the respondents being male (table 5.20).

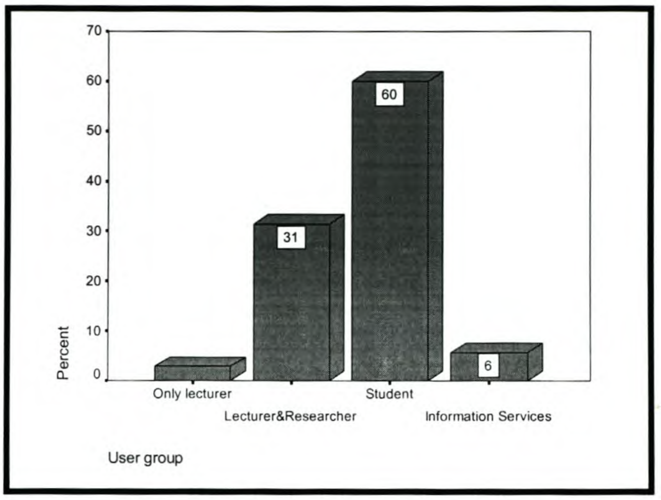


Figure 5.7: Profile of the user status of respondents

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

Table 5.20: Cross-tabulation of user status and gender

Count

		Gender		Total
		Female	Male	
User group	Only lecturer		1	1
	Lecturer & researcher	2	9	11
	Student	11	10	21
	Information Services	1	1	2
Total		14	21	35

Table 5.21: Cross-tabulation of user status and preferred language

Count

		Language			Total
		Afrikaans	English	Other	
User group	Only lecturer	1			1
	Lecturer & researcher	6	4	1	11
	Student	16	5		21
	Information Services	2			2
Total		25	9	1	35

The following remarks regarding the information related to the respondent's computer literacy, exposure, experience, usage and training can be reported:

- 48.6% of the respondents rated themselves as very computer literate and 45.7% of the respondents rated themselves as literate (figure 5.8);
- Slightly more than half of the respondents (57.1%) indicated that they have more than 6 years experience with computers, whilst 17.1% have 4 to 6 years experience (table 5.23);

- The majority of respondents are exposed to computers on a regular basis with 80% of the respondents having access to a computer at work and at home (table 5.22);
- 94.3% of the respondents indicated that they use a computer everyday (table 5.24); and
- In terms of formal computer training received (figure 5.9), more than half of the respondents (57.1%) claim to have received 10 or more hours of formal computer training, while 14.3% received between 4 and 10 hours training. Formal computer training, is however not a guarantee of ensuring ease of usage with computers. 25.4% indicated that they have had less than 2 hours of training.

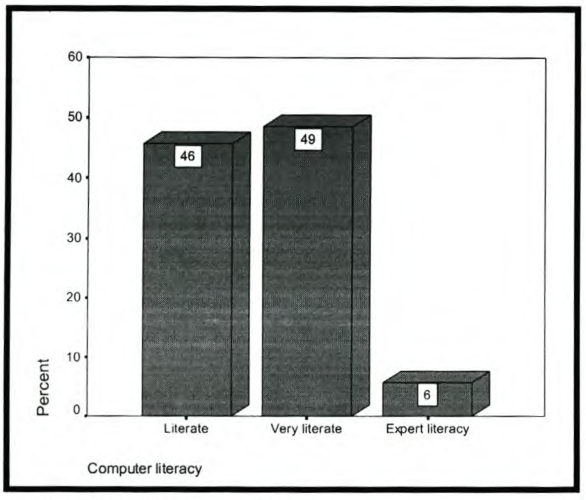


Figure 5.8: Computer literacy

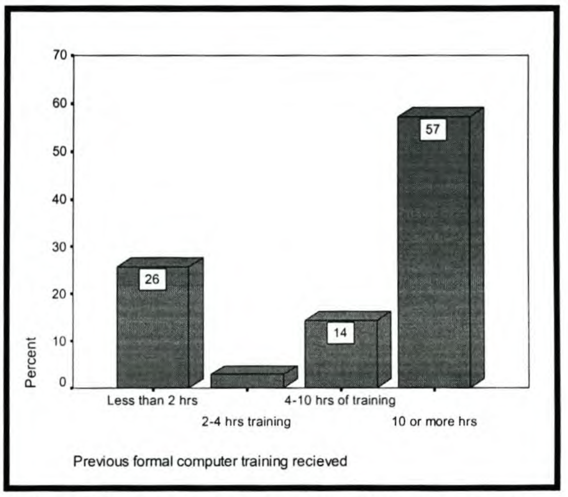


Figure 5.9: Amount of previous formal computer training received

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

Table 5.22: Computer exposure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only access to a computer at work	4	11.4	11.4	11.4
	Only access to a computer at home	3	8.6	8.6	20.0
	Access to a computer at work and at home	28	80.0	80.0	100.0
	Total	35	100.0	100.0	

Table 5.23: Computer experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than one year experience	1	2.9	2.9	2.9
	1-3 years experience	8	22.9	22.9	25.7
	4-6 years experience	6	17.1	17.1	42.9
	More than 6 years experience	20	57.1	57.1	100.0
	Total	35	100.0	100.0	

Table 5.24: Frequency of computer usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I use a computer approximately once a week	2	5.7	5.7	5.7
	I use a computer everyday	33	94.3	94.3	100.0
	Total	35	100.0	100.0	

Jordan (1998) and Bevan and Macleod (1994) maintain that previous experience with a product itself is likely to affect the ease or difficulty with which a particular user completes a particular task with the product. They note that experience with other similar products may also affect how usable a product is for a user. In terms of issues concerned with previous exposure to *NetMeeting* and similar video conferencing systems, the following results can be reported:

- Only one of the respondents (2.9%) has had previous exposure to *NetMeeting*. The rest of the respondents (97.1%), have had no previous exposure to *NetMeeting* (table 5.26); and
- In terms of the synchronous CMC media embedded within *NetMeeting*, the respondents indicated the highest previous exposure (28.6%) with the interactive text chat medium. Considering the real-time file transfer medium function, 22.9% of the participants have had previous exposure. Previous exposure to the program sharing (20%) and whiteboard (8.6%) media functions are relatively low. It is significant here, that only 2.9% and 5.7% of the respondents have had previous exposure to the video and audio conferencing functions, respectively (table 5.25).

Table 5.25: Summary of the number of respondents from the sample that indicated previous exposure to synchronous CMC media.

Synchronous CMC media	Number of Respondents					
	Previous exposure		No previous exposure		Total	
	N	Percent	N	Percent	N	Percent
Video conferencing	1	2.9%	34	97.1%	35	100.0%
Audio conferencing	2	5.7%	33	94.3%	35	100.0%
Program sharing	7	20.0%	28	80.0%	35	100.0%
Whiteboard	3	8.6%	32	91.4%	35	100.0%
Interactive chat	10	28.6%	25	71.4%	35	100.0%
File Transfer	8	22.9%	27	77.1%	35	100.0%

Table 5.26: Amount of previous exposure to the *NetMeeting* software application

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No previous exposure	34	97.1	97.1	97.1
	Second exposure	1	2.9	2.9	100.0
	Total	35	100.0	100.0	

Part of the formative usability testing of NetMeeting was a 20-minute introductory training session given to the respondents, facilitated by the researcher. A quick overview of the different media functions were given, as the assumption is made that many of these systems are usually implemented without any support, in terms of training that has been provided. The following remarks concerning the respondents' view on the training is presented:

- Almost two thirds of the respondents (60%) agreed that the amount (see figure 5.10), as well as the level and intensity (see figure 5.11), of training they received was sufficient; and
- In both cases, approximately a third of the respondents indicated that the amount (see figure 5.10), as well as the level and intensity (figure 5.11) of training that was provided, was more than sufficient.

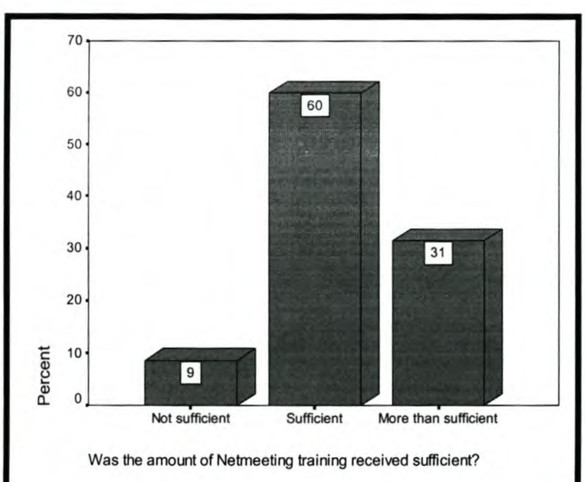


Figure 5.10: Amount of NetMeeting training

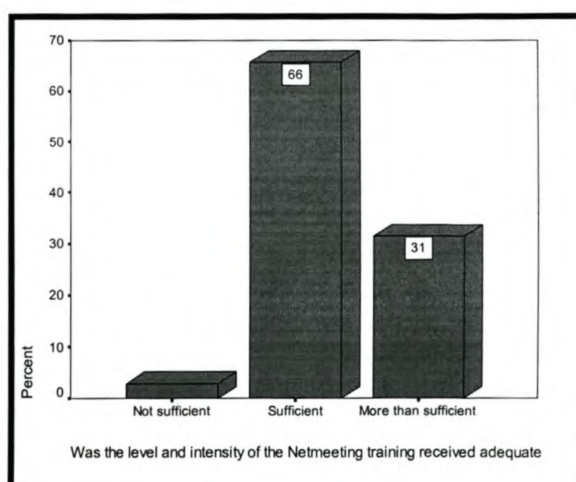


Figure 5.11: Level and intensity of NetMeeting training

5.4.3 Descriptive statistics concerning the usability of *NetMeeting*

The following section will provide a concise review of the usability dimensions that were examined in the usability questionnaire. The dimensions include general usefulness / utility, general effectiveness and efficiency, reliability, ease of use, consistency and compatibility, error management, learnability, user satisfaction and error rate. The findings and hypotheses will be discussed in accordance with the structure of the questionnaire.

HYPOTHESIS ONE (A):

Hypothesis one (a) states that a positive perception exists regarding the general usefulness / utility of *NetMeeting*. Usefulness concerns the degree to which a product enables a user to achieve his or her goals and is an assessment of the users motivation for using the product at all, whereas utility refers to the functionality (the value, worth and helpfulness) of the system. This hypothesis was tested by reviewing the results obtained from the questionnaire.

In tables 5.27 to 5.36, using parentheses, the number within the parentheses indicates the question number in the questionnaire to which the item refers and should be read in conjunction with the questionnaire.

As depicted in table 5.27, the majority of the responses are positive:

- Slightly more that two thirds of the respondents (68%) agree (34% strongly and 34% mostly) that *NetMeeting* would increase their productivity, as well as the productivity of other role-players;
- 51% of the respondents mostly agree and 29% strongly agree that the software application will be useful in the execution of their job;
- The majority of respondents (89%) indicated that *NetMeeting* is useful when sharing information with various role-players. Of the 89%, 46% strongly agree and 43% mostly agree that *NetMeeting* will be useful for virtual information sharing. Furthermore, 63% of the respondents strongly agree that *NetMeeting* aids and improves communication between role-players. This is positive, as it

indicates that *NetMeeting* is perceived to be useful for the ultimate goal of the VIS - information sharing;

- The majority of respondents (71%) agree (40% mostly, and 31% strongly) that the software application will make it easier to do their job. Furthermore, 43% of the respondents strongly agree and 34% mostly agree that using the system will add value to their learning experience;
- There is strong agreement that implementation of *NetMeeting* will enhance the overall competitiveness of departments and the university as a whole. 46% of respondents mostly agree, and 34% strongly agree that the university's competitiveness will be enhanced with the implementation of *NetMeeting*, whereas 54% mostly agree that their department's competitiveness will be enhanced if *NetMeeting* was to be implemented; and
- In terms of the promotion of flexible learning, by way of *NetMeeting*, 49% of the respondents strongly agree and 34% mostly agree that it succeeds in this objective.

Table 5.27: Frequency table for General Usefulness / Utility of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Usefulness / utility (18)	12	34%	12	34%	4	11%	2	6%	2	6%	1	3%	2	6%
Usefulness / utility (19)			1	3%			1	3%	5	14%	18	51%	10	29%
Usefulness / utility 20									4	11%	16	46%	15	43%
Usefulness / utility (21)							5	14%	5	14%	15	43%	10	29%
Usefulness / utility (22)	3	9%	10	29%	6	17%	10	29%	2	6%	2	6%	2	6%
Usefulness / utility (23)							3	9%	7	20%	14	40%	11	31%
Usefulness / utility (24)									4	11%	9	26%	22	63%
Usefulness / utility (25)							1	3%	5	14%	18	51%	11	31%
Usefulness / utility (26)	15	43%	12	34%	6	17%			1	3%	1	3%		
Usefulness / utility (27)	6	17%	19	54%	6	17%	2	6%			1	3%	1	3%
Usefulness / utility (28)					1	3%			6	17%	16	46%	12	34%
Usefulness / utility (29)	3	9%	2	6%			4	11%	9	26%	8	23%	9	26%
Usefulness / utility (30)			2	6%	2	6%			7	20%	12	34%	12	34%
Usefulness / utility (31)							2	6%						

Hypothesis one (a), which states that a positive perception exists regarding the general usefulness / utility of *NetMeeting* is, therefore accepted.

HYPOTHESIS TWO (A):

Hypothesis two (a) states that a positive perception exists that the utilisation of *NetMeeting* will lead to improved effectiveness and efficiency. Effectiveness refers to the extent to which the system enables the tasks to be completed accurately and the goals achieved. Efficiency refers to the degree to which the system enables the tasks to be completed in a timely, competent and economical fashion. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.28: Frequency table for Effectiveness and Efficiency of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Effectiveness (32)			2	6%	1	3%	1	3%	7	20%	19	54%	5	14%
Effectiveness (33)	9	26%	17	49%	7	20%	2	6%						
Effectiveness (34)			1	3%					4	11%	12	34%	18	51%
Effectiveness (35)	12	34%	14	40%	2	6%	4	11%	2	6%	1	3%		
Effectiveness (36)					1	3%	6	17%	3	9%	12	34%	13	37%
Efficiency (37)					1	3%	5	14%	8	23%	13	37%	8	23%
Efficiency (38)					1	3%	2	6%	2	6%	13	37%	17	49%
Efficiency (39)	7	20%	12	34%	2	6%	5	14%	5	14%	3	9%	1	3%

Table 5.28 indicates that the majority of responses are positive:

- 54% of the respondents mostly agree and 14% strongly agree that they could effectively complete their work using this system;
- A majority of the respondents indicated that using *NetMeeting* would enhance their information sharing effectiveness. 26% strongly agree and 49% mostly agree with this statement;
- With regards to the issues concerning communication facilitated by *NetMeeting*, 51% of the respondents strongly agree that they can effectively communicate information. Furthermore, 40% mostly agree and 34% strongly agree that using *NetMeeting* will improve their accuracy of communication;

- Slightly more that two thirds of the respondents (37% strongly and 34% mostly), agree that using *NetMeeting* would improve the accuracy of information sharing between role-players;
- 83% of the respondents agree (to varying degrees) that they would be able to efficiently complete their work as a result of using *NetMeeting*, whilst only 3% of the respondents disagree with this statement;
- 49% of the respondents strongly agree, and 37% mostly agree that using *NetMeeting* would save time when information needs to be shared; and
- Even though some technological problems were periodically encountered during the experiments, slightly more than half of the respondents (54%) still agree that the speed of the system is fast enough.

Hypothesis two (a), which states that a positive perception exists that the utilisation of *NetMeeting* will lead to improved effectiveness and efficiency, is therefore accepted.

HYPOTHESIS THREE (A):

Hypothesis three (a) states that a positive perception exists regarding the reliability of *NetMeeting*. Reliability refers to the dependability of the system and the repeatability, without failure, of tasks using the system. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.29: Frequency table for Reliability of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Reliability (40)	8	23%	12	34%	4	11%	2	6%	8	23%	1	3%		
Reliability (41)	7	20%	10	29%	1	3%	17	49%						
Reliability 42)	12	34%	9	26%	2	6%	10	29%			1	3%	1	3%

Table 5.29 indicates that the majority of responses are positive:

- 23% of the respondents strongly agree, 34% mostly agree and 11% slightly agree that *NetMeeting* did not stop or hang often during the execution of tasks;

- Although 23% of the respondents slightly agree that the system often stops or hangs during the execution of tasks, 52% of the respondents reported (in varying degrees) that it was not difficult to restart the system when it stopped and 66% felt confident that they could restart the system on their own, not requiring support; and
- One should note, however, that 49% of the respondents did in fact choose the 'neutral' response category when asked if they found it difficult to restart NetMeeting.

Hypothesis three (a), which states that a positive perception exists regarding the reliability of *NetMeeting*, is therefore accepted.

HYPOTHESIS FOUR (A):

Hypothesis four (a) states that a positive perception exists concerning the general ease of use of *NetMeeting*. Ease of use refers to the effortlessness and user-friendliness of the system. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.30 indicates that the majority of responses are positive:

- It can be established from table 5.30, that 94% of the respondents indicated that they are satisfied with the level of ease with which they completed the tasks, while utilising *NetMeeting*;
- 60% mostly agree and 29% strongly agree that it is easy to read the various characters on the screen. Furthermore, 86% of the respondents agree that a reasonable amount of steps are required to complete specific tasks, whilst using the system;
- None of the respondents agreed that it was frustrating to use the system. 6% were undecided on this matter, while 46% mostly agree and 37% strongly agree that using *NetMeeting* was not a frustrating experience;
- Only 3% of the respondents slightly agree that is was difficult to use the system, 40% strongly agree and 49% mostly agree that *NetMeeting* is easy to use. Furthermore, 60% mostly agree and 26% strongly agree that *NetMeeting* is user-friendly;
- 46% of the respondents mostly agree and 14% strongly agree that they feel very confident in using *NetMeeting*, whilst 11% slightly disagree on this matter;

- 83% of the respondents agree (in varying degrees) that the system seems to be designed for all levels of users; and
- 46% of the respondents mostly agree and 26% strongly agree that they find *NetMeeting* to be flexible to interact with.

Table 5.30: Frequency table for General Ease of Use of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Ease of Use (43)	10	29%	20	57%	1	3%	2	6%	1	3%			1	3%
Ease of Use (44)					2	6%			2	6%	21	60%	10	29%
Ease of Use (45)							2	6%	2	6%	18	51%	13	37%
Ease of Use (46)	13	37%	16	46%	4	11%	2	6%						
Ease of Use (47)	2	6%	1	3%	4	11%	3	9%	4	11%	16	46%	5	14%
Ease of Use (48)	14	40%	17	49%	2	6%	1	3%	1	3%				
Ease of Use (49)			1	3%			1	3%	3	9%	21	60%	9	26%
Ease of Use (50)	13	37%	13	37%	5	14%			4	11%				
Ease of Use (51)					5	14%	1	3%	7	20%	14	40%	8	23%
Ease of Use (52)			1	3%			3	9%	6	17%	16	46%	9	26%
Ease of Use (53)			1	3%	1	3%	15	43%	4	11%	9	26%	5	14%

Hypothesis four (a), which states that a positive perception exists regarding the general ease of use of *NetMeeting*, is therefore accepted.

HYPOTHESIS FIVE (A):

Hypothesis five (a) states that a positive perception exists concerning the error management capabilities of *NetMeeting*. Error management refers to the degree to which the system or software application allows the user to effectively identify, diagnose and rectify errors. This hypothesis was tested by reviewing the results obtained from the questionnaire.

As can be seen from table 5.31, the majority of responses of the respondents, regarding the questions that pertain to the error management capability of *NetMeeting*, are located in the 'neutral' response category. Examples include that 49% of the respondents were undecided on whether the help messages on screen is helpful, 69% of the respondents could not give an opinion on whether error messages suggest solutions to problems and 63% chose the 'neutral' response category when asked whether error messages diagnose the source and cause of a problem. The researcher suspects that these responses could be as a result of the fact that most of the respondents made few errors and where therefore not compelled to rectify errors.

In this instance, it is noteworthy to mention that according to table 5.32, 60% of the respondents, when asked what the average number of errors was they made in completing a specific task, indicated that, on average, they made no errors. Furthermore, 25.7% of the respondents indicated that they made, on average, one error per task, whilst 8.6% of the respondents responded that they made two or three errors per task.

Table 5.31: Frequency table for Error Management of *NetMeeting*

	Strongly disagree		**Mostly disagree**		**Slightly disagree**		Neutral		Slightly agree		**Mostly agree**		**Strongly agree**	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Error Management (56)	5	14%	12	34%	5	14%	7	20%	2	6%	3	9%	1	3%
Error Management (57)	1	3%	1	3%			17	49%	5	14%	6	17%	5	14%
Error Management (58)			1	3%	2	6%	22	63%	3	9%	4	11%	3	9%
Error Management (59)			2	6%	3	9%	24	69%	2	6%	2	6%	2	6%
Error Management (60)	8	23%	3	9%	4	11%	13	37%	6	17%			1	3%

Although it would seem as though the respondents made relatively few errors, it is interesting to note that according to table 5.33, 71.4% of the respondents still assume that they made more errors than the average user. This finding may possibly indicate that most of the respondents experienced some degree of a lack of confidence when using *NetMeeting*. With increased exposure to the system, it is however expected that users will become more comfortable in using the system, which could result in increased confidence and ease when utilising *NetMeeting*.

Furthermore, table 5.31 depicts the fact that 14% of the respondents strongly agree and 34% mostly agree that it was easy to recover when they did make a mistake whilst using the system, and 23% strongly agree that it was easy to find the help function on the screen.

Table 5.32: "The average number of errors I made completing a specific task was..."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	21	60.0	60.0	60.0
	1 error	9	25.7	25.7	85.7
	2-3 errors	3	8.6	8.6	94.3
	6-7 errors	1	2.9	2.9	97.1
	8 errors	1	2.9	2.9	100.0
	Total	35	100.0	100.0	

Table 5.33: "I think I made more errors than the average user"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	25	71.4	71.4	71.4
	2	8	22.9	22.9	94.3
	3	2	5.7	5.7	100.0
	4				
	5				
	Disagree				
	Total	35	100.0	100.0	

In view of the findings mentioned above, it is not possible to make a clear judgement with regards to hypothesis five. Therefore, the researcher refrains from asserting that **hypothesis five (a)**, which states that a positive perception exists concerning the error management capabilities of *NetMeeting,* is accepted.

HYPOTHESIS SIX (A):

Hypothesis six (a) states that a positive perception exists concerning the consistency and compatibility of *NetMeeting*. Consistency refers to the ability of the system to respond to user inputs in a consistent way and to perform similar tasks in similar ways. Compatibility refers to the degree to which the system's method of operation matches with the user's expectations. This hypothesis was tested by reviewing the results obtained from the questionnaire.

As can be seen from table 5.34, the majority of responses were positive:

- 43% of the respondents indicate that they feel mostly in control of *NetMeeting* when they are using it. 26% strongly agree and 26% slightly agree on this matter;
- 34 % of respondents mostly agree, 29% strongly agree and 14% slightly agree that *NetMeeting* is consistent and thus responds to user inputs in the same way every time that it is used;

Table 5.34: Frequency table for Consistency and Compatibility of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Consistency (54)					1	3%	1	3%	9	26%	15	43%	9	26%
Consistency (55)							8	23%	5	14%	12	34%	10	29%
Compatibility (61)			1	3%			3	9%	7	20%	16	46%	8	23%
Compatibility (62)			1	3%	4	11%	8	23%	8	23%	7	20%	7	20%
Compatibility (63)					1	3%	2	6%	2	6%	20	57%	10	29%
Compatibility (64)					5	14%	5	14%	5	14%	14	40%	6	17%
Compatibility (65)							2	6%	2	6%	19	54%	12	34%
Compatibility (66)							1	3%	6	17%	19	54%	9	26%
Compatibility (67)									6	17%	16	46%	13	37%

- The majority of the respondents (89%) agree (to varying degrees) that the software application corresponds with their idea of the way in which tasks should be executed;
- 6% of the respondents slightly agree, 57% mostly agree and 29% strongly agree that the organisation of menus or icons is logical. Only 3% of the respondents disagree on this matter;
- 71% of the respondents agree (to varying degrees) that the icons used in the *NetMeeting* interface are similar to other interfaces they have used. Furthermore, 23% slightly agree, 20% mostly agree and 20% strongly agree that the results of commands (icon interaction) entered into *NetMeeting* are similar to other software applications they have used, or have been trained in;
- A vast majority of the respondents (94%) agree (to varying degrees) that the command names are meaningful and clearly understandable, whilst 17% of the respondents slightly agree, 54% mostly agree and 26% strongly agree that the terminology used by *NetMeeting*, is in line with standard terminology; and

- All of the respondents agree (17% slightly, 46% mostly and 37% strongly) that *NetMeeting* performs the tasks that they require, thus meeting their needs.

Hypothesis six (a), which states that a positive perception exists concerning the consistency and compatibility of *NetMeeting*, is therefore accepted.

HYPOTHESIS SEVEN (A):

Hypothesis seven (a) states that a positive perception exists concerning the learnability of *NetMeeting*. Learnability refers to the time and effort required to reach a specified level of user performance. This hypothesis was tested by reviewing the results obtained from the questionnaire.

As can be seen from table 5.35, the majority of the responses are positive:

- 20% of the respondents strongly agree, 37% mostly agree and 23% slightly agree that sufficient information is always provided on the screen when it's needed;
- A significant amount of the respondents (94%) envisage that most people would learn to use NetMeeting quickly. Furthermore, 37% of the respondents strongly agree, 29% mostly agree and 11% slightly agree that they did not need to learn much before they could work with *NetMeeting*;

Table 5.35: Frequency table for Learnability of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Learnability (68)	7	20%	13	37%	8	23%	1	3%	4	11%	2	6%		
Learnability (69)							2	6%	4	11%	19	54%	10	29%
Learnability (70)	13	37%	10	29%	4	11%	1	3%	5	14%	2	6%		
Learnability (71)							3	9%	6	17%	15	43%	11	31%
Learnability (72)	5	14%	11	31%	4	11%	2	6%	9	26%	4	11%		
Learnability (73)	15	43%	12	34%	3	9%	1	3%	2	6%			2	6%
Learnability (74)	7	20%	17	49%	4	11%			7	20%				

- A majority of the respondents (86%) reported that learning to operate *NetMeeting* is easy, whilst 6% slightly disagree and 6% strongly disagree on this matter; and
- 17% of the respondents slightly agree, 43% mostly agree and 31% strongly agree that they quickly became skilful in operating *NetMeeting*.

Hypothesis seven (a), which states that a positive perception exists regarding the learnability of *NetMeeting*, is therefore accepted.

HYPOTHESIS EIGHT (A):

Hypothesis eight (a) states that a high level of satisfaction exists regarding the use of *NetMeeting*. Satisfaction refers to the user's level of comfort with the system, feelings towards, and acceptability of the system to the user. This hypothesis was tested by reviewing the results obtained from the questionnaire.

As can be seen from table 5.36, the majority of the responses were positive:

- Almost all of the respondents (91%) agree that they found it satisfying to work with *NetMeeting*. No respondents disagreed on this statement;
- 46% of the respondents feel strongly and 40% mostly feel that they would like to use *NetMeeting* frequently;
- 26% of the respondents strongly agree, 37% mostly agree and 14% slightly agree that they did not feel awkward using *NetMeeting*, whilst 11% indicated that they did indeed feel awkward using *NetMeeting*;
- The vast majority of the respondents (97%) agree (11% slightly, 49% mostly and 37% strongly) that interfacing with *NetMeeting* is pleasant. Furthermore, 14% of the respondents slightly agree, 40% mostly agree and 29% strongly agree that *NetMeeting* has an extremely attractive presentation;
- Almost all of the respondents (94%) agree (11% slightly, 49% mostly and 34% strongly) that they would recommend *NetMeeting* to the respective role-players with whom they interact;

- 17% of the respondents slightly agree, 37% mostly agree and 43% strongly agree that NetMeeting would appeal to both occasional and regular users; and
- The vast majority of the respondents (97%) agree (in varying degrees) that they are satisfied with the amount of time it takes to complete the tasks, as set out in the experiment.

Table 5.36: Frequency table for User Satisfaction of *NetMeeting*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
User Satisfaction (75)							3	9%	2	6%	19	54%	11	31%
User Satisfaction (76)					1	3%	1	3%	3	9%	14	40%	16	46%
User Satisfaction (77)	9	26%	13	37%	5	14%	3	9%	4	11%	1	3%		
User Satisfaction (78)							1	3%	4	11%	17	49%	13	37%
User Satisfaction (79)							2	6%	4	11%	17	49%	12	34%
User Satisfaction (80)					3	9%	3	9%	5	14%	14	40%	10	29%
User Satisfaction (81)					1	3%			6	17%	16	46%	12	34%
User Satisfaction (82)							1	3%	6	17%	13	37%	15	43%

Hypothesis eight (a), which states that a high level of satisfaction exists regarding the use of *NetMeeting,* is therefore accepted.

5.4.4 Descriptive statistics concerning general information about *NetMeeting*

This section reports on the user's overall reaction to the *NetMeeting* software application. Two approaches were taken in order to gather general information.

- **Semantic differential scales:** In order to acquire information with regards to respondents' general reaction to *NetMeeting*, five semantic differential scales were included in the questionnaire (section C). The respondents had to indicate their general reaction towards *NetMeeting,* in terms of the different dimensions presented (e.g. terrible to wonderful, difficult to easy etc.). Figures 5.12 to 5.16 present the results of the respondents' overall reaction to *NetMeeting* regarding the given dimensions.

- **Open-ended questions:** general information dimensions (section D of the questionnaire), were measured by way of open-ended questions (coded though content analysis) that allowed participants to make suggestions or comments that may not otherwise have been addressed by the questionnaire. The respondents were asked to comment on the following questions (see figures 5.17 – 5.19 for the results):
  - What do you like about the system or software application? List the most positive aspects;
  - What do you dislike about the system / software application? List the most negative aspects;
  - Is there anything specific that you would like to change or add to the system or software application?

  The respondents listed the following characteristics when asked what features of *NetMeeting* they liked the most (see figure 5.17):
  - The interactive aspect of the system;
  - The real-time communication capabilities of the system;
  - The ease with which the system could be operated;
  - The fact that it incorporates live interactive video and therefore adds an extra dimension (non verbal communication information) to the communication (as opposed to asynchronous systems);
  - The speed of the system;
  - The level of enjoyment when working with the system;
  - The flexibility of interaction when using the system; and
  - The data collaboration capabilities of the system (e.g. whiteboard and file transfer).

  The respondents listed the following characteristics when asked what features of *NetMeeting* they disliked the most (see figure 5.18):
  - It was found to be time-consuming to work with the system;
  - Lack of sufficient audio quality;
  - The use of unfamiliar icons on the interface;
  - The interface has an unattractive presentation;

- Insufficient bandwidth available, which influenced the quality of audio and video negatively, or even causing these functions to be unavailable; and
- Poor video quality.

The respondents listed the following suggestions when asked what they would want to change or add (in terms of features or capabilities) to *NetMeeting* (see figure 5.19):

- Improve the audio quality;
- Ensure a bigger interface window;
- Increase the readability of the interactive text chat function;
- Add labels to the icons.

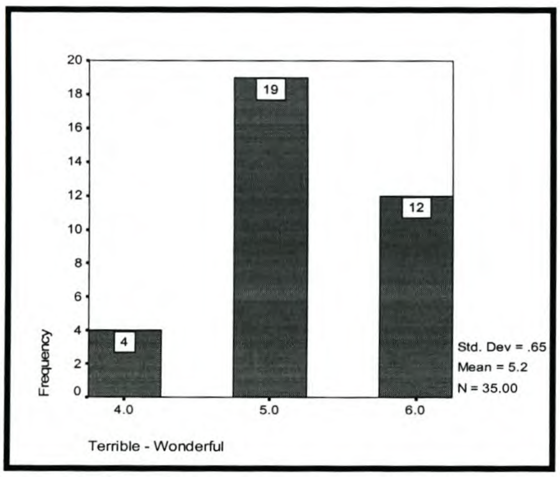


Figure 5.12: Histogram for respondents' overall reaction (terrible – wonderful) to *NetMeeting*

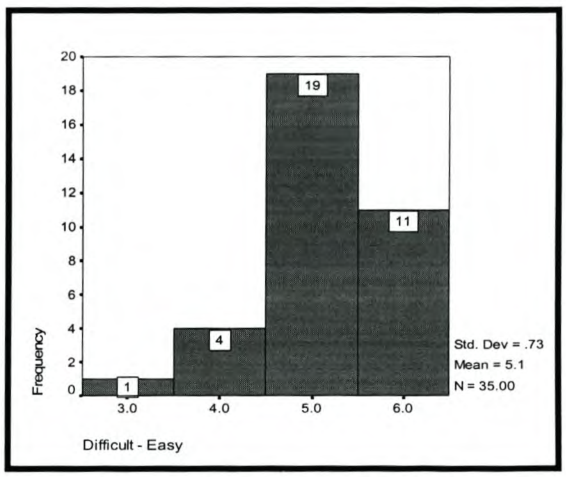


Figure 5.13: Histogram for respondents' overall reaction (difficult – easy) to *NetMeeting*

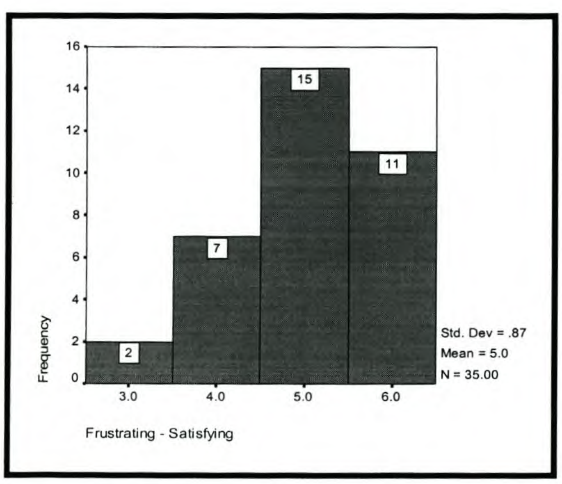


Figure 5.14: Histogram for respondents' overall reaction (frustrating – satisfying) to *NetMeeting*

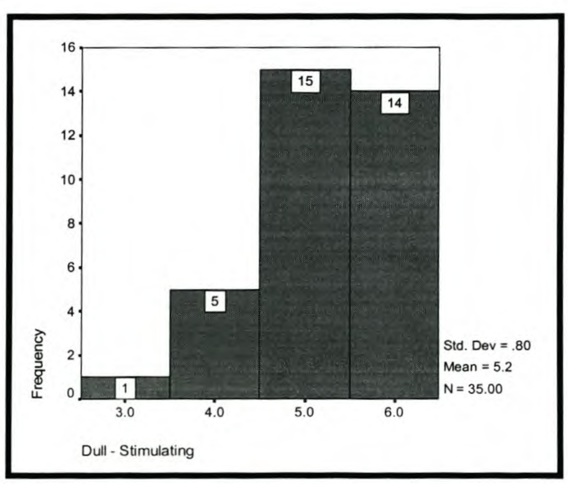


Figure 5.15: Histogram for respondents' overall reaction (dull – stimulating) to *NetMeeting*

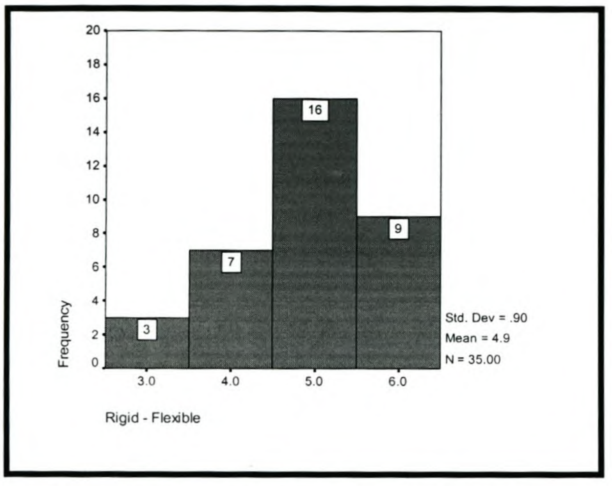


Figure 5.16: Histogram for respondents' overall reaction (rigid – flexible) to *NetMeeting*

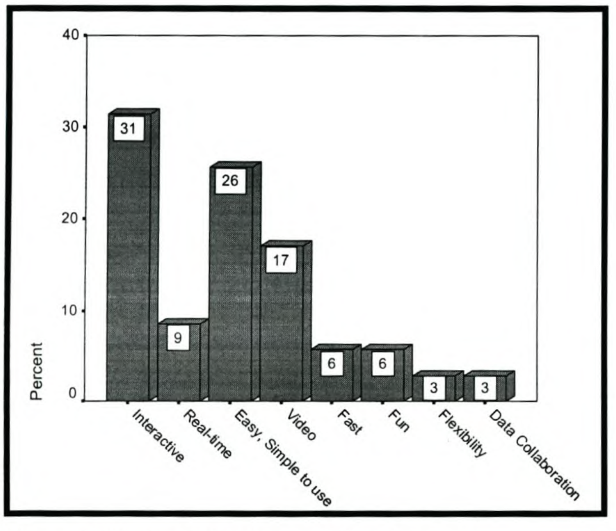


Figure 5.17: Most liked about *NetMeeting*

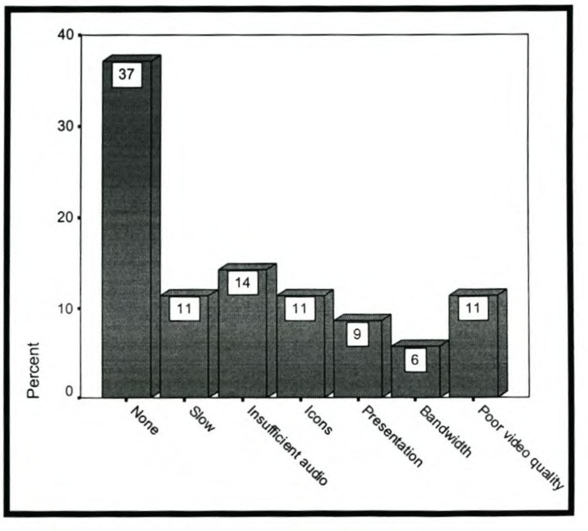


Figure 5.18: Disliked most about *NetMeeting*

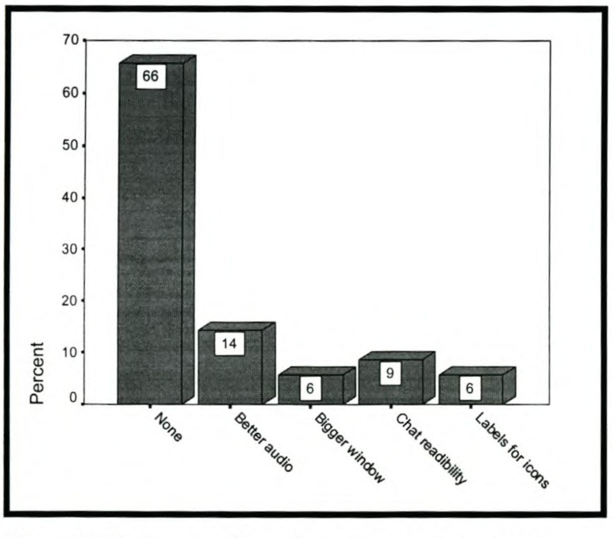


Figure 5.19: Suggestions for proposed changes

5.5 THE RESEARCH FINDINGS: *NETMEETING* USABILITY AND FEASIBILITY (OBJECTIVE DATA)

The following section presents an overview of the research findings related to the usability, feasibility and viability of the software application, *NetMeeting*. This section will focus specifically on addressing the following objectives:

- Objective 6 (a), which was specified as, to evaluate the usability of *NetMeeting* by conducting formal usability testing in a controlled experimental environment, to obtain objective data through utilising objective measurement techniques (human performance measurement);
- Objective 7 (a), which related to conducting prototype experiments with *NetMeeting* within the technological infrastructure of the US;
- Objective 8, which was stated as, to acquire information about the internal quality of the technological infrastructure of the US, such as its bandwidth capabilities and average network usage and hardware capabilities or limitations;
- Objective 9 (a), which was specified as, to acquire information about the external quality (audio, video and data collaboration quality) of the software application, *NetMeeting*, when utilised within the technological infrastructure parameters of the US; and
- Objective 10 (a), which relates to documenting general limitations of *NetMeeting* when applied within the current technological infrastructure of the US.

5.5.1 Feasibility and viability results: Results of the prototype experiments

Four prototype experiments were conducted in order to gain information about the feasibility of *NetMeeting,* when used within the technological infrastructure of the US. The three main goals of the prototype experiments included the exploring of firewall constraints, the establishing of benchmarks as well as which of the media functions embedded within *NetMeeting* are not supported by Intranet-to-Intranet (on-campus to on-campus) and Intranet-to-Internet (on-campus to off-campus) connections. The results of the experiments are briefly discussed below.

5.5.1.1 Firewall constraints

The prototype experiments positively confirmed the known fact that there are known issues when *NetMeeting* has to transmit through firewalls. All attempts to establish a connection from outside the US network failed, due to the restrictions imposed by the US firewall. The implication of this is that at the time of the experiments, a *NetMeeting* conference was only possible between users within the LAN (Local Area Network) of the US. Users outside of the LAN would need a trusted dial-up connection (*Telenet*) to establish a *NetMeeting* conference with another user behind the US firewall. The user phoning in from outside the US network will, therefore, have to pay for the phone call being made to the US server. Users from outside the 021 area code might even have to pay long distance call charges because a connection to a local ISP (Internet Service Provider), like *M-Web* or *IAfrica* cannot be utilised. It is therefore concluded that *NetMeeting,* when utilised within these circumstances, has limited viability due to the cost factors involved. This system does, however, have considerable benefits when utilised in a distance education context, and the costs could therefore be justified in specific situations.

5.5.1.2 Benchmarks and feasibility of the media

The prototype experiments were conducted between sets of two (person-to-person testing) and four users (group testing) that were considered to be expert users of *NetMeeting*. The participants were given the task protocol sheet and completed the tasks set out in it during an experimental session. The results of the prototype experiments, relating to the benchmarks and feasibility of the media, are presented in table 5.37.

Table 5.37: Results of the prototype experiments for *NetMeeting*

Media embedded within *NetMeeting* that were tested for feasibility within US technological parameters		TYPE OF COMMUNICATION AND CONNECTION BETWEEN COMPUTERS			
		Person-to-Person		Group	
		Experiment 1: Intranet-to-Intranet connection	Experiment 2: Intranet-to-Internet connection	Experiment 3: Intranet-to-Intranet connection	Experiment 4: Intranet-to-Internet connection
Video and Audio	Feasible to use	Yes	No	No	No
	Benchmark*	2.5 minutes	n/a	n/a	n/a
Interactive text (chat)	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	4 minutes	4 minutes	4 minutes	4 minutes
Whiteboard	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	5 minutes	5 minutes	5 minutes	5 minutes
Program sharing	Feasible to use	Yes	Yes	No	No
	Benchmark*	7.5 minutes	7.5 minutes	n/a	n/a
Real-time file transfer	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	2.5 minutes	2.5 minutes	2.5 minutes	2.5 minutes

***Note: the benchmark indicated is the time within which the participants are supposed to finish the specific task (as specified in the Task Protocol Sheet, e. g. draw a picture on the whiteboard).**

5.5.2 Internal System quality specifications

Due to the fact that the external system quality and quality of use (usability) depends to a large degree on the internal system quality, the researcher deemed it necessary to shortly state the details of the internal system quality regarding the computers that were used for the various experiments.

The following system requirements (internal system quality) are, according to the Microsoft Windows *NetMeeting* 3 Resource Kit (undated), a pre-requisite for successful installation and utilisation of *NetMeeting*:

- For Windows 95 and Windows 98, a Pentium 90 processor with 16 MB of RAM; a Pentium 133 or later processor with at least 16 MB of RAM is recommended;
- For Windows NT 4.0, a Pentium 90 processor with 24MB of RAM; a Pentium 133 or later processor with at least 32 MB of RAM is recommended;
- A 28.8 Kbps or faster modem, ISDN, or LAN connection;
- Sound card with microphone and speakers;

- Cameras with a video capture card, universal serial bus (USB) cameras, or a parallel port camera that provides a Video for Windows driver; and
- Internet Explorer version 4.01 or later.

In appendix A, a summary of the internal system qualities of the computers that was used for all the experiments (*NetMeeting* and *Yahoo Messenger*) was provided. In terms of the internal system qualities (CPU capability, bandwidth and hardware), the researcher concluded that theoretically, the conditions were optimal for the successful functioning of *NetMeeting*.

5.5.3 Objective measurement results

The performance measurement results presented below were obtained from the task-logging sheets (see appendix E) that were filled out by an observer during each of the experimental sessions. The purpose of this is to provide descriptive summaries of the performance data, with the aim of establishing the usability and feasibility problems with *NetMeeting,* when utilised within the technological infrastructure of the US.

5.5.3.1 General experimental details

The following parameters had to be considered when the experiments were designed:

- The type of communication that *NetMeeting* will be used for (person-to-person or group communication);
- The type of connection between the computers (thus Intranet-to-Intranet or Intranet-to-Internet); and
- The role-player combination groups, e.g. student-to-student.

Given the parameters above, ten different combinations of experiments were developed. Table 5.38 provides an overview of the specific combinations.

Table 5.38: Ten different experimental combinations.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5	Experiment 6	Experiment 7	Experiment 8	Experiment 9	Experiment 10
Type of Communication										
Person-to-person	×	×	×	×	×	×	×	×		
Group									×	×
Type of Connection										
Intranet-to-Intranet	×	×	×	×	×					
Intranet-to-Internet						×	×	×	×	×
Role-player combinations (scenarios)										
A: Student-to-Student	×					×				
B: Student-to-Lecturer		×					×			
C: Student-to-Information Service suppliers			×							
D: Lecturer / Researcher-to-Information Service Suppliers				×						
E: Lecturer / Researcher-to –Lecturer / Researcher					×			×		
F: Students-to-Students									×	×

During the experimental phase, sixteen experiments were conducted over a two-week period, involving 35 participants. All of the experimental combinations as mentioned above were tested at least once. Selected combinations were tested more than once, depending on the availability of the different role-players in the sample.

5.5.3.2 Performance Measurement Criteria

In order to choose appropriate objective performance measurement criteria, the researcher considered the nature of the investigation and the objectives (relating to the usability evaluation) of this study. Consequently, the following performance criteria were deemed to be most suitable to be used as an indicator of the respondents' performance when using the system.

a. Task Time

The task timings relate to how much time participants required in order to complete each task. The mean time is indicated in each case, which is a rough indication of how the group performed as a whole. The mean time was compared to the original benchmark for the task to conclude if users, in general, performed better or worse than expected. In each case, the standard deviation is also documented. The standard deviation may be thought of as expressing the average distance that the scores (in this case, the different completion times for the different tasks) in a set of data fall, from the mean (Schweigert, 1998). A small standard deviation (such as 0.5 minutes with a mean time of 6 minutes) will imply that user's performance was generally similar, with regards to these results. If, however, the standard deviation was 3 minutes with the same mean time (6 minutes), a much broader distribution of times is represented. In such a case, Rubin (1994) suggests that a second investigation should be conducted in order to try and uncover the reason for the broader distribution.

b. Task accuracy rate

Task accuracy is an indication of correct performance (Rubin, 1994). The following indicators of task accuracy were calculated:

- Percentage of participants performing successfully within the time benchmark;
- Percentage of participants performing successfully, regardless of the time benchmark; and
- Percentage of participants performing successfully that required assistance, regardless of the time benchmark.

The first indicator is used as an indicator of correct performance. If 7 out of 10 participants, for example, achieved success within the allotted time, then the task accuracy would be 70%. The second indicator provides an indication of the percentage of participants who were at least able to complete that task successfully, even if it was not done within the expected time. The last indicator can point towards serious problems with product because it provides an indication of the percentage of participants that needed assistance and extra time to perform the task successfully. If this number is very high it indicates very serious problems with the product.

c. **Reliability**

Reliability refers to the dependability of the system. The following indicator was used to calculate the reliability of *NetMeeting*:

- The percentage of times that the system stopped, hung or had to be restarted whilst completing a specific task during the course of the experiment.

Furthermore, the amount of times that a participant required assistance, when the system or media function had to be restarted within each task, was also calculated.

5.5.3.3 Performance Measurement Results

The following section will provide an overall description of the performance measurement results for the users' performance when completing a specific task, while utilising *NetMeeting*. The data was obtained from the task logging sheets, where the observer documented the detail of the experiments.

Table 5.39: Mean task times for tasks 1-5 of the *NetMeeting* experiment

		N	Minimum	Maximum	Mean	Std. Deviation
Valid	Task 1: Task time (minutes)	35	.20	4.50	1.89	1.23
	Task 2: Task time (minutes)	35	1.15	8.30	4.39	1.57
	Task 3: Task time (minutes)	35	2.45	8.50	5.29	1.47
	Task 4: Task time (minutes)	27	1.23	6.20	3.79	1.53
	Task 5: Task time(minutes)	27	.20	4.10	1.70	1.10
	Valid N (listwise)	33/27				

Table 5.40: Performance measurement data for tasks 1 - 5, performed during the *NetMeeting* experiment.

PERFORMANCE MEASUREMENT CRITERIA (n = 35)		TASK 1		TASK 2		TASK 3		TASK 4		TASK 5	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Task Accuracy											
Valid	Within Benchmark	25	71.4	11	31.4	31	88.6	27	77.1	21	60.0
	Outside of benchmark without assistance	5	14.3	21	60.0	1	2.9			3	8.6
	Outside benchmark with assistance	5	14.3	3	8.6	3	8.6			3	8.6
Missing	System							8	22.9		
Total		35	100.0	35	100.0	35	100.0	35	100.0	35	100.0
Reliability											
Valid	None	29	82.9	34	97.1	34	97.1	27	77.1	27	77.1
	Once	5	14.3	1	2.9	1	2.9				
	Twice	1	2.9								
Missing	System							8	22.9	8	22.9
Total		35	100.0	35	100.0	35	100.0	35	100.0	35	100.0
Assistance required on restart											
Valid	Not applicable	29	82.9	34	97.1	34	97.1%	27	77.1%	27	77.1%
	Restart on own	4	11.4	1	2.9	1	2.9%				
	Required assistance on restart	2	5.7								
Missing	System							8	22.9	8	22.9
Total		35	100.0	35	100.0	35	100.0	35	100.0	35	100.0

TASK 1: Log onto *NetMeeting* conference and establish communication through video and audio conferencing

In terms of the performance measures, the following data on the participant's performance while using the system to complete task one can be reported:

- 71.4% of the respondents managed to complete task one within the benchmark time (2.5 minutes) that was set out for the task (table 5.40);
- In terms of the task accuracy rate, is it evident from table 5.40 that 14.3% of the respondents managed to complete the task outside of the benchmark time, but without requiring any assistance. 14.3% did, however, require assistance to successfully complete this task; and

- It can be reported, in terms of the reliability of the system, that on five occasions was it necessary to restart the *NetMeeting* software application during this task. On one occasion, a participant had to restart the system twice, before the task could be completed (table 5.40).

TASK 2: Communicate by utilising the Interactive text chat medium

In terms of the performance measures, the following data regarding the participant's performance whilst using the system for task two can be reported:

- Only 31.4% of the respondents managed to complete the task within the benchmark time, which was 4 minutes (table 5.40);
- In terms the task accuracy rate, is it evident from table 5.40 that almost two thirds of the participants (60%) could complete the task outside of the benchmark time, without requiring any assistance. 8.6%, did however, require assistance in order to successfully complete this task; and
- It was only necessary on one occasion to close and to reopen the chat function, due to technical problems (table 5.40). The participant demonstrated the necessary knowledge to perform the action without requiring any assistance (table 5.40).

TASK 3: Utilise the whiteboard for collaborative drawing

In terms of the performance measures, the following data regarding the participant's performance whilst using the system for the whiteboard task can be reported:

- A vast majority of the respondents (88.6%) managed to complete the task within the benchmark time which was 7.5 minutes (see table 5.40);
- 2.9% completed the task outside of the benchmark time without assistance, whereas 8.6% required assistance in order to complete the task (table 5.40); and
- On only one occasion, was it necessary to close and reopen the whiteboard function, due to technical problems

(table 5.40). The participant demonstrated the necessary knowledge to perform the action without requiring any assistance (table 5.40).

TASK 4: Utilise the program sharing medium for the collaborative editing of a document

In terms of the performance measures, the following data regarding the participant's performance whilst using the system with the program-sharing task can be reported:

- All of the respondents that could use the program sharing medium managed to complete the task within the benchmark time (5 minutes). 8 of the respondents did not utilise the program sharing function due to the fact that they were in a group session, where restrictions of the system resulted in the usage of this function not being available (table 5.37); and
- It was not necessary, on any occasion, to restart the program sharing function (table 5.40).

TASK 5: Transfer a file

In terms of the performance measures, the following data regarding the participant's performance whilst the system for the file transfer task can be reported:

- Almost two thirds of the respondents (60%) could complete the task within the benchmark time of 2.5 minutes, whilst 8.6% completed the task outside of the benchmark time, without requiring any assistance (table 5.40);
- 8.6% of the respondents required assistance in order to complete the task (table 5.40); and
- It was not necessary, on any occasion, to restart the file transfer function (table 5.40).

In terms of the performance measurement results, the following general conclusions can be drawn from the data presented above:

- In all the tasks, with the exception of task 2, 60% and more of the respondents managed to complete the task within the proposed benchmark time without any assistance being required. The task accuracy rate in this instance is therefore relatively high and *NetMeeting* could thus be regarded as usable when measured according to this criteria,

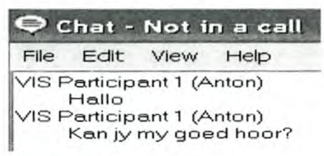
- Only in the case of task 2, did a relatively larger amount of the respondents (60%) require assistance to complete the task outside the benchmark time, whilst other percentages in this category are relatively low (14.3%, 2.9% and 8.6);
- Relatively small amounts of respondents (14.3% & 8.6%) required assistance to complete the tasks. If these percentages were high, it would indicate that participants would need assistance and extra time to perform the task successfully and therefore indicate serious usability problems with the product. This is, however, not the case here and *NetMeeting* could therefore be regarded as useful when measured in terms of this performance criteria;
- In terms of reliability can it be reported that a large amount of the respondents (82.9%, 97.1% and 77.1%) indicated that they did not have to restart the system at any point in time. With tasks 4 and 5 a lower reliability level was achieved. In 22% of the time these functions could not be utilised due to technical problems.

It can, therefore, be concluded that the participants experienced relatively little difficulty in completing the specified tasks, and the general conclusion is therefore drawn that *NetMeeting* displayed an acceptable level of usability.

5.5.3.4 NetMeeting: Usability problem analysis

The goal of this section is to provide an overview of the range of widespread difficulties and problems that users encountered while working with *NetMeeting*. The data was obtained from the task logging sheets, where the observer noted errors or difficulties encountered by the participants when completing a specific task. Rubin (1994) proposes that if 70% of the participants could not successfully complete a specific task (during the usability testing), then the researcher should focus on those tasks in the usability problem analysis of the system. The researcher will, however, refrain from using this 70% benchmark, due to the probability that other variables (embedded within the internal system quality, e.g. bandwidth availability and network usage) could have influenced the task completion rate of the users. The issues documented below are therefore general trends that were observed, regarding selected functional problems that a significant amount of users experienced and will thus be documented as the limitations of the *NetMeeting* software application and system.

USABILITY PROBLEM ANALYSIS	COMMMENTS
General Several users experienced difficulty in associating the icons with the media that they represent. Examples include the program sharing and whiteboard icons:  	The icons seemed to not be very cognitively compatible with the user's mental map of that which it represents. Thus, labels should be added onto the icons in order to make them more recognisable.
Program sharing Users experienced difficulty with the program sharing function where there was no audio available, or where the audio quality was poor. This is because if a program is being shared, the screen is relatively cluttered and it becomes difficult to communicate through the interactive text chat (which is the alternative communication medium to audio). Furthermore, when the recipient is allowed control of the program being shared, the sender does not have control of his or her desktop and will therefore not be able to communicate through the interactive text chat function.	The program sharing medium will not be effective in a situation were the audio quality is not sufficient. This limits the usefulness of this medium, due to the fact that the audio quality is a function of various, often unreliable, internal system variables (bandwidth, network usage, hardware and software properties of the system) that would influence the clarity thereof.
In instances where there was a functionality problem (such as the slow speed of the system), due to internal system variables, the program sharing session often became unsynchronised as a user was often left to wonder if they should proceed to request control or not.	
When a program is shared, its entire window is reflected to the other computer participating in the conference. If a part of the window is covered up on the computer screen of the person sharing the program or document, the other	The system should remind the users that all other windows must be minimised before sharing a program or document.

participant will see a graphic pattern in the overlapping area. Several users, for example, did not minimise all other *NetMeeting* screens and the other participant thus encountered this problem.	
Interactive text chat The interactive text chat functionality does not provide feedback on the progress of a chat session. Many synchronisation problems were experienced by users due to this fact, especially where the chat function was the only means for communicating in the group sessions. This could present a problem, as it was the only way in which participants could communicate, given the fact that the audio and video functionality did not work during group sessions.	The system should provide feedback by displaying the following feedback message in the taskbar of the chat screen, while the other participant is typing a message: "VIS Participant 1 (the user's name) is typing a message."
The chat readability could also be improved. Users found the placing of comments under the name of the participants, less readable, as opposed to placing them next to the name of the participant.	Example 
Real-time File transfer A common problem that most of the users experienced with the file transfer medium, was related to the saving of the transferred file. The file transfer dialogue box only provides three options here: open, close or delete. As part of the task they had to perform, users were asked to save the file. However, no 'save' option is available. Many users hesitated as to which option to choose, not realising that in choosing the 'close' option, the file is saved by default in the *NetMeeting* received files folder (although this was mentioned in the training session at the beginning of the experiment).	Example 

5.5.4 External System Quality of NetMeeting

For the purpose of this study, the external quality of the system was referred to as the result of the combined behaviour of the software application (e.g. *NetMeeting*) and the computer system (hardware, e.g. microphones, speakers) that were used. It was established that the external quality, to a large extent depends on the internal system quality, as specified above. In order to measure the external quality of the system (after participants were exposed to the system), the Transmission System Quality questionnaire was developed and administered after each experiment. The data obtained from the questionnaire provided a quantitative description of the participant's subjective evaluations of the external quality of *NetMeeting*, in terms of the quality of its video, audio and data collaboration media. The results of the questionnaire are presented in figures 5.20 – 5.22 and tables 5.41 – 5.43.

Video Quality

The following remarks regarding the respondents' overall evaluation of the video quality of *NetMeeting*, can be reported (figure 5.20):

- 46% rated the overall video quality as good, whilst 14% rated it as being excellent;
- 34% of the respondents could not rate the video function as a result of two reasons. Firstly, 22% (8 respondents in two group sessions of 4 people each) of the 33% could not utilise the video due to being engaged in a group session (*NetMeeting* does not allow interactive video for more than two participants at once). Secondly, the other 11% (4 respondents) were engaged in the Intranet-to-Internet experiments, which were limited to the 48kbps bandwidth capabilities of the modem that was used to establish the connection (video is very bandwidth-demanding and 48 kbps is usually not enough to allow any video transmission); and
- *NetMeeting* thus received a very favourable evaluation, regarding its video quality, since only 6% of the total amount of respondents (66%) that could rate the video quality, rated it as either bad or fair.

Furthermore, participants were asked to indicate whether they agree or disagree with certain statements about the video quality of *NetMeeting*. Respondents had to specify their assessment on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). The following results are reported (table 5.42). The researcher determined the mode (the most frequently occurring number) in each case in order to describe the results:

- The majority of the respondents slightly agree with the statement that the video quality was acceptable (the mode for this question is 5);

- Most of the respondents mostly agree that the video was clear enough (the mode was 6);
- Most of the respondents slightly agree that the size of the video was adequate (the mode here was 6); and
- Most of the respondents, however, perceived the video quality to not be comparable with a face-to-face situation. This can be seen in the fact that the mode here is 2, which represents the answering category 'mostly disagree'.

Audio Quality

The following remarks, regarding the respondents' overall evaluation of the audio quality of *NetMeeting*, can be reported (figure 5.21):

- Slightly more than one third (35%) of the respondents rated the overall audio quality as either fair or good;
- 31% of the respondents assessed the overall audio quality as either bad or poor; and
- 34% of the respondents could not use the audio medium as a result of the same reasons (mentioned above) that limited the live video transmission.

The following section provides an exposition of the respondents' assessment (on the seven-point scale) regarding the questions concerning the audio quality of *NetMeeting*. The researcher once again determined the mode (the most frequently occurring number) to describe the results (table 5.41):

- Most of the respondents strongly disagreed that the audio quality was acceptable and that the audio communication facilitated by *NetMeeting* is comparable with a face-to-face communication situation (a mode of 1 was observed in both cases);
- Most of the respondents slightly agreed that they frequently lost some information during the connection, as a result of the poor audio quality (a mode of 5 was perceived here); and
- Most of the respondents, however, slightly agreed that the audio quality was clear enough when it was broadcast (a mode of 5 was perceived here).

Quality of Data Collaboration Media

The following remarks regarding the respondents' overall evaluation of the quality of the data collaboration media (whiteboard, program sharing and real-time file transfer) of *NetMeeting*, can be reported (figure 5.22):

- 54% of the respondents assessed the quality of the data collaboration media as good, whilst 46% of the respondents perceived the quality to be excellent. Due to the fact that the data collaboration media is not as bandwidth demanding as the video and audio functionalities, it was used in all of the experiments and all the respondents were thus exposed to the media.

The following results, pertaining to the respondents' ratings on the questions that correlate to the data collaboration media, are presented (table 5.43):

- A large amount of the respondents mostly agree that the response time of the file transfer function was sufficiently quick (a mode of 6 was observed in this case); and
- Furthermore, most of the respondents mostly agreed that the response time of the program sharing and whiteboard media was sufficiently quick (a mode of 6 was observed in both the cases).

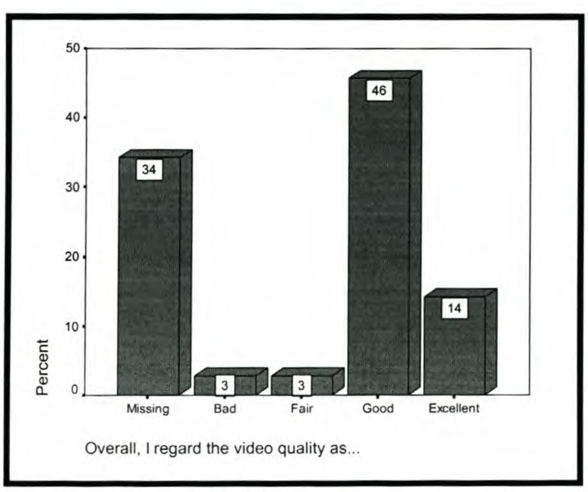


Figure 5.20: Overall video quality

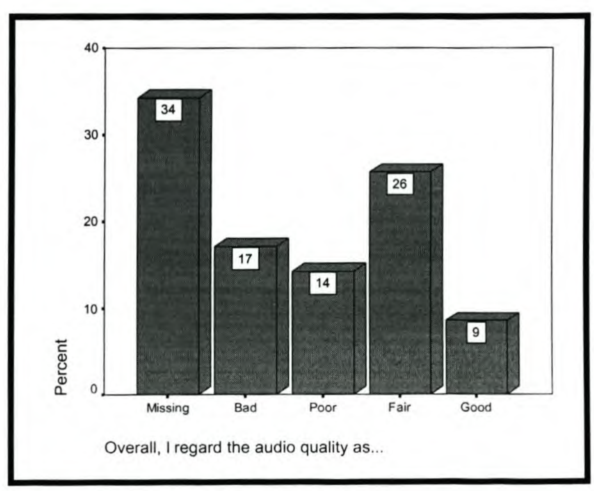


Figure 5.21: Overall audio quality

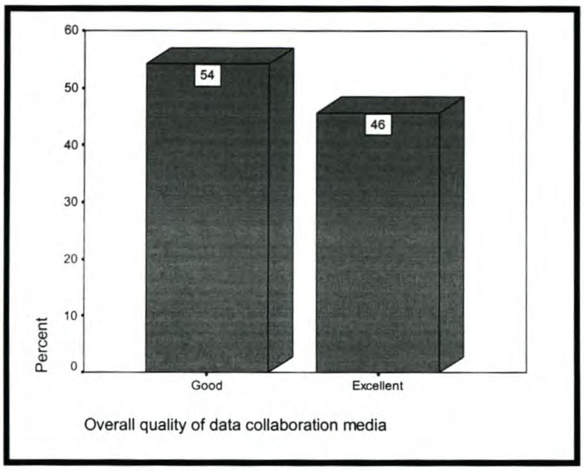


Figure 5.22: Overall quality of data collaboration media

Table 5.41: Summary of descriptive statistics regarding respondent's ratings on the questions, relating to the audio quality of *NetMeeting.*

		The audio quality was acceptable	The audio was clear enough	Audio comparable with face to face situation	I frequently lost some information during the connection due to the audio quality
N	Valid	23	23	23	23
	Missing	12	12	12	12
Mean		3.3043	3.4783	2.6957	5.8696
Median		3.0000	3.0000	2.0000	5.0000
Mode		1.00	5.00	1.00	5.00
Std. Deviation		2.0099	1.9741	1.8448	1.9142

Table 5.42: Summary of descriptive statistics regarding respondent's ratings on the questions, relating to the video quality of *NetMeeting.*

		Video Quality Acceptable	Video was clear enough	Size of video was adequate	Video quality was comparable with a face to face situation
N	Valid	23	23	23	23
	Missing	12	12	12	12
Mean		5.9565	6.0000	5.0870	4.7826
Median		6.0000	6.0000	6.0000	5.0000
Mode		6.00	6.00	6.00	6.00
Std. Deviation		1.2961	1.2792	1.6764	1.5942

Table 5.43: Summary of descriptive statistics regarding respondent's ratings of the quality of the data collaboration media of *NetMeeting*

		Response time of the file transfer was quick enough	Response time of the program sharing function was quick enough	Response time of the whiteboard was quick enough
N	Valid	35	35	35
	Missing	0	0	0
Mean		6.1143	5.9143	6.2571
Median		6.0000	6.0000	6.0000
Mode		6.00	6.00	6.00
Std. Deviation		.9000	.8531	.7800

5.6 THE RESEARCH FINDINGS: *YAHOO MESSENGER* USABILITY (SUBJECTIVE DATA)

The following section of research findings pertain to the usability of the software application, *Yahoo Messenger*. The findings for this section are represented in two segments. The first segment will provide a brief description of the sample, in terms of the biographical information. Hereafter, the usability findings are presented, as analysed, in terms of the hypotheses stated.

5.6.1 Descriptive statistics concerning the biographical information

5.6.1.1 Background

The general biographical information segment of the usability questionnaire consists of four broad sections;

- The first segment gives an indication of the general background of the participants. Questions here are related to the candidates' gender, preferred language and his or her user group;
- The second portion consists of questions that relate to the respondents' level of technology-related knowledge and ability. These questions are related to computer literacy, exposure, experience and frequency of computer usage;
- The third section relates to the candidates level of previous exposure to the software application, *Yahoo Messenger*; and
- The fourth section covers issues that are related to the *Yahoo Messenger* experiment. These questions cover the training received and tasks completed.

5.6.1.2 Biographical results

- The questionnaire was issued to 33 individuals.
- 61% of the respondents fell into the student user group, whilst 27% of the respondents indicated themselves to be lecturers and researchers (figure 5.23).
- 39% of the respondents were female and 61% male (table 5.44).
- More than two thirds of the respondents (76%) indicated that Afrikaans was their first language, 21% indicated that

English was their first language and one respondent's first language is German (table 5.45). All of the respondents were, however, competent enough in English to use *Yahoo Messenger*.

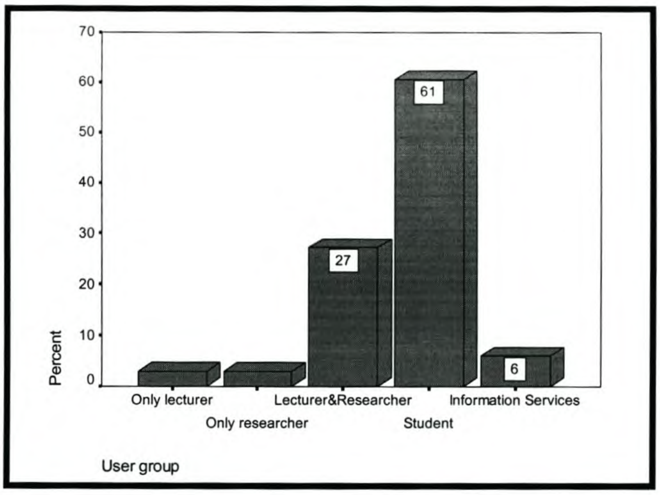


Figure 5.23: Profile of user status of respondents

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

Table 5.44: Cross-tabulation of user status and gender
Count

		Gender		Total
		Female	Male	
User group	Only lecturer		1	1
	Only researcher		1	1
	Lecturer & researcher	2	7	9
	Student	10	10	20
	Information Services	1	1	2
Total		13	20	33

Table 5.45: Cross-tabulation of user status and preferred language
Count

		Language			Total
		Afrikaans	English	Other	
User group	Only lecturer	1			1
	Only researcher			1	1
	Lecturer & researcher	7	2		9
	Student	15	5		20
	Information Services	2			2
Total		25	7	1	33

The following remarks, regarding the information related to the respondent's computer literacy, exposure, experience, usage and training can be reported:

- As seen in figure 5.24, 48.6% of the respondents rated themselves as very computer literate and 45% of the respondents rated themselves as literate, whilst 6% of the respondents rated themselves as experts, regarding their computer literacy;

- Slightly more than half of the respondents (54.5%) indicated that they have more than 6 years experience with computers, whilst 18.2% have 4 to 6 years experience (table 5.47);
- The majority of respondents are exposed to computers on a regular basis, with 84.8% of the respondents having access to a computer at work and at home (table 5.46). Furthermore, 93.9% of the respondents indicated that they use a computer everyday (table 5.48); and
- Figure 5.25 indicates that 51.5% of the respondents claim to having received 10 or more hours of formal computer training, while 18.2% indicated that they have received between 4 to10 hours of formal computer training. Almost a quarter of the respondents (24.2%) claim to have received less than two hours of formal computer training.

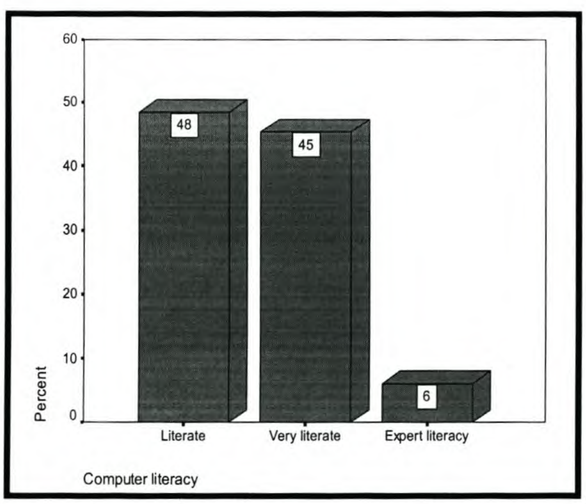


Figure 5.24: Computer literacy

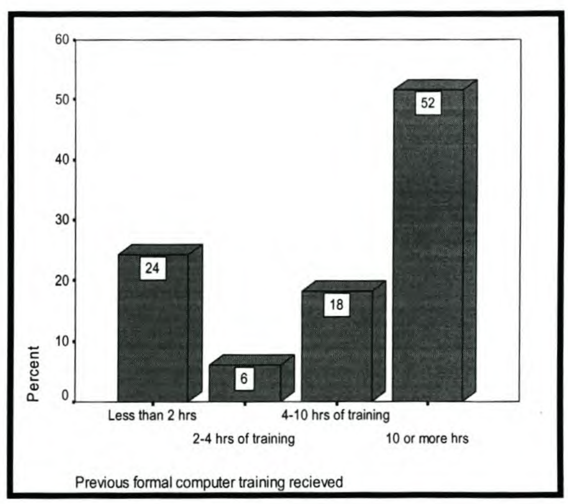


Figure 5.25: Previous formal computer training received

Table 5.46: Computer exposure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only access to a computer at work	4	12.1	12.1	12.1
	Only access to a computer at home	1	3.0	3.0	15.2
	Access to a computer at work and at home	28	84.8	84.8	100.0
	Total	33	100.0	100.0	

Table 5.47: Computer experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than one year experience	1	3.0	3.0	3.0
	1-3 years experience	8	24.2	24.2	27.3
	4-6 years experience	6	18.2	18.2	45.5
	More than 6 years experience	18	54.5	54.5	100.0
	Total	33	100.0	100.0	

Table 5.48: Frequency of computer usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I use a computer approximately once a week	2	6.1	6.1	6.1
	I use a computer everyday	31	93.9	93.9	100.0
	Total	33	100.0	100.0	

Jordan (1998) and Bevan and Macleod (1994) maintain that previous experience with a product itself is likely to affect the ease or difficulty a particular user has in completing a particular task with the product. They note that experience with other similar products might also affect how usable a product is for a user. In terms of the issues concerned with the respondents' previous exposure to *Yahoo Messenger* and similar video conferencing or instant messaging systems, the following results can be reported:

- 84.8% (see table 5.50) of the respondents indicated that they have had no previous exposure to *Yahoo Messenger.* One of the respondents (3%) reported that working with *Yahoo Messenger* in the experiment was their tenth (or more) exposure, while 3 (9%) of the respondents indicated that it was their fourth to ninth exposure to *Yahoo Messenger*; and
- Regarding the synchronous CMC media embedded within *Yahoo Messenger*, the respondents' highest previous exposure (33.3%) was with the interactive text chat medium function. 27.3% of the participants have had previous exposure to instant messaging medium and 21.2% of the respondents reported previous exposure to

the file transfer function (see table 5.49). Only 6.1% and 9.1% of the respondents have had previous exposure to the video and audio conferencing media functions, respectively (table 5.49).

Table 5.49: Summary of the number of respondents from the sample that indicated previous exposure to synchronous CMC media.

Synchronous CMC media	Number of Respondents					
	Previous exposure		No previous exposure		Total	
	N	Percent	N	Percent	N	Percent
Video conferencing	2	6.1%	31	93.9%	33	100.0%
Audio conferencing	3	9.1%	30	90.9%	33	100.0%
Instant Messaging	9	27.3%	24	72.7%	33	100.0%
File Transfer	7	21.2%	26	78.8%	33	100.0%
Interactive chat	11	33.3%	2	66.7%	33	100.0%

Table 5.50: Amount of previous exposure to the *Yahoo Messenger* software application

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No previous exposure	28	84.8	84.8	84.8
	Second exposure	1	3.0	3.0	87.9
	Fourth to ninth exposure	3	9.1	9.1	97.0
	Tenth (or more) exposure	1	3.0	3.0	100.0
	Total	33	100.0	100.0	

Part of the formative usability testing of *Yahoo Messenger* was a 20-minute informal introductory training session that was provided for the respondents, which was facilitated by the researcher. This was merely a short overview of the different media functions embedded with the software application, as the assumption is made that many of these systems are usually implemented without any support, in terms of the formal training that is provided. *NetMeeting* and *Yahoo Messenger*, for example, can both be downloaded from the Internet and no training is provided. Within the context of the US, it is often the case that new software applications will be obtained by the user when downloading it from the US NAL (Novell Application Launcher). Users will only be trained if they request to join a formal training session for the specific software application.

The following remarks concerning the respondents' view on the informal training are presented:

- Most of the respondents agreed (see figure 5.26 and 5.27) that the amount (66.7%), as well as the level and intensity (63.6%) of training that they received was sufficient; and
- 21.2% of the respondents indicated that the amount of training received was more than sufficient, whereas 24.2% of the respondents indicated that the level and intensity of training that was provided, was more than sufficient.

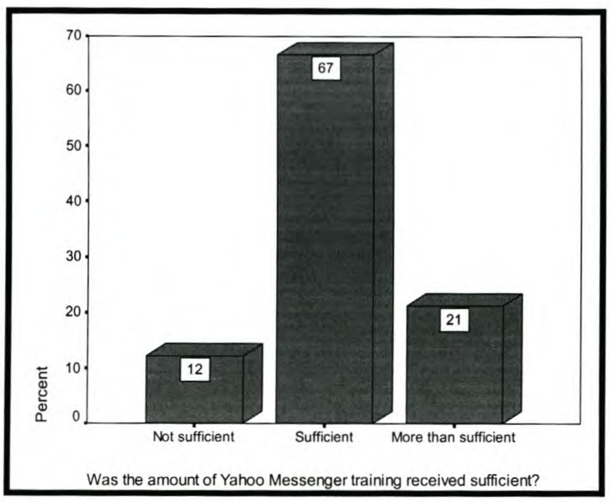


Figure 5.26: Amount of *Yahoo Messenger* training received

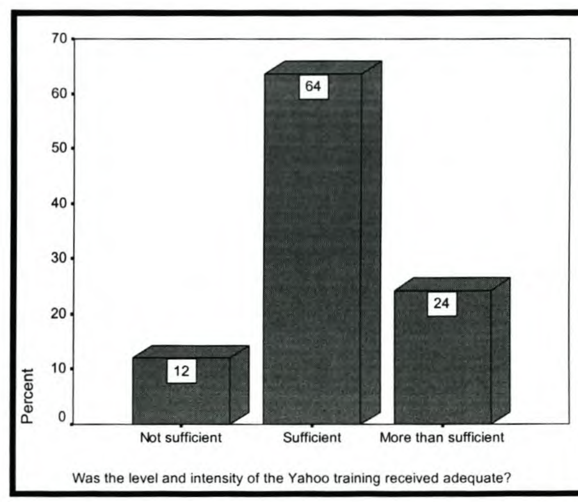


Figure 5.27: Level and intensity of *Yahoo Messenger* training received

Note: All percentages have been rounded to the nearest tenth of a percentage by the SPSS program.

5.6.2 Descriptive statistics concerning the usability of *Yahoo Messenger*

The following section will provide a concise review of the usability dimensions that were examined in the usability questionnaire. The dimensions include general usefulness / utility, general effectiveness and efficiency, reliability, ease of use, consistency and compatibility, error management, learnability, user satisfaction and error rate. The findings and hypotheses will be discussed in accordance with the structure of the questionnaire.

HYPOTHESIS ONE (B):

Hypothesis one (b) states that a positive perception exists regarding the general usefulness / utility of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

In tables 5.51 to 5.59, using parentheses, the number within the parentheses indicates the question number in the questionnaire to which the item refers and should be read in conjunction with the questionnaire.

Table 5.51: Frequency table for general usefulness / utility of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Usefulness / utility (18)	1	3%	11	33%	8	24%	2	6%	4	12%	6	18%	1	3%
Usefulness / utility (19)					5	15%	8	24%	6	18%	14	42%		
Usefulness / utility 20			1	3%			3	9%	10	30%	15	45%	4	12%
Usefulness / utility (21)					2	6%	4	12%	9	27%	15	45%	3	9%
Usefulness / utility (22)			8	24%	7	21%	10	30%	5	15%	2	6%	1	3%
Usefulness / utility (23)	1	3%			3	9%	5	15%	9	27%	12	36%	3	9%
Usefulness / utility (24)			2	6%			1	3%	6	18%	16	48%	8	24%
Usefulness / utility (25)					1	3%	1	3%	9	27%	20	61%	2	6%
Usefulness / utility (26)	2	6%	21	64%	7	21%	1	3%			2	6%		
Usefulness / utility (27)	4	12%	16	48%	6	18%	1	3%	4	12%	1	3%	1	3%
Usefulness / utility (28)			1	3%	2	6%	3	9%	9	27%	14	42%	4	12%
Usefulness / utility (29)					2	6%	7	21%	9	27%	10	30%	5	15%
Usefulness / utility (30)			1	3%	3	9%	3	9%	6	18%	14	42%	6	18%
Usefulness / utility (31)	1	3%					2	6%	10	30%	17	52%	3	9%

As can be seen from table 5.51, the majority of the responses are positive:

- Although 18% of the respondents disagree that using *Yahoo Messenger* will increase their productivity as well as that of other role-players, more than half of the respondents do, in fact, agree that using *Yahoo Messenger* will improve their own productivity, as well as the productivity of other role-players (3% strongly, 33% mostly and 24% slightly);

- Almost two thirds of the respondents agree (18% slightly and 42% mostly) that they find the system useful in the execution of their job, whereas a significant amount of the respondents (72%) also indicated that using *Yahoo Messenger* would make it easier to do their job;
- 12% of the respondents strongly agree, 45% mostly agree and 30% slightly agree that they find *Yahoo Messenger* useful when sharing information with various role-players;
- 64% of the respondents mostly agree and 6% strongly agree that using *Yahoo Messenger* will add value to their learning experience. Furthermore, 61% of the respondents mostly agree and 27% slightly agree that using Yahoo Messenger would enhance processes related to learning, networking and research;
- 78% of the respondents agree (in varying degrees) that implementing *Yahoo Messenger* would enhance the overall competitiveness of their department. 27% slightly agree, 42% mostly agree and 12% strongly agree that implementing *Yahoo Messenger* would enhance the competitiveness of the US as a whole; and
- 91% of the respondents agree (30% slightly, 52% mostly and 9% strongly) that *Yahoo Messenger* promotes flexible learning.

Hypothesis one (b), which states that a positive perception exists regarding the general usefulness / utility of *Yahoo Messenger,* is therefore accepted.

HYPOTHESIS TWO (B):

Hypothesis two (b) states that a positive perception exists that the utilisation of *Yahoo Messenger* will lead to improved effectiveness and efficiency. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.52 shows that although the responses are mostly positive, it is more distributed than previous ratings:

- Slightly more than two thirds of the respondents (72%) agree (in varying degrees) that they can effectively complete their work by making use of *Yahoo Messenger*;

- 6% strongly agree, 45% mostly agree and 24% slightly agree that using *Yahoo Messenger* would enhance their information sharing effectiveness, while the majority of the respondents (84%) furthermore indicated (24% slightly, 36% mostly and 24% strongly) that by utilising *Yahoo Messenger* they could effectively communicate information;

Table 5.52: Frequency table for the effectiveness and efficiency of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Effectiveness (32)			2	6%	1	3%	6	18%	11	33%	11	33%	2	6%
Effectiveness (33)	2	6%	15	45%	8	24%	3	9%	3	9%	1	3%	1	3%
Effectiveness (34)	1	3%			3	9%	1	3%	8	24%	12	36%	8	24%
Effectiveness (35)	4	12%	15	45%	6	18%	1	3%	4	12%	1	3%	2	6%
Effectiveness (36)					3	9%	3	9%	10	30%	12	36%	5	15%
Efficiency (37)	1	3%	1	3%	4	12%	4	12%	7	21%	13	39%	3	9%
Efficiency (38)	2	6%	1	3%			4	12%	10	30%	9	27%	7	21%
Efficiency (39)	1	3%	6	18%	6	18%	1	3%	7	21%	6	18%	6	18%

- Although 12% of the respondents slightly disagree that using *Yahoo Messenger* would improve the accuracy of communication, three quarters (75%) of the respondents did however agree (12% strongly, 45% mostly and 18% slightly) that using *Yahoo Messenger* would, in fact, improve their accuracy of communication;
- A majority of the respondents (81%) agree (to varying degrees) that using *Yahoo Messenger* would improve the accuracy of information sharing between different role-players;
- 69% of the respondents agree (to varying degrees) that they would be able to efficiently complete their work when using *Yahoo Messenger*, whilst 18% of the respondents disagree (3% strongly, 3% mostly and 12% slightly) with this statement;
- 21% of the respondents strongly agree, 27% mostly agree and 30% slightly agree that using *Yahoo Messenger* would save them time when information needs to be shared; and
- Even though some technological problems were periodically encountered during the experiments, slightly more than half of the

respondents (57%) still agree that the speed of the system is fast enough.

Hypothesis two (b), which states that a positive perception exists that the utilisation of *Yahoo Messenger* will lead to improved effectiveness and efficiency, is therefore accepted.

HYPOTHESIS THREE (B):

Hypothesis three (b) states that a positive perception exists regarding the reliability of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.53: Frequency table for the reliability of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Reliability (40)	6	18%	2	6%	2	6%	7	21%	6	18%	6	18%	4	12%
Reliability (41)	8	24%	3	9%	6	18%	8	24%	5	15%	3	9%		
Reliability (42)	11	33%	7	21%	3	9%	9	27%	3	9%				

Table 5.53 indicates that the majority of responses are positive:

- 48% of the respondents agree (in varying degrees) that *Yahoo Messenger* often stopped or hung during the execution of tasks, whilst 30% of the respondents disagree (18% strongly, 6% mostly and 6% slightly) on this matter; and
- It is worth mentioning that 51% of the respondents reported (in varying degrees) that it was not difficult to restart the system when it stopped and (63%) felt confident (in varying degrees) that they could restart the system on their own, without requiring any support.

Due to the fact that almost half of the respondents indicated that the system often stopped or hung during the execution of tasks, **hypothesis three (b)**, which states that a positive perception exists regarding the reliability of *Yahoo Messenger*, is therefore not accepted.

HYPOTHESIS FOUR (B):

Hypothesis four (b) states that a positive perception exists concerning the general ease of use of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.54: Frequency table for the ease of use of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Ease of Use (43)	7	21%	7	21%	5	15%	3	9%	6	18%	4	12%	1	3%
Ease of Use (44)	1	3%			1	3%	1	3%	10	30%	14	42%	6	18%
Ease of Use (45)			2	6%	5	15%	1	3%	6	18%	12	36%	7	21%
Ease of Use (46)	7	21%	7	21%	6	18%	4	12%	5	15%	2	6%	2	6%
Ease of Use (47)					7	21%	3	9%	7	21%	12	36%	4	12%
Ease of Use (48)	10	30%	8	24%	5	15%	5	15%	3	9%	2	6%		
Ease of Use (49)	1	3%			4	12%	2	6%	6	18%	13	39%	7	21%
Ease of Use (50)	10	30%	9	27%	6	18%	1	3%	7	21%				
Ease of Use (51)	1	3%	3	9%	6	18%	4	12%	7	21%	9	27%	3	9%
Ease of Use (52)	1	3%	1	3%	3	9%	1	3%	9	27%	12	36%	6	18%
Ease of Use (53)			2	6%	2	6%	14	42%	6	18%	6	18%	3	9%

- As can be seen from table 5.54, 75% of the respondents indicated (in varying degrees) that they were satisfied with the level of ease with which they completed the tasks, while utilising *Yahoo Messenger*;
- 60% of the respondents agree (21% mostly, 18% slightly and 21% strongly) that it was not a frustrating experience to use *Yahoo Messenger*. 12% were undecided with regards to this matter, while 27% of the respondents agree that it was frustrating to use the system;
- 42% mostly agree, 30% slightly agree and 18% strongly agree that it is easy to read the various characters on the screen. 57% of the respondents agree (in varying degrees) that a reasonable amount of steps are required to complete specific tasks with *Yahoo Messenger*;
- Although 9% of the respondents slightly agree and 6% mostly agree that is difficult to use *Yahoo Messenger*, more than two thirds (69%) of the respondents (in varying degrees) found *Yahoo*

Messenger easy to use. Furthermore, 39% of the respondents mostly agree and 21% strongly agree that *Yahoo Messenger* is user-friendly;

- 81% of the respondents agree (27% slightly, 36% mostly and 18% strongly) that they find *Yahoo Messenger* flexible to interact with,
- 36% of the respondents mostly agree, 21% slightly agree and 12% strongly agree that they feel very confident in using *Yahoo Messenger*, whilst 21% slightly disagree on this matter; and
- Slightly more than half (57%) of the respondents agree (in varying degrees) that *Yahoo Messenger* seems to be designed for all levels of users and 75% of the respondents believe that they would not need the support of a technical person in order to be able to use *Yahoo Messenger*.

Hypothesis four (b), which states that a positive perception exists regarding the general ease of use of *Yahoo Messenger*, is therefore accepted.

HYPOTHESIS FIVE (B):

Hypothesis five (b) states that a positive perception exists concerning the error management capabilities of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.55: Frequency table for error management of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Error Management (56)	5	15%	4	12%	9	27%	10	30%	3	9%	1	3%	1	3%
Error Management (57)			2	6%			23	70%	5	15%	3	9%		
Error Management (58)			2	6%	3	9%	22	67%	3	9%	3	9%		
Error Management (59)			4	12%	2	6%	22	67%	2	6%	3	9%		
Error Management (60)	3	9%	6	18%	3	9%	15	45%	3	9%	2	6%	1	3%

As can be seen from table 5.55, approximately the same pattern of response is observed here, as was perceived for this dimension in the usability evaluation of *NetMeeting*. A majority of the responses given by the respondents, with regards to the questions that pertaining to the error management capability of *Yahoo Messenger,* are located in the 'neutral' response category. Examples include the fact that 70% of the respondents were undecided as to whether the help messages on screen are helpful, 67% of the respondents could not give an opinion on whether error messages suggests solutions to problems and 67% chose the 'neutral' response category, when asked whether error messages diagnose the source and cause of a problem. It is the opinion of the researcher, however, that it cannot be assumed that these responses could be partly attributed to the fact that most of the respondents made few errors and were therefore not compelled to rectify errors (as was the assumption with *NetMeeting*). The researcher holds this view based on the results of table 5.56.

According to the information found in table 5.56, only 27.3% of the respondents, when asked about the average number of errors they made in completing a specific task, indicated that they made no errors, on average. As this is a relatively small percentage of the total respondents, it is assumed that most of the respondents (72.7%) should have had sufficient opportunities to judge the error management capabilities of *Yahoo Messenger* and would thus have been able to make a clear judgement. The reason for the response pattern is uncertain and it is therefore not possible to make a clear judgement with regards to hypothesis five. The researcher thus refrains from asserting that **hypothesis five (b)**, which states that a positive perception exists concerning the error management capabilities of *Yahoo Messenger,* is accepted.

Table 5.56: "The average number of errors I made completing a specific task was..."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	9	27.3	27.3	27.3
	1 error	11	33.3	33.3	60.6
	2-3 errors	6	18.2	18.2	78.8
	4-5 errors	1	3.0	3.0	81.8
	6-7 errors	4	12.1	12.1	93.9
	8 errors	2	6.1	6.1	100.0
	Total	33	100.0	100.0	

HYPOTHESIS SIX (B):

Hypothesis six (b) states that a positive perception exists concerning the consistency and compatibility of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.57: Frequency table for consistency and compatibility of *Yahoo Messenger.*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Consistency (54)			2	6%	6	18%	3	9%	4	12%	14	42%	4	12%
Consistency (55)			2	6%			4	12%	5	15%	16	48%	6	18%
Compatibility (61)			1	3%	7	21%	3	9%	11	33%	7	21%	4	12%
Compatibility (62)			2	6%	2	6%	5	15%	10	30%	11	33%	3	9%
Compatibility (63)					4	12%	3	9%	5	15%	14	42%	7	21%
Compatibility (64)			1	3%	2	6%	3	9%	7	21%	15	45%	5	15%
Compatibility (65)					1	3%	3	9%	10	30%	10	30%	9	27%
Compatibility (66)					1	3%	3	9%	6	18%	14	42%	9	27%
Compatibility (67)			2	6%			1	3%	9	27%	13	39%	8	24%

Table 5.57 shows that although the responses are mostly positive, they are more evenly distributed than previous ratings:

- 15% of the respondents slightly agree, 48% mostly agree and 18% strongly agree that *Yahoo Messenger* is consistent and thus responds to user inputs in the same way every time that it is used;
- Two thirds of the respondents (66%) agree (in varying degrees) that they feel 'in control' of *Yahoo Messenger* when using it, while 6% mostly disagree and 18% slightly disagree with regards to this matter;
- 15% of the respondents slightly agree, 42% mostly agree and 21% strongly agree that the organisation of menus and icons of the *Yahoo Messenger* interface is logical;
- 81% of the respondents agree (in varying degrees) that the icons used in the *Yahoo Messenger* interface are similar to those seen on other interfaces that they have used. Furthermore, 30% slightly agree, 33% mostly agree and 9% strongly agree that the results of commands (icon interaction) entered into *Yahoo Messenger* are similar to other interfaces they have used, or have been trained on;

- 30% of the respondents slightly agree, 30% mostly agree and 27% strongly agree that the command names of the *Yahoo Messenger* interface are meaningful and clearly understandable, whilst 87% of the respondents agree (in varying degrees) that the terminology being used by *Yahoo Messenger* is in line with standard terminology; and
- A vast majority of the respondents (90%) agree (27% slightly, 39% mostly and 24% strongly) that *Yahoo Messenger* performs the tasks that they require, thus meeting their needs.

Hypothesis six (b), which states that a positive perception exists concerning the consistency and compatibility of *Yahoo Messenger,* is therefore accepted.

HYPOTHESIS SEVEN (B):

Hypothesis seven (b) states that a positive perception exists concerning the learnability of *Yahoo Messenger.* This hypothesis was tested by reviewing the results obtained from the questionnaire.

Table 5.58: Frequency table for the learnability of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Learnability (68)	6	18%	7	21%	13	39%	3	9%	2	6%	2	6%		
Learnability (69)			1	3%	3	9%			9	27%	15	45%	5	15%
Learnability (70)	6	18%	11	33%	5	15%	1	3%	7	21%	2	6%	1	3%
Learnability (71)					3	9%	4	12%	10	30%	9	27%	7	21%
Learnability (72)	3	9%	7	21%	4	12%			14	42%	4	12%	1	3%
Learnability (73)	7	21%	10	30%	6	18%	2	6%	3	9%	4	12%	1	3%
Learnability (74)	4	12%	7	21%	8	24%	1	3%	9	27%	2	6%	2	6%

Table 5.58 shows that although the majority of the responses are positive, they are also fairly distributed:

- 18% of the respondents strongly agree, 21% mostly agree and 39% slightly agree that sufficient information is always provided on the screen at the time that it is needed;
- The majority of the respondents (87%) assume (in varying degrees) that most people would learn to use *Yahoo Messenger*

quickly. Furthermore, 18% of the respondents strongly agree, 33% mostly agree and 15% slightly agree that they did not need to learn much before they could work with *Yahoo Messenger*;

- 30% of the respondents slightly agree, 27% mostly agree and 21% strongly agree that they quickly became skilful in operating *Yahoo Messenger*; and
- Slightly more than two thirds of the respondents (69%) reported (in varying degrees) that learning to operate *Yahoo Messenger* is easy, whilst 9% slightly disagree and 12% mostly disagree regarding this matter.

Hypothesis seven (b), which states that a positive perception exists regarding the learnability of *Yahoo Messenger*, is therefore accepted.

HYPOTHESIS EIGHT (B):

Hypothesis eight (b) states that a high level of satisfaction exists regarding the use of *Yahoo Messenger*. This hypothesis was tested by reviewing the results obtained from the questionnaire.

As can be seen from table 5.59, the majority of the responses were positive:

- Three quarters of the respondents (75%) agree (to varying degrees) that they found it satisfying to work with *Yahoo Messenger*;
- 15% of the respondents strongly agree, 30% mostly agree and 18% slightly agree that they would like to use *Yahoo Messenger* frequently;
- The vast majority of the respondents (81%) agree (39% slightly, 27% mostly and 15% strongly) that interfacing with *Yahoo Messenger* is a pleasant experience. Furthermore, 60% of the respondents agree (to varying degrees) that *Yahoo Messenger* has a very appealing presentation;
- 15% of the respondents strongly agree, 27% mostly agree and 27% slightly agree that they did not feel awkward using *Yahoo Messenger*, whilst 18% of the respondents indicated (in varying degrees) that they did felt awkward when using *Yahoo Messenger*;

Table 5.59: Frequency table for user satisfaction of *Yahoo Messenger*

	Strongly disagree		Mostly disagree		Slightly disagree		Neutral		Slightly agree		Mostly agree		Strongly agree	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
User Satisfaction (75)			2	6%	3	9%	3	9%	11	33%	8	24%	6	18%
User Satisfaction (76)	1	3%	1	3%	5	15%	5	15%	6	18%	10	30%	5	15%
User Satisfaction (77)	5	15%	9	27%	9	27%	4	12%	4	12%	2	6%		
User Satisfaction (78)			1	3%	1	3%	4	12%	13	39%	9	27%	5	15%
User Satisfaction (79)	2	6%	1	3%	3	9%	7	21%	7	21%	9	27%	4	12%
User Satisfaction (80)	1	3%	3	9%	3	9%	6	18%	5	15%	10	30%	5	15%
User Satisfaction (81)	1	3%			2	6%			9	27%	16	48%	5	15%
User Satisfaction (82)			3	9%	2	6%	1	3%	10	30%	13	39%	4	12%

- 60% of the respondents agree (21% slightly, 27% mostly and 12% strongly) that they would recommend *Yahoo Messenger* to the respective role-players with whom they interact;
- 30% of the respondents slightly agree, 39% mostly agree and 12% strongly agree that both occasional and regular users would enjoy using *Yahoo Messenger*; and
- The vast majority of the respondents (90%) agree (in varying degrees) that they are satisfied with the amount of time it took to complete the tasks, as set out in the experiment.

Hypothesis eight (b), which state that a high level of satisfaction exists regarding the use of *Yahoo Messenger,* is therefore accepted.

5.6.3 Descriptive statistics concerning general information about *Yahoo Messenger*

This section reports on the user's overall reaction to the *Yahoo Messenger* software application. The same two approaches i.e. semantic differential scales and open-ended questions that was used with *NetMeeting*, were utilised to gather the general information.

The respondents listed the following characteristics when asked what features of *Yahoo Messenger* they liked the most (figure 5.28):

- The interactive aspect of the system;
- The ease with which the system could be operated;
- The fact that it incorporates live interactive video and therefore adds an extra dimension to communication (as opposed to asynchronous systems);
- The audio capability that it supports;
- Attractive presentation;
- The history (record keeping) function, as all chat sessions can be saved.

The respondents listed the following aspects when asked what features of *Yahoo Messenger* they disliked the most (figure 5.29):

- The speed of the system is too slow;
- The audio quality is poor;
- The system is user-unfriendly;
- There are too many steps required to accomplish a task;
- The video quality is poor.

The respondents listed the following suggestions when asked about those features or capabilities of *Yahoo Messenger* that they would want to change or add (figure 5.30):

- To make the system more user-friendly;
- To improve the video quality;
- To improve the audio quality;
- To ensure that the screen is less cluttered;
- To incorporate whiteboard and program sharing capabilities.

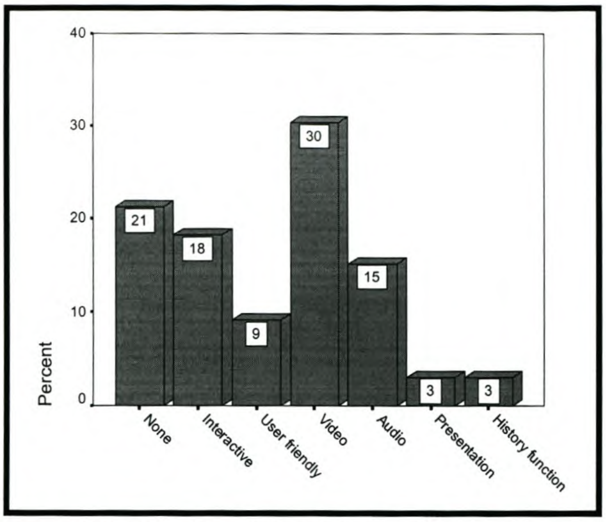


Figure 5.28: Most liked about *Yahoo Messenger*

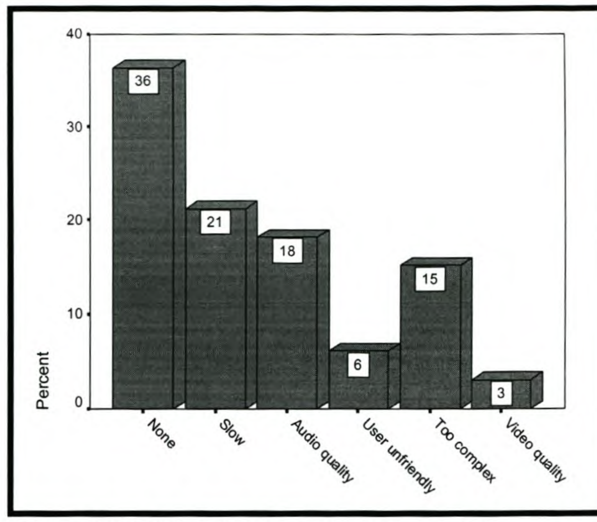


Figure 5.29: Most disliked about *Yahoo Messenger*

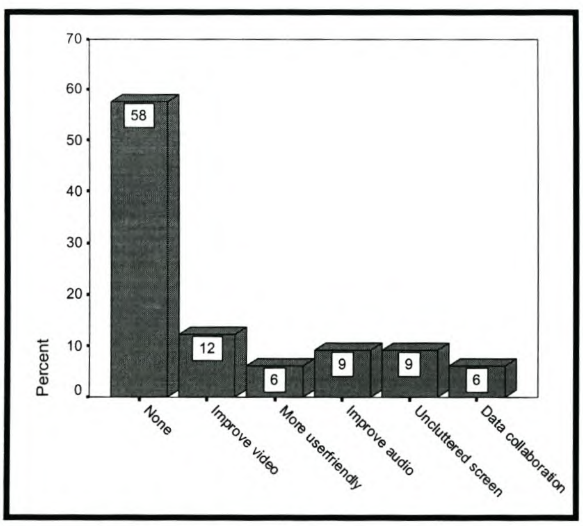


Figure 5.30: Suggestions for proposed changes

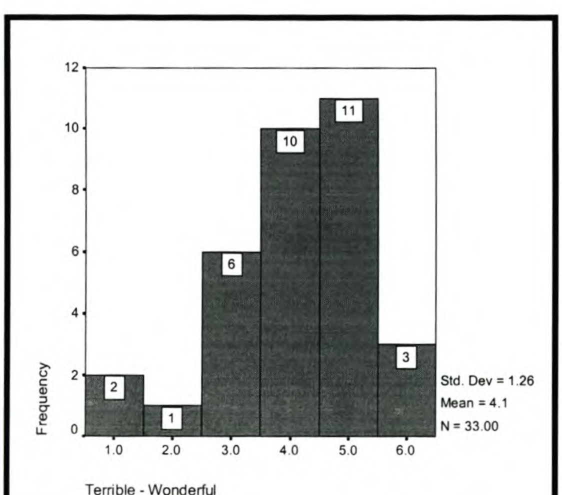


Figure 5.31: Histogram for respondents' overall reaction to *Yahoo Messenger* (terrible – wonderful)

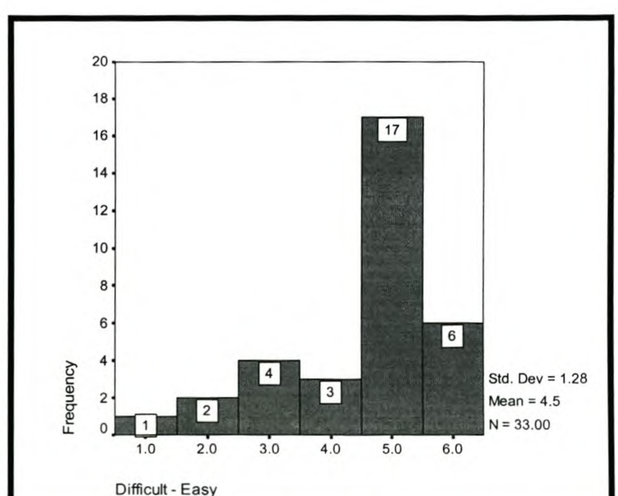


Figure 5.32: Histogram for respondents' overall reaction to *Yahoo Messenger* (difficult – easy)

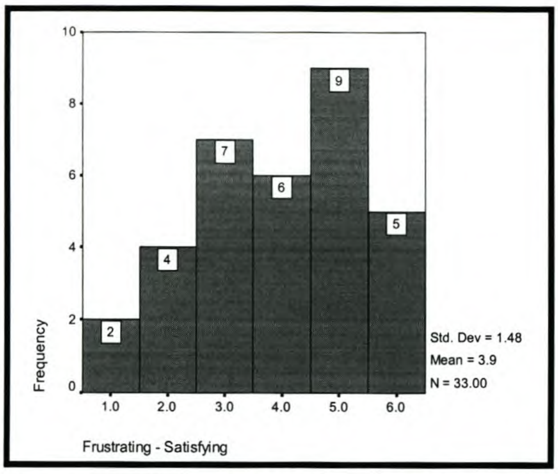


Figure 5.33: Histogram for respondents' overall reaction to *Yahoo Messenger* (frustrating – satisfying)

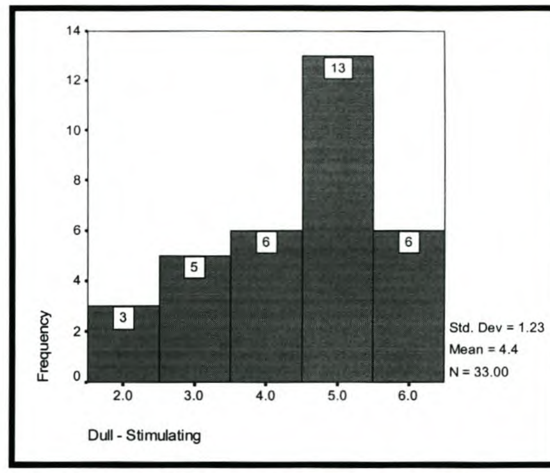


Figure 5.34: Histogram for respondents' overall reaction to *Yahoo Messenger* (dull – stimulating)

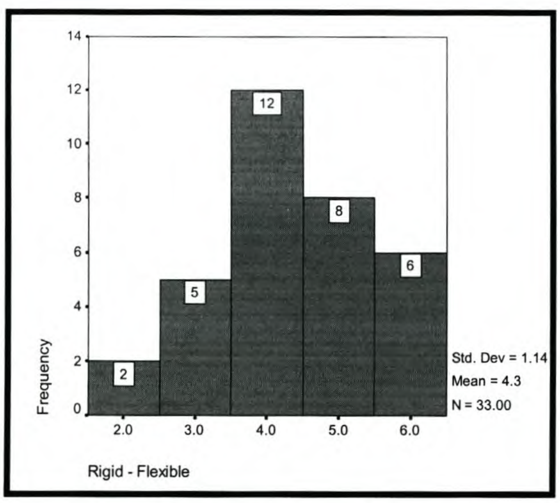


Figure 5.35: Histogram for respondents' overall reaction to *Yahoo Messenger* (rigid – flexible)

5.7 THE RESEARCH FINDINGS: *YAHOO MESSENGER* USABILITY AND FEASIBILITY (OBJECTIVE DATA)

The following section presents an overview of the research findings related to the usability and feasibility of the software application, *Yahoo Messenger*. This section will focus specifically on addressing objectives 6b – 10b.

5.7.1 Feasibility and viability results: Results of the prototype experiments

Four prototype experiments were conducted in order to gain information about the feasibility of *Yahoo Messenger* when used within the technological infrastructure of the US. The three main goals of the prototype experiments included the exploring of firewall constraints, the establishing of benchmarks as well as which of the media functions embedded within *Yahoo Messenger* are not supported by Intranet-to-Intranet (on-campus to on-campus) and Intranet-to-Internet (on-campus to off-campus) connections. The results of the experiments are briefly discussed below.

5.7.1.1 Firewall constraints

A firewall represents a combination of certain hardware and software that filter what flows into the intranet from the Internet (Horton, 2000). For a participant to be able to utilise *Yahoo Messenger*, for which the server is located on the Internet, it was necessary for the participants accessing the server from the US LAN, to open up certain ports through the US firewall. This was done by opening up the Inet-Key for each participant before the experiment started. Participants that accessed the *Yahoo Messenger* server from outside the US LAN, did not have to perform this action. They could access the *Yahoo Messenger* server through their Internet service provider, e.g. *M-Web* or *IAfrica*. These findings imply that *Yahoo Messenger* has a high level of flexibility, as it can be used by anyone anywhere with only access to the Internet being required. In terms of cost factors should it be noted that the user would always have to carry the cost for utilising *Yahoo Messenger*, whether access is gained from on or off campus. Off campus users will have to make use of a local ISP (Internet Service Provider), whereas on-campus users have to open their personal *'InetKey'* which enables them to make use of the Internet, but at their own expense. A question mark should therefore be placed upon the viability of *Yahoo Messenger* for application in the US context due to these factors.

5.7.1.2 Benchmarks and feasibility of the media

The prototype experiments were conducted between sets of two (person-to-person experiment) and four users (group experiment) on two separate occasions. These participants were considered to be expert users of *Yahoo Messenger*. They were given the task protocol sheet and completed the tasks, during an experimental session. The results of the prototype experiments regarding the benchmarks and feasibility of the media are presented in table 5.60.

Table 5.60: Results of the prototype experiments for *Yahoo Messenger*

Media embedded within *Yahoo Messenger* that was tested for feasibility within US technological parameters		TYPE OF COMMUNICATION AND CONNECTION BETWEEN COMPUTERS			
		Person-to-Person		Group	
		Experiment 1: Intranet-to-Intranet connection	**Experiment 2:** Intranet-to-Internet connection	**Experiment 3:** Intranet-to-Intranet connection	**Experiment 4:** Intranet-to-Internet connection
Video	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	4 minutes	4 minutes	4 minutes	4 minutes
Audio	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	4 minutes	4 minutes	4 minutes	4 minutes
Instant Messaging (chat)	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	2.5 minutes	2.5 minutes	2.5 minutes	2.5 minutes
Real-time file transfer	Feasible to use	Yes	Yes	Yes	Yes
	Benchmark*	3 minutes	3 minutes**	3 minutes	3 minutes**

***Note: the benchmark indicated is the time within which the participants are expected to finish the specific task (as specified in the Task Protocol Sheet, e.g. transfer a file).**
****Note: The experts indicated that this benchmark is very dependent on the server traffic.**

5.7.2 Internal System quality specifications

It has previously been established that the external system quality and quality of use (usability) depends to a large degree on the internal system quality (see figure 3.3). Therefore, the researcher deemed it necessary to shortly state the details of the internal system quality of the computers that was used for the experiments.

The following system requirements are, according to the *Yahoo Messenger* website, a pre-requisite for the successful installation and utilisation of *Yahoo Messenger*. For Windows 95, 98, NT, ME, 2000 or XP, the following requirements are mentioned:

- an Internet connection;
- an active (free) *Yahoo Messenger* account;
- Microsoft Internet Explorer 5.5 or higher;
- downloaded *Yahoo Messenger* software;
- a microphone and speakers; and
- a *Yahoo Messenger* compliant webcam.

The same computers that were used for the *NetMeeting* experiment was also used for the *Yahoo Messenger* experiments and therefore the summary of the internal system qualities provided in appendix A are also applicable to this part of the experiments. Once again, the researcher concluded that, theoretically, the internal system quality was sufficient to support the successful functioning of *Yahoo Messenger.*

5.7.3 Objective measurement results

The performance measurement results presented below were obtained from the task-logging sheets (see appendix E) that were filled out by an observer during each of the experimental sessions. The purpose of this is to provide descriptive summaries of the performance data, with the aim of establishing the usability and feasibility problems with *Yahoo Messenger,* when utilised within the technological infrastructure of the US.

5.7.3.1 General experimental details

In designing the experiments, the same parameters were considered as in the case of *NetMeeting* (refer to paragraph 5.5.3.1). Ten different combinations of experiments were developed. Table 5.61 provides an overview of the specific combinations.

Fourteen experiments were conducted over a two-week period, involving 33 participants. All of the experimental combinations as mentioned above were tested at least once. Some of the combinations were tested more than once, depending on the availability of the different role-players in the sample.

Table 5.61: Ten different experimental combinations.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5	Experiment 6	Experiment 7	Experiment 8	Experiment 9	Experiment 10
Type of Communication										
Person-to-person	×	×	×	×	×	×	×	×		
Group									×	×
Type of Connection										
Intranet-to-Intranet	×	×	×	×	×					
Intranet-to-Internet						×	×	×	×	×
Role-player combinations (scenarios)										
A: Student-to-Student	×					×				
B: Student-to-Lecturer		×					×			
C: Student-to-Information Service Suppliers			×							
D: Lecturer / Researcher-to-Information Service Suppliers				×						
E: Lecturer / Researcher-to –Lecturer / Researcher					×			×		
F: Students-to-Students									×	×

5.7.3.2 Performance Measurement Criteria

In order to choose appropriate objective performance measurement criteria, the researcher considered the nature of the investigation and the objectives (relating to the usability evaluation) of this study. The following performance criteria were deemed to be most suitable to be used as an indicator of the respondents' performance when using the system, i.e. task time, task accuracy rate and reliability. For a more in-depth discussion on these criteria, refer to paragraphs 5.5.3.2 (a) – (c).

5.7.3.3 Performance Measurement Results

The objective of the following section is to provide a description of the performance measurement results for the users' performance with a specific task, while utilising *Yahoo Messenger.* The data was obtained from the task logging sheets, where the observer documented the detail of the experiments.

Table 5.62: Mean task times for tasks 1-5 of the *Yahoo Messenger* experiments

		N	Minimum	Maximum	Mean	Std. Deviation
Valid	Task 1: Task time	33	.30	4.48	2.22	1.0
	Task 2: Task time	33	1.30	6.50	3.99	1.38
	Task 3: Task time	33	1.08	6.02	2.21	1.14
	Task 4: Task time	33	.45	6.55	2.74	1.69
	Task 5: Task time	26	.31	6.51	1.83	1.31
	Valid N (listwise)	33				

Table 5.63: Performance measurement data for tasks 1 - 5, performed during the *Yahoo Messenger* experiment.

PERFORMANCE MEASUREMENT CRITERIA (n = 33)		TASK 1		TASK 2		TASK 3		TASK 4		TASK 5	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Task Accuracy											
Valid	Within Benchmark	20	60.6	14	42.4	31	93.9	25	75.8	22	66.7
	Outside of benchmark without assistance	8	24.3	14	42.4	2	6.1	6	18.2	2	6.1
	Outside benchmark with assistance	5	15.2	5	15.2			2	6.1	2	6.1
Missing	System									7	21.2
Total		33	100.0	33	100.0	33	100.0	33	100.0	33	100.0
Reliability											
Valid	None	27	81.8	29	87.9	31	93.9	28	84.8	25	75.8
	Once	2	6.1	3	9.1	2	6.1	4	12.1	1	3.0
	Twice	4	12.1	1	3.0			1	3.0		
Missing	System									7	21.1
Total		33	100.0	33	100.0	33	100.0	33	100.0	33	100.0
Assistance required on restart											
Valid	Not applicable	27	81.8	29	87.9	31	93.9	28	84.8	25	75.8
	Restart on own	2	6.1	3	9.1	2	6.1	4	12.1	1	3.1
	Required assistance on restart	4	12.1	1	3.0			1	3.0		
Missing	System									7	21.1
Total		33	100.0	33	100.0	33	100.0	33	100.0	33	100.0

TASK 1: Log onto *Yahoo Messenger* and establish a contact list

In terms of the performance measures, the following data regarding the participant's performance with the system for task one can be reported:

- Slightly less than two thirds of the 60.6% of the respondents managed to complete task one within the benchmark time (2.5 minutes) that was set out for the task (table 5.63);
- 39.5% of the respondents (table 5.63) needed more than 2.5 minutes to complete the task. Of the 39.5%, 24.3% managed to complete the task without requiring any assistance, whilst 15.2% required assistance to successfully complete this task;
- On two occasions (6.1% if the time) was it required of the respondents to perform the action of logging in once again, after the initial attempt, due to server problems. On a further 4 occasions (12.1%) of the time was it necessary to perform another two logging actions, before the participant was connected to the server (table 5.63). One could therefore assume that the connection to the server is not very stable and reliable; and
- 6.1% of the respondents managed to overcome the problem and log onto the server without requiring any assistance, whilst 12.1% of the participants required assistance (table 5.63).

TASK 2: Communicate by utilising the instant messaging medium

In terms of the performance measures, the following data regarding the participant's performance with the system for task two can be reported:

- Only 42.4% of the respondents managed to complete task two within the benchmark time (4 minutes) that was set out for the task (see table 5.63);
- In terms the task accuracy rate, is it evident from table 5.63 that 42.4% of the respondents managed to complete the task outside of the benchmark time, without requiring any assistance. 15.2% did however require assistance to successfully complete this task;
- On three separate occasions (9.1% of the time) was it was necessary to restart the instant messaging function in order

to be able to complete the task (table 5.63). On one occasion (3% of the time) was it necessary to restart the instant messaging function twice (table 5.63); and

- Three of the respondents (9.1%) managed to restart the instant messaging function on their own, whilst one respondent required assistance to do so (table 5.63).

TASK 3: Communicate by utilising the voice conferencing medium

In terms of the performance measures, the following data regarding the participant's performance with the system for task three can be reported:

- A vast majority of the respondents (93.9%) managed to complete the task within the benchmark time (4 minutes) (see table 5.63);
- Only 2 participants (6.1%) needed more than 4 minutes to complete this task, whilst requiring no assistance in doing so (table 5.63); and
- In two instances (6.1% of the time) were it necessary to restart the voice conferencing medium function once again before the medium could be utilised to establish communication between the participants (table 5.63). Both the respondents managed to restart the medium on their own without assistance (table 5.63).

TASK 4: Enable the video conferencing medium

In terms of the performance measures, the following data regarding the participant's performance with the system for task four can be reported:

- 75.8% of the respondents managed to complete the task within the benchmark time of 4 minutes (table 5.63);
- 18.2% of the respondents completed the task outside of the benchmark time without requiring any assistance to do so (table 5.63);
- 6.1% of the respondents, did however, require assistance to successfully complete the task (table 5.63);

- On four occasions (12.1% of the time) was it required of the specific participants to restart the video medium function once, after attempting to do so initially (table 5.63). On one occasion was it required of the participant to restart the video medium function twice before it could be utilised (see table 5.63); and
- 12.1% of the respondents managed to restart the function on their own, whilst one participant required assistance to restart the video medium function (table 5.63).

TASK 5: Transfer / receive a file

The following data regarding the participant's performance with *Yahoo Messenger*, in terms of the performance measures for this task, can be reported:

- 66.7% of the respondents managed to complete the task within the benchmark time of 3 minutes (see table 5.63);
- 6.1% of the respondents completed the task outside of the benchmark, without requiring assistance to do so (table 5.63);
- 6.1% of the respondents required assistance to complete the task (table 5.63);
- On seven occasions could the task not be completed (see table 5.63). On three of these seven occasions was this the result of human error, whilst in the other four cases the completion of the task could not be recorded due to the time it would have taken to wait for the file transfer to finish (these times stretched up to anywhere between 15-20 minutes in the cases where a modem dial-up connection was used for the experiment); and
- With the exception of the seven cases where the task could not be completed, was it only necessary in one instance to restart the file transfer function in order to complete the task (table 5.63). In this case, the respondent managed to restart the function without requiring any assistance (table 5.63).

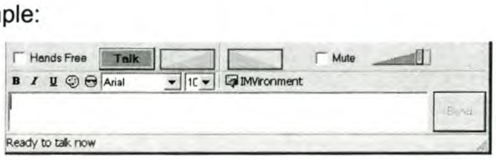
In terms of the performance measurement results, the following general conclusions can be drawn from the data presented above:

- The lowest amount of respondents that managed to complete a specific task within the specified benchmark time was 42.4% (task two), whereas for all the other tasks, a relatively high percentage of the respondent managed to complete the tasks within the benchmark time (60,6%, 93.9%, 75.8% & 66.7%) without requiring any assistance. A relatively high task accuracy rate was therefore achieved;
- Across all the tasks, relatively little assistance was required (15.2%, 6.1%) where respondents managed to complete the task outside of the benchmark time. Again one should note that a serious usability problem would be present if a high percentage of the participant was not able to complete the task – with extra time and assistance given. The numbers here, however, indicate the opposite and no serious usability problems was implicated;
- Although the reliability rate seems quite high (over all the tasks) one should note that 12.1% of the participants had to restart the system twice when logging in (task 1) and 6.1% had to restart the system once. These percentages seem quite low but it does, however, impact the user's perception of the dependability of the system negatively. Problems to establish a connection with the server, could influence the user negatively and lead to frustration and negative feelings towards the system.

It can, therefore, be concluded that the participants experienced relatively little difficulty in completing the specified tasks, and the general conclusion is therefore drawn that *Yahoo Messenger* displayed an acceptable level of usability.

5.7.3.4 *Yahoo Messenger*: Usability problem analysis

The goal of this section is to provide an overview of the range of widespread difficulties and problems users encountered while working with *Yahoo Messenger*. The issues documented below are general trends of selected functional problems that a significant amount of users experienced.

USABILITY PROBLEM ANALYSIS	COMMENTS
Instant Messaging A vast majority of the respondents performed the same error when attempting to send an instant message. The system requires of the user to first click on the recipient's name, and then to type the message. Many of the respondents omitted the step of clicking on the recipient's name and therefore proceeded to send a message that could not be delivered. In such a case, the system does not provide feedback that the delivery of the message failed and the user continues without noticing the problem.	The system should provide a feedback message to the user when a message is being sent without specifying the intended recipient.
Voice conferencing Most of the users initially found it difficult to successfully utilise the voice medium. To use this medium, one needs to press the 'voice' button (and hold it in) while speaking. Many users commented that they found this function redundant, because one could still talk and be heard without pressing the button. Example: 	Remove the functionality as it is clearly redundant.
On pressing the voice button one also needs to wait for it to become activated (it turns a brighter shade of green). When the video is utilised with the voice, however, the system's reaction time is considerably slower. It therefore happened quite often that a user would press the voice button and talk, without noticing that the system (due to the time delay) did	Provide a feedback message that notifies the user that the voice medium is activated and ready to be used.

not register the voice activation and the information communicated would thus be lost.	
Video conferencing Yahoo Messenger does not allow the participants to customise the window size of the video screen. In a group session the computer's desktop therefore becomes cluttered, as 4 video screens and the conferencing dialogue box, is being displayed.	The system should allow the user to customise the size of the video screen.
Video and Voice conferencing A group conferencing session is established by a participant inviting other participants to join the conference that he or she has established. When users are in a group conferencing session, it could (and did happen in both group experiments) that one or two of the participants experience server problems and their connection was automatically terminated. These users had to log in again to the server. The system does not, however, allow these participants to come back into the conferencing session once they have left. A new conferencing session should then be established. This function does not allow for flexible conferencing, especially within an unstable and unreliable server environment.	Revise the conference functionality to ensure better flexibility, allowing participants to join or leave the conference at any stage.

5.7.4 External system quality of *Yahoo Messenger*

For the purpose of this study, the external quality of the system was referred to as the result of the combined behaviour of the software application (e.g. *Yahoo Messenger*) and the computer system (hardware, e.g. microphones, speakers) (see figure 3.2) that were used. It was established that the external quality, to a large extent, depends on the internal system quality, as specified above. In order to measure the external quality of the system (after participants were exposed to the system) the Transmission System Quality questionnaire was developed and administered after each experiment. The data obtained from the questionnaires provides a quantitative description of the participant's subjective evaluations of the external quality of *Yahoo Messenger*, in terms of its video and audio quality.

The results of the questionnaire are presented in figures 5.36 and 5.37, as well as tables 5.64 and 5.65. The following remarks regarding the overall video quality of *Yahoo Messenger*, as perceived by the participants can be reported (figure 5.36):

- 33% rated the overall video quality as good, whilst 30% rated it as being fair;
- 6% of the respondents could not use the video function, due to a server problem experienced during the experiment; and
- 15% of the respondents rated the video quality as poor, whilst 12% rated it as excellent.

Respondents were also asked to indicate to what extent they disagree or agree with a range of statements about the video quality of *Yahoo Messenger*. On the scale, a one represents a strong disagreement with the statement, whereas a seven represents a strong agreement with the statement. The following results can be reported (table 5.65):

- Most of the respondents slightly agree with the statement that the video quality was acceptable (the mode for this question was 5);
- The majority of the respondents mostly agree that the video was clear enough (the mode was 6);
- Most of the respondent slightly agree that the size of the video was adequate (the mode here was 6); and
- Most of the respondents, however, perceived the video quality to not be comparable to a face-to-face situation. This can be seen in the fact that the mode here is 2, which represents the answering category 'mostly disagree'.

The following remarks regarding the overall audio quality of *Yahoo Messenger*, as perceived by the participants, can be reported (figure 5.37):

- More than half of the respondents perceived the audio quality as not good. 27% of the respondents rated it as poor, whilst 24% rated it as bad;
- 42% of the respondents, did however, rate the audio quality as relatively good (24% rated it as fair, whilst 18% rated it as good); and

- 6% of the respondents could not use the audio medium due to a server problem experience during the experiment.

As was the case with the evaluation of the video quality, the respondents were also asked to indicate to what extent they disagree or agree with a range of statements about the audio quality of *Yahoo Messenger*. On the scale, a one represents a strong disagreement with the statement, whereas a seven represents a strong agreement with the statement. The following results can be reported (table 5.64):

- A majority of the respondents mostly disagree that the audio quality was acceptable and that it was clear enough (a mode of 2 was achieved in both of these cases);
- Furthermore, most of the respondents indicated that the audio quality they experienced was not at all comparable with a face-to-face communication situation (the mode was 1, thus indicating a strong disagreement on this statement); and
- There is also a strong indication that most of the respondents experienced frequent information loss due to the poor audio quality (the mode here equals 5).

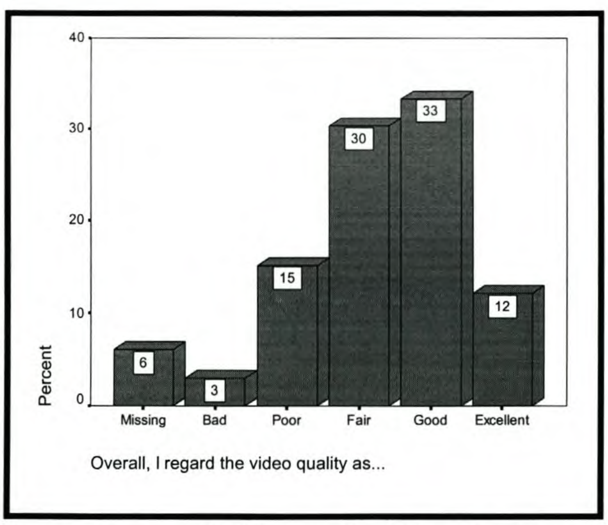


Figure 5.36: Overall video quality (Yahoo Messenger)

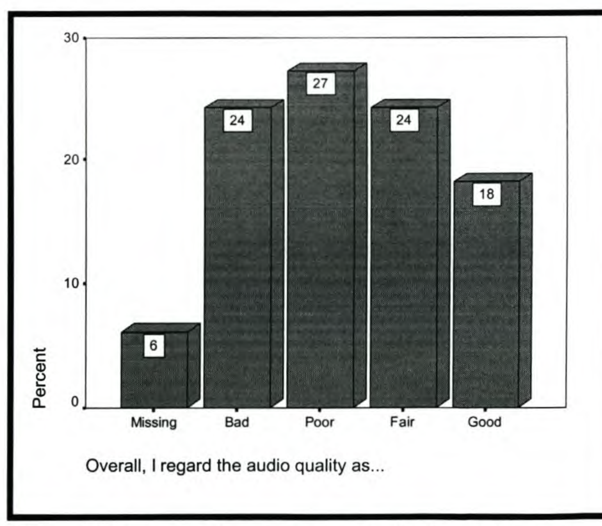


Figure 5.37: Overall audio quality (Yahoo Messenger)

Table 5.64: Summary of descriptive statistics regarding respondent's ratings on the audio quality of *Yahoo Messenger*

		The audio quality was acceptable	The audio was clear enough	Audio quality was comparable with face to face situation	I frequently lost some information during the connection due to the poor audio quality
N	Valid	31	31	31	31
	Missing	2	2	2	2
Mean		3.4516	3.2258	2.4516	5.1935
Median		3.0000	2.0000	2.0000	5.0000
Mode		2.00	2.00	1.00	5.00
Std. Deviation		1.7858	1.9444	1.5883	1.6817

Table 5.65: Summary of descriptive statistics regarding respondent's ratings on the video quality of *Yahoo Messenger*

		Video Quality Acceptable	Video was clear enough	Size of video was adequate	Video quality was comparable with a face to face situation
N	Valid	31	31	31	31
	Missing	2	2	2	2
Mean		4.5161	5.1935	5.0000	3.7742
Median		5.0000	5.0000	5.0000	4.0000
Mode		5.00	6.00	5.00	2.00
Std. Deviation		1.7102	1.2495	1.3416	1.8387

5.8 CONCLUSION

The purpose of this chapter was to report the results achieved in this study and to provide a summary thereof. The aim of the study was to research certain aspects as it pertained to synchronous CMC media when utilised within the technological infrastructure of the US. This chapter provided a logical exposition of the research results, as it addresses the specific objectives of this study, which encapsulate the aim of this study.

With regards to the needs analysis, a description of the different needs of the lecturer and student role-player groups was provided, as well as a priority list of the needs of the role-players with regards to the different synchronous CMC media that was researched. With regards to the users' perceptions of the usability of both *NetMeeting* and *Yahoo Messenger*, can it be reported that almost all hypotheses are supported by the results. Only three hypotheses are not supported by the results. Furthermore, extensive and valuable research results was obtained with regards to the user's performance with the systems, their perceptions about the external quality of the systems and the feasibility of the systems when utilised with the current technological infrastructure of the US. General limitations of the systems were also documented in the form of a brief usability problem analysis. The next chapter consists of the general conclusion, and will offer recommendations for future research in this topic.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

Major changes in higher education are taking place all over the world. The way that knowledge is packaged, delivered, accessed and acquired is transformed by new information and communication technologies and thereby alters higher education's core production and delivery processes. Furthermore, there has been an increased emphasis on lifelong learning and significant evidence that non-traditional providers of higher education occupy an increasingly pertinent presence in higher education. Such factors compel tertiary education institutions to urgently consider and respond to these changes and demands.

Institutions of tertiary education that want to remain competitive, both locally and internationally, should therefore act pro-actively with the successful and innovative integration of relevant technologies into currently established procedures. A paradigm shift should therefore be facilitated, which dictates that technology should not only be viewed as simply a supplement to the existing structure, but should rather be viewed as a new ingredient that has the potential to change the traditional tertiary education institution, through its implementation as a strategic benefit.

A closer look at the US's strategic initiatives, regarding global information technology trends, revealed that several strategic decisions have been made to maintain national and international competitiveness. One of these initiatives is embedded within the US's e-campus initiative, which proposes that both synchronous and asynchronous electronic communication possibilities at the US will be increased. It is anticipated that these new communication possibilities will constitute the supporting technological systems that will assist in the creation of a virtual information space that supports the new educational paradigm of constructivism. These supporting technological systems are, however, only technological devices that link users to collaborative conversational networks within the VIS. The purpose of these conversational networks is to create a means though which ideas and materials can be shared and exchanged with the ultimate purpose of aiding individuals in building their own conceptual networks of interrelated ideas, strategies and theories, constructing and sharing knowledge.

Synner, Soderstrom and Parnes (2001) maintain that a common deficiency found in the use of net-based learning environments, such as the VIS proposed above, is the lack of support for spontaneous interaction between students, as well as between students and lecturers. They furthermore emphasise that synchronous media, such as real-time textual chat and video conferencing (as is supported by *NetMeeting* and *Yahoo Messenger*) enhance the possibilities for communication, creating environments that not only distribute static information, but also allow for a higher level of interaction between all the relevant role-players (students, lecturers, researchers and information service suppliers). The implementation of synchronous technologies such as *NetMeeting* and *Yahoo Messenger,* which will allow for this spontaneous, higher level of interaction should, however, be tested thoroughly in order to ensure effective utilisation of these technologies. This study, therefore, empirically researched the vital aspects of the supporting technological systems (*NetMeeting* and *Yahoo Messenger*) in order to facilitate the creation and utilisation of an effective VIS environment, within the current technological infrastructure of the US (see figure 4.1).

This chapter will shortly discuss the conclusions drawn from the results obtained in the research, after which the shortcomings of the study are also discussed. Lastly, recommendations for future research will be made.

6.2 AIM OF THE RESEARCH

The aim of this research was to investigate and explore issues related to the usability and feasibility of, as well as user's perceived need for, synchronous CMC media, as implemented within the technological infrastructure of the US, with the aim of enhancing information sharing between inter alia, information service suppliers, lecturers, student and researchers. The need for this investigation linked directly with strategic decisions made by the US, related to the potential increase of electronic synchronous and asynchronous communication possibilities for enhanced information sharing and communication possibilities. The researcher, however, acknowledged that the degree to which the synchronous CMC media add value to the learning and information sharing processes within the VIS will be influenced by three elements.

These three elements include:

- the usability of the software applications (*NetMeeting* and *Yahoo Messenger*) within which the media are embedded;
- the perceived need of the role-players for the specific media; as well as
- the feasibility and viability (the internal and external quality) of the systems, when employed within the technological infrastructure of the US.

Each of these elements was formulated as a goal within this study. Furthermore, a host of objectives were identified (specifically linked to each goal). The following section will provide a logical exposition of the research findings as they were presented in chapter five and thus the conclusions drawn from the findings.

6.3 RESEARCH FINDINGS AND RECOMMENDATIONS

6.3.1 Needs analysis findings and recommendations

The first goal of this study was to conduct a needs analysis, focusing on the lecturer and student role-player groups, in terms of their needs pertaining to the synchronous CMC media embedded within *NetMeeting* and *Yahoo Messenger*. The following findings and recommendations can be reported.

6.3.1.1 Lecturer needs analysis

From the biographical results documented in section 5.2.2, it is evident that the majority of the lecturers that were tested were from the faculty of science, followed by arts, education and business management faculties. There are, however, ten faculties at the US and the sample is therefore not entirely representative of the full range of the different fields of study that is presented by the US. Each of these different fields of study are unique and therefore it is understandable that the needs of each, with regards to the synchronous CMC media, will also differ distinctly. Due to the constraints faced during the course of this study, it was however not possible to obtain a representative sample to establish the needs of the lecturer role-player group, with regards to the synchronous CMC media, embedded within the software applications that were evaluated. This is a definite shortcoming of this study, and the researcher recommends that a more in-depth, comprehensive investigation should be conducted in order to establish the different needs of the lecturers, before any of the synchronous CMC media are made available.

Conducting such an investigation would serve a dual purpose. Firstly, a reliable profile of the needs of the lecturers, pertaining to the nature of their specific field of study will be obtained. This investigation, will however, have another important purpose – that of creating an awareness of the different synchronous CMC media that are available to enhance information sharing and communication. This awareness and subsequent exposure to available technologies should impact favourably on the lecturers' technology acceptance and optimism thereof, creating a positive atmosphere that will be vital in ensuring that the US reaches its goal of becoming a 'networked' university that incorporates relevant information and communication technologies in order to achieve local and international competitiveness.

Based upon the results in section 5.2.3 (description of the lecturer pre- and post needs analysis), the researcher provided a table, ranking the order of the lecturers' needs in terms of the different media. This provides an indication of the relative importance of the media, in terms of the respondents' needs. The results (table 5.9) provided evidence that that there was the greatest need for the real-time file transfer, followed by the program sharing media, followed by the video and audio conferencing, whiteboard, interactive chat and finally the instant messaging media. However, due to the limited sample size (only 7 lecturers) that the above-mentioned results are based upon, the researcher would like to advise the reader to consider the results with great caution as these rankings are not exhaustive and fully representative of the needs of the lecturer role-player group population.

A valid interpretation that could be obtained from the results, however, was the identification of a common denominator underlying the ranking of the needs (as was presented in table 5.9). In this case, the general tendency seems to be that the data collaboration media (file transfer and program sharing), that enables quick and immediate access to different sources of data, seems to be the synchronous media that is perceived to be most applicable to the collaboration needs of the lecturer role-player group. This finding confirms research findings by Coventry (undated), which states it is not always necessarily the video aspect of desktop-based video conferencing systems within which the ultimate utility of the system is embedded, but often the file transfer and other collaborative working opportunities that it offers. Access to these data collaboration media enables users to share and discuss information quickly, cutting out the time and cost of a courier.

Another possible reason for the preference in the need for the program sharing and file transfer data collaboration media could be that it offers lecturers with a unique opportunity to collaborate with other subject matter experts, regardless of their dispersed geographical locations. It therefore creates an opportunity to reach a wider audience (other researchers and lecturers) and to make use of scarce expertise. A specific application for the program sharing media could be that it provides these lecturers or researchers with opportunities for collaborative editing of a document. A researcher could therefore submit a document to the relevant party and collectively propose suggestions and changes. This could lead to increase cooperation between subject matter experts, better research outputs (quality and quantity) as well as enhanced relationships between institutions of tertiary education over geographical boundaries, both locally and internationally.

Consequently, such enhanced relationships between institutions would most probably result in an increased number of student exchange programs. In such situations, the use of desktop-based video conferencing systems, such as *NetMeeting*, could provide for relatively effortless collaboration between the student and the study leader (compared to current systems like e-mail). In this situation relatively large files can also be transferred, as opposed to a size limitation that is placed on files that are attached to e-mail.

6.3.1.2 Student needs analysis

The same limitations that were experienced with the lecturer needs analysis sample, were experienced with the students needs analysis sample. The students' biographical information (section 5.3.2.2) revealed that there was only limited representation of all the faculties at the US. Furthermore, another limitation is the fact that almost half of the student respondents were not post graduate students, but final year undergraduate students. The interpretations derived from the data should therefore be considered with caution and should not be deemed to be fully representative of the needs of the student role-player group, with regards to the synchronous CMC media.

Based on the results of section 5.3.3 (description of the pre- and post needs analysis), a ranked order of the needs of the students, with regards to the different media, was once again provided (table 5.18). It is evident from the results that the greatest need was for the interactive text chat media, followed by the file transfer function, instant messaging media, video and audio conferencing, program sharing and lastly, the whiteboard media. The common denominator underlying the higher ranking needs here, is clearly not only the media that provides quick and easy data collaboration opportunities (as was the case with the lecturers). Conversely, it rather seems that the students found the opportunities for CMC, that allow for a higher level of interaction between all the relevant role-players, as more important. The researcher would, however, once again recommend that a more in-depth comprehensive study should be considered before the media are made available to the students, in order to gain more conclusive results.

It has been established, earlier on, that learning is increasingly being viewed as a personal, as well as social activity (Palloff & Pratt, 1999). The indication of the high need for the text chat function, could therefore point to the fact that students see this media as a quick and easy way of communicating. This medium could also be utilised for social purposes by creating an atmosphere of comfort and trust between participants, which would most probably translate into increased learning experiences, due to the fact that users are more confident and at ease with the system.

The use of media, which specifically is focused on providing a 'richer' communication and collaboration experience, could effectively promote the constructivists learning experience, by:

- encouraging frequent contact between fellow students and students and lecturers and encouraging student motivation and involvement;
- enhancing the learning experience through cooperation and collaboration, as a result of the sharing and discussing of ideas that could deepen understanding and increase involvement in learning;
- talking about, reflecting on, and applying learning facilitates active engagement in learning and encourages the

transformation of tacit knowledge to new explicit knowledge, creating new knowledge, and

- an overall enriched learning experience.

Another possible application of the synchronous CMC media is within the MOO of the US. A relatively simple version of the *LinguaMOO* (presented in chapter 2, section 2.3.3) has already been created for the US and can be accessed at the following address: http://www.moo.sun.ac.za. The researcher suggests that students should be informed about the MOO of the US in order to start a process of awareness of the technologies available to aid learning. With the correct control, the use of interactive text chat in the MOO for social purposes could lead to an increased level of computer literacy and level of computer experience, thereby breaking down resistance to technology and ensure an increased acceptance of the of similar technologies for learning experiences.

6.3.2 Usability findings and recommendations

The second goal of this study centered on the evaluation of the usability of the software applications, *NetMeeting* and *Yahoo Messenger*. Various objectives were identified in this regard. The following section will focus on providing the research findings and recommendations that address objectives 3 (a and b) to 6 (a and b).

6.3.2.1 Description of *NetMeeting* and *Yahoo Messenger*

A comprehensive description of the nature of the software applications *NetMeeting* and *Yahoo Messenger*, evaluated in this study, is provided in section 2.5.5.4. The decision to evaluate these software applications was made in accordance with the Department of Information Technology at the US. This decision was mainly based on relevant cost and availability factors.

NetMeeting was chosen because it is a standard add-in to all of *Microsoft's* operating systems. Therefore, the US would have no additional costs, such as the purchasing of software, in order to ensure installation on campus. This made the system extremely viable for on-campus to on-campus use. *NetMeeting*, however, does not support effective multi-user group conferencing sessions. This was evident, as there was no video or audio transmission available in both experimental group sessions (even when the sessions were conducted between computers connected through the campus network, where the optimum amount of bandwidth, 10 Mbps, was available). It is therefore recommended that *NetMeeting* should rather be utilised for one-to-one collaboration sessions.

A further enquiry into the functionalities that *NetMeeting* offers, however, revealed that a *Microsoft Exchange 2000 Conferencing Server* could be purchased. This would support the creation of an effective *NetMeeting* multi-user group conferencing collaborative environment. There would, however, be costs involved in the purchasing of the server, which will limit the viability of the system to a certain extent. The researcher therefore recommends that a cost-benefits analysis should be conducted, in order to establish whether the cost of purchasing such a conferencing server is justified by the advantages of the system. Therefore, the researcher would like once again to highlight the importance of conducting a thorough needs analysis plus cost benefit analysis in order to establish whether or not there is enough of a need to justify the purchasing of such a server.

Yahoo Messenger was chosen for evaluation, due to the fact that it is a free client-based instant messaging service available to anyone that has access to the *Internet*. Hence, there are no costs involved (for the US) in providing users with the system. Users will, however, have to carry the costs of *Yahoo Messenger* conference sessions and this therefore could limit the system's viability from a user's perspective.

Although it was possible to conduct multi-user group conferencing sessions with *Yahoo Messenger*, all the experiments revealed that the *Yahoo Messenger* server environment is not sufficiently stable and reliable (users were often not able to log onto the server, or were spontaneously thrown off of the server). A further limitation of the *Yahoo Messenger* system, is that it only incorporates one type of data collaboration medium – the real-time file-transfer function. In the light of the findings regarding the needs of the lecturers (presented earlier), a question mark should be placed next to applicability of the *Yahoo Messenger* software application to meet the needs of the lecturer role-player group. *Yahoo Messenger*, could however, be more applicable to the needs of the student role-player group – considering the results of the student needs analysis that was presented above.

6.3.2.2 Defining the concept of usability within the VIS Project environment

A comprehensive overview of the concept of usability can be found in chapter three of this thesis. Throughout the chapter, the researcher has placed usability within the context of this study and highlighted the important aspects that pertain to this study.

6.3.2.3 Usability evaluation (subjective data)

a. Perception of *NetMeeting* usability

The specific usability attributes that were investigated, in order to establish the participants' perception of the usability of *NetMeeting,* include general usefulness/utility, effectiveness and efficiency, reliability, ease of use, error management, consistency and compatibility, learnability and user satisfaction. The following section will provide a short overview of the research results as it pertained to the participants' perception of the usability of *NetMeeting.*

- **General usefulness/utility**. 89% of the respondents indicated that *NetMeeting* is useful when sharing information with various role-players, whilst almost two thirds of the respondents agree that *NetMeeting* aids and improves communication between role-players. The majority of the respondents agreed that *NetMeeting* would be useful and helpful in the execution of their job and also make it easier to do their job. Furthermore, there was strong agreement that the implementation of *NetMeeting* will, most probably, promote flexible learning, as well as enhance the competitiveness of the respective departments, and the university as a whole. These findings, therefore, verify that the proposed conceptual integration of communities of practice (through supporting effective, easy information sharing and communication practices) and flexible learning, most likely encapsulates the value of the VIS environment, as was proposed earlier.

- **Effectiveness and efficiency**. A majority of the respondents agreed that using *NetMeeting* would enhance their information sharing and communication effectiveness, whilst saving time in doing so. More than two thirds of the respondents agree that the accuracy of information sharing would be improved, whilst 83% of the respondents agreed that their work efficiency would be improved. There was, therefore, considerable agreement with regards to the idea that using *NetMeeting* would lead to improved effectiveness and efficiency in performing work-related tasks and sharing information effectively and rapidly.

- **Reliability.** Slightly more than two thirds of the respondents indicated that the *NetMeeting* did not stop or hung often during the execution of tasks, whilst 23% of the respondents agreed that the system often stopped or hung during the execution of tasks. This is supported by the performance measurement data, which indicates that the total amount of times that the system stopped or had to be restarted (over all the experiments) equaled 8, which translated into 22.8% (8/35) of the time. This figure confirms that 23% of the respondents experienced problems with the reliability of the system. In six of the eight cases, the respondents could restart the application or medium on their own, whilst assistance was required in the other two cases. Two thirds of the total sample, however, indicated that felt confident that they could restart *NetMeeting* on their own. This figure is therefore partly verified by the performance data, as 75% of the respondents indicated that they would be able to restart the system on their own. The reliability of the system is, however, extremely dependent on the internal system qualities such as network usage and available bandwidth and the researcher would therefore recommend that users should be informed of this constraint.

Based upon the findings above, it is evident that the effective implementation and utilisation of *NetMeeting* might require extensive support from the Department of Information Technology (IT) at the US. This should be taken into account when a decision is made about the viability of the system, as support provided by IT personnel (in terms of man-hours) could become expensive.

- **Ease of use**. The majority of the respondents regarded the system as easy to use and reported that it is was not a frustrating experience to use the system. They regarded the system as user-friendly and experienced satisfaction with the level of ease with which they completed the tasks. In short, they felt confident using *NetMeeting*.

- **Error Management.** It was not possible to make a decisive judgment on the error management capabilities of *NetMeeting,* because the respondents seemed to hold no strong opinion regarding this issue. The researcher suspects that this is due to the fact that the respondents were not exposed to situations where the error management capabilities of the system had to be utilised. A more in-depth study, focusing specifically on the error management capabilities of *NetMeeting* should thus be conducted in order to gain conclusive evidence about this usability attribute.

- **Consistency and compatibility.** The majority of the respondents indicated that *NetMeeting* responds to user inputs in a consistent way, and that they feel in control when using *NetMeeting*. Overall, users perceived *NetMeeting* to be very compatible. A majority of the respondents agree that *NetMeeting* corresponds with their idea of the way in which tasks should be executed, whilst all the respondents agree that *NetMeeting* meets their needs. A few of the respondents indicated that *NetMeeting* differs from similar applications, in terms of the icons and commands that are used. The recognition of icons can, however be increased by placing permanent labels on each icon.

- **Learnability.** The vast majority of the participants found the system to be learnable, indicating that most people would learn to use *NetMeeting* quickly and easily without having to learn much before doing so. This could lead to increased acceptance of the technology. A few respondents, however, indicated that they found that it was difficult to remember names and uses of specific commands and sometimes wondered if they were using the right commands, feeling there was often not sufficient information on the screen when it was needed. These items are, associated with the provision of labels on icons and can therefore be documented as a considerable drawback of the system. It should be noted here that a vast majority of the respondents reported that the amount, as well as level and intensity of *NetMeeting* training received was sufficient and even more that sufficient. The training, however, only comprised of a brief 20-minute introductory session to on the system and it can therefore be concluded that the system is very learnable, not requiring lengthy and intense training sessions in order that the users might work effectively.

- **Satisfaction.** 91% of the respondents found it to be a satisfying experience to work with *NetMeeting*. A similar amount of respondents felt that they would like to use *NetMeeting* frequently, agreeing that it is a pleasant experience to work with this software application. This result can be regarded as significant. A few respondents, however, indicated that they felt awkward whilst using *NetMeeting*. This may be as a result of a lack of comfort with the technology and is subject to change with increased exposure to the technology. The feeling of awkwardness could also be attributed to the fact that most of the respondents involved in the experiments did not know each other at all and felt that it was daunting to view and talk with a stranger in a slightly artificial situation.

b. Perception of *Yahoo Messenger* usability

The specific usability attributes that were investigated, in order to establish the participants' perception of the usability of *NetMeeting,* include general usefulness/utility, effectiveness and efficiency, reliability, ease of use, error management, consistency and compatibility, learnability and user satisfaction. The following section will provide a short overview of the research results as it pertained to the participants' perception of the usability of *Yahoo Messenger*.

- **Usefulness/utility.** Most of the respondents agreed that using *Yahoo Messenger* would make it easier to do their job and that they find *Yahoo Messenger* useful in the execution of their job. Furthermore, there was much agreement that *Yahoo Messenger* would be useful when sharing information, in processes related to learning, networking and research, as well as adding value to the user's learning experience and promoting flexible learning. A third of the respondents, however, felt that using *Yahoo Messenger* would not increase their productivity. This could be a slight possibility, where the users of the system do not understand the functionality of the system and therefore not decide to utilise a specific function for a specific purpose. *Yahoo Messenger* does contain a vast majority of extra functions, for example links to the news and weather (as a result of being a commercial product) and a user could therefore easily be distracted by all of these additional functionalities within the system.

- **Effectiveness.** Most of the respondents deemed the system effective, agreeing that it would enable them to complete their work, as well as to share information and communicate effectively. Most of the respondents also agreed that they would be able to complete their work efficiently as a result of using *Yahoo Messenger*, agreeing that using the system saves them time when information needs to be shared. A few respondents, however, questioned whether the accuracy of their communication and information sharing practices would improve as a result of utilising *Yahoo Messenger*. This could be as a result of the relative unreliability of the server connection and the often poor audio quality which could result in a frequent loss of information during communication.

- **Reliability.** Almost half of the respondents indicated that *Yahoo Messenger* often stopped or hung during the execution of tasks. The performance measurement data also revealed that in 54.5% of the time, respondents experienced problems with the reliability of the system and had to restart either *Yahoo Messenger* or the specific media function. 66% of the time, the respondents were able to restart the application or media on their own, whilst assistance was required for the other 33% of the time. The conclusion is, however, that *Yahoo Messenger* is not very reliable. This could be as a result of the various internal system quality factors, such as the server traffic and connection. Users should be made aware of these system constraints and should therefore be provided with adequate training so that they would be able to restart the system on their own, effortlessly.

- **Ease of use.** Most of the respondents indicated that they were satisfied with the ease of use with which they completed tasks and found the system user-friendly, flexible to interact with and indicated that they would not need the support of a technical person to be able to use *Yahoo Messenger.* Between 20-27% of the respondents did, however, find it frustrating to work with *Yahoo Messenger* and did not feel very confident in using the system. This frustration should be addressed, before the system is implemented, in order to find out exactly what it was that frustrated the users. This possibly highlights a need for additional training, which should then also address the users' lack of confidence, and thereby make it easier for users to work with the system.

- **Error management.** It was not possible to make a decisive judgment on the error management capabilities of *Yahoo Messenger,* as a large amount of the respondents did not seem to hold a strong opinion on this issue (the majority of the responses related to the error management capabilities was located in the 'neutral' response category). A more in-depth study, focusing specifically on the error management capabilities of *Yahoo Messenger,* should thus be conducted to gain conclusive evidence on this usability attribute.

- **Consistency and Compatibility.** The majority of the respondents (81%) agreed that *Yahoo Messenger* is consistent, responding to user inputs consistently in the same way, whilst two thirds indicated that they feel that they are in control when using *Yahoo Messenger*. 24% of the respondents, however, indicated that they do not feel in control when using *Yahoo Messenger*. This reaction could be related to the previously indicated lack of confidence when working with the system. A slightly more intense training session, together with longer exposure to the system, would most probably address these control and confidence issues.

Overall, a vast majority of the respondents regarded the system as compatible with their expectations, thus meeting their needs. A fifth of the respondents indicated, however, that *Yahoo Messenger* (in some instances) does not adhere to their idea regarding the way in which the tasks should be executed. This could be due to the limited training that was provided, where only one (sometimes two) command paths were demonstrated – although the system usually allows for more options in executing a task. The researcher therefore recommends that a slightly more comprehensive training session could be provided (as the 20 minute introductory session that was provided before the experiment), which would orientate the user with all of the different options to execute a task – after which the user can choose the option that is most compatible with his or her mental map (expectation) regarding the way in which the task should be executed.

- **Learnability.** The majority of the respondents found *Yahoo Messenger* to be learnable, indicating that they became skilful quickly in using the system and did not need to learn much before they could work with the system. Most of the respondents also envisage that the majority of users would learn to use *Yahoo Messenger* quickly. A few respondents, however, indicated that they found it difficult to remember names and the uses of specific commands, sometimes wondering if they were using the correct commands and felt there was often insufficient information on the screen when it was needed. It should be noted here, that the majority of the respondents reported that the amount, as well as level and intensity of *Yahoo Messenger* training received was sufficient and even more that sufficient. The training, however, only comprised of a brief 20-minute introductory session to the system and it can therefore be concluded that the system is very learnable, not requiring lengthy and intense training sessions in order that the users might work effectively.

- **Satisfaction.** Three quarters of the respondents found that it was a satisfying experience to work with *Yahoo Messenger*. A similar amount of respondents felt that they would like to use *Yahoo Messenger* frequently, agreeing that it is a pleasant experience to work with this software application. Almost a fifth of the respondents, however, indicated that they felt awkward when using *Yahoo Messenger*. This may be because of a lack of comfort, confidence and feelings of control (as was reported earlier) in relation to the technology. This problem will, most probably, be overcome with increased exposure to the technology. The feeling of awkwardness could also be attributed to the fact that the majority of the respondents involved in the experiments did not know each other well (or even not at all) and therefore found it daunting to view and talk to a stranger in this slightly artificial environment.

6.3.2.4 Usability evaluation (objective data)

a. *NetMeeting* performance measurement results

With regards to the *NetMeeting* performance measurement results it can be reported that the participants' performance when using the system was exceptionally good. Across all the tasks a high task accuracy rate was achieved, with most of the respondents managing to complete the tasks within the benchmark time. The only exception here was found with the interactive text chat task, where merely a third of the respondents managed to complete the task within the benchmark time. This phenomenon could, however, be ascribed to the low typing speed of the respondents.

Rubin (1994) highlights that the task accuracy indicator consisting of the percentage of participants that completed the task outside of the benchmark time, whilst also requiring assistance, can point towards serious problems with a product. He maintains that if this number is very high, it indicates very serious problems with the product, as respondents needed extra time and assistance to complete the task. The highest percentage that was recorded for this performance indicator was 14.3% (task one). The researcher regards this as a relatively low percentage and therefore concludes that the participants did not experience major problems whilst completing the tasks with *NetMeeting*.

The third set of performance criteria that were recorded, had to do with the reliability of the system and the amount of assistance that the participants required when completing the specific tasks. The reliability results have already been discussed in section 6.3.2.3, together with the participants' perception of the reliability of *NetMeeting,* and will therefore not be discussed again.

b. *Yahoo Messenger* performance measurement results

With regards to the *Yahoo Messenger* performance measurement results, it can be reported that the participants' performance when using the system, was fairly good. There was a high task accuracy rate achieved with each task, as the majority of the respondents managed to complete the tasks within the benchmark time. Once again, the lowest rate observed here was during the interactive text chat task, where only 42.4% of the respondents managed to complete the task within the benchmark time. This phenomenon could, once again, be attributed to the respondent's low typing speed. The highest percentage of participants that completed the tasks outside of the benchmark, after requiring assistance is once again regarded as relatively low (15.2%) by the researcher. This indicates that there is no serious usability problem with *Yahoo Messenger*.

6.3.3 Feasibility and viability findings and recommendations

The third goal of this study centered on the evaluation of the feasibility and viability of the software applications, *NetMeeting* and *Yahoo Messenger,* when utilised within the current technological infrastructure of the US. Various objectives were identified in this regard. The following section will focus on a discussion of the research findings and recommendations that pertain to objectives 7 (a and b) to 10 (a and b).

6.3.3.1 *NetMeeting* and *Yahoo Messenger* prototype experiments

The results of the *NetMeeting* prototype experiments confirmed that *NetMeeting* is not able to effectively facilitate multi-user group conferencing sessions (sessions where more than two persons log onto one conference). Person-to-person conferencing sessions are, however, viable and have the potential to aid users in effectively collaborating and sharing information. The prototype results further confirmed that the video and audio media capabilities are not available, with an Intranet-to-Internet connection, due to bandwidth constraints. In these cases only the interactive text chat function and data collaboration media could be utilised. This is a definite constraint to the system, due to the fact that the data collaboration media (program sharing and whiteboard) require the effective utilisation of audio communication in order to be utilised effectively. In an Intranet-to-Intranet situation, both the video and audio (as well as the data collaboration media) worked effectively and could be extremely useful for users.

Consequently, the researcher recommends, that given the high level of acceptance and high rating of usability that *NetMeeting* has achieved, the technological expansion requirements to ensure the feasibility and viability of the system should be investigated by the Department of Information Technology at the US.

The results of the *Yahoo Messenger* prototype experiments confirmed that all of the media functions provided within *Yahoo Messenger* can always be utilised, regardless of the type of connection that is established between the computers involved. However, the prototype experiments, illustrated that *Yahoo Messenger* does function in a relatively unstable server environment and users should be made aware of this fact and should be provided with training (or adequate support) that they may effectively handle the problems encountered within the unstable environment.

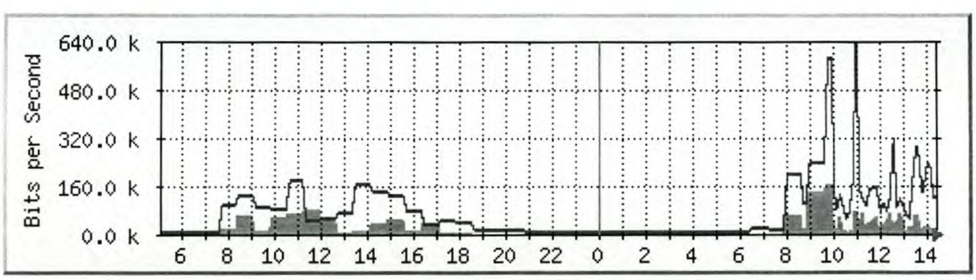
6.3.3.2 *NetMeeting* and *Yahoo Messenger* internal quality: bandwidth and network issues

One of the major findings when considering the use and implementation of desktop-based video conferencing devices, such as the systems tested in this study, is that without sufficient network resources (bandwidth) or reliability (network) it becomes practically impossible to make a virtual learning environment work effectively.

A vivid illustration of this reality was clear during the *NetMeeting* experiments, where an on-campus (Intranet) to off-campus (Internet) situation was simulated. In all of these experiments, no video or audio functionalities could be utilised as a result of the limited bandwidth capability (the bandwidth being limited to the 48kbps of the modem connection that the off-campus participant used when connecting from outside of the US network). These incidents illustrated the finding proposed by Krawchuk (2000), as he points out that the amount of network load and potential delays in traffic delivery increases, as the amount of media richness (for example live video and audio) a system tries to introduce, increases.

In the case of *Yahoo Messenger*, the audio and video media could always be utilised (regardless of the type of connection between the computers), but the quality of video and audio was, however, negatively influenced where the amount of bandwidth was limited to 48kbps. These findings reveal the considerable limitations of these systems when utilised in situations that simulate distance learning environments (which is one of the more common applications for these systems) and the researcher recommends that a further investigation should be conducted to establish if, and how, these constraints can be overcome.

Due to ample bandwidth that is available on the campus network (10Mbps), the experiments that simulated an on-campus (Intranet) to on-campus situation (Intranet) situation, almost never suffered the limitations as was mentioned above. Network usage information obtained for the duration of the experiments showed that an average of only 8.1% of the total network capacity (10Mbps) was utilised during this period (see figure 6.1). This is a relatively low percentage, and therefore the researcher would suspect that the limitations that were experienced during on-campus (Intranet) to on-campus (Intranet) experiments could possibly be attributed to the code of the *NetMeeting* software application and the dial-up connection that is established. One could, however, state that the US network is relatively stable and does provide sufficient resources to make the utilisation of *NetMeeting* feasible.



Max In 170.9 kb/s (1.7%) Average In 24.8 kb/s (0.2%) Current In 19.5 kb/s (0.2%)
Max Out 635.1 kb/s (6.4%) Average Out 74.0 kb/s (0.7%) Current Out 124.3 kb/s (1.2%)
Average amount 8.1%

Figure 6.1: Average amount of network usage experienced (8.1% of the total network capability,10 Mbps) for the timeframe within which the experiments were conducted (26 August to 6 September 2002).

A solution to the bandwidth limitations of the off-campus situation that was investigated, was to allow off-campus users access to the US network. This attempt failed on several occasions, due to firewalls and other security considerations impeding free access to the US network. Krawchuk (2000) noted that applications such as *NetMeeting,* which rely on multicasting (dynamic assignment of ports), are unable to transmit through firewalls. For institutions like the US, that use firewalls, this realistically constrains the options of interaction by placing a restriction on the range of users.

The researcher recommends that an investigation could be launched to ascertain the possibilities related to the use of selective firewalls, therefore allowing selected users access to the US network. The US governance should be actively involved in the investigation and decisions should furthermore be based on the results of a thorough cost-benefit analysis.

6.3.3.3 *NetMeeting* and *Yahoo Messenger* internal quality: hardware issues

Synner et al. (2001) point out that the hardware (equipment such the microphone, speakers, computer etc.) is critical for ensuring of effective electronic communication between participants, especially when using desktop video-conferencing tools. They point out that non-robust technology quickly becomes a major source for negative and limited activity and the negative quality of real-time discussions. Furthermore, research that has been conducted in this regard, has revealed that network and desktop hardware issues frequently lead to problems for students in using synchronous tools.

A specific issue, regarding video conferencing tools is the fact that audio hardware is difficult to setup practically, without risking feedback or noise. This could cause audio feedback, as was experienced quite a few times during experiments. With proper support from the observer, the problem could be illuminated. However, Synner et al. (2001) point out, that this is one of the most common reasons why users find these environments complex – it simply requires experience to successfully setup the audio levels in order to avoid problems. If *NetMeeting* or *Yahoo*

Messenger should thus be implemented, as an endorsed desktop-based video conferencing tool for the US, adequate support should be provided to ensure that users do not encounter the abovementioned problem.

Another concern, related to desktop-hardware issues, pertains to the use of proper microphones. For the experiments conducted in this study, a *Logitech Quickcam* webcam was used. This webcam has an inbuilt microphone. This microphone was effective in the situation where outside noise was minimised, as was the conditions within which the experiments were conducted. On a few occasions (for example the experiments with the groups), the researcher however noticed that the built-in microphone – as a result of its placement on top of the computer – captured sound from the surrounding environment to such an extent that it hampered communication and the participants had to bring the audio communication to a halt. The researcher would thus recommend that freestanding microphones would be purchased and implemented for use in noisy student computer areas.

6.3.3.4 ***NetMeeting*** and ***Yahoo Messenger*** external quality: video and audio quality

Many researchers have demonstrated the importance of video in collaborative virtual learning environments, such as the VIS. Tang and Isaacs (cited in Patrick, 1999) found that the video channel proved to be useful for interpreting long pauses and for providing access to body gestures, which are used to facilitate interaction between people. Krawchuk (2000) points out that research has shown that there was no significant difference in task performance when using a video channel. Partrick (1999, p.32) supports this view by stating that, "video is important for video conferencing but the main effects are in the nature of the interactions and the perceptions of the user, not in the performance of tasks". However, it was observed that participants who did not have a video channel reported difficulties in mutual understanding because the users were not sure that they were being understood.

Part of the data analysis that was presented in chapter five, pertained to the respondents' evaluation of the quality of the audio and video media and data collaboration media – in the case of *NetMeeting*. With regards to the *NetMeeting* video quality, the audio quality and the quality of the data collaboration media, the participants generally rated the overall quality (of these three external quality elements) as good. In the case of *Yahoo Messenger*, most of the respondents rated the video quality as good, but the audio quality as poor.

The researcher would like to point out that these results should be viewed with some caution, as Krawchuk (2000) rightly points out that the range of tolerance amongst users, regarding the level of acceptable video quality, could vary considerably. Studies undertaken at *Hewlett Packard* established that some users found video delivered at 6-8 frames per second (as was the average amount of frames being broadcast during the experiments in this study) as usable, whereas other users found the video displayed at this rate to be highly distracting and would rather not have had any video at all, if the amount of frames per second was below a certain level (Patrick, 1999). These results would seem to indicate that there is, to some degree, a subjective nature to the assessment of video quality and therefore the results of this study should be viewed in this light.

Kies et al. (cited in Patrick, 1999), however, performed a detailed study of video quality in video conferencing and found that large individual differences in the tolerance of low quality video may be related to the users' prior experience, expectations and other factors. It was not within the scope of this study to do a detailed analysis of the external quality of *NetMeeting* and *Yahoo*

Messenger and therefore the researcher recommends that a further investigation should be conducted to establish which individual differences, and to what degree these differences, influence users' tolerance of the video quality.

In conclusion, the following general recommendations are made in terms of results of this study:

- given the high level of acceptance and high rating of usability that both *NetMeeting* and *Yahoo Messenger* has achieved, the technological expansion requirements to ensure the feasibility and viability of the systems should be investigated by the Department of Information Technology at the US;
- an infrastructure audit should be conducted to establish the current available infrastructure in terms of suitable computers, microphones and web-cams to facilitate the implementation of these technologies on campus;
- a more in-depth needs analysis should be conducted, starting with the lecturer and post-graduate student role-player groups. This information should be used to establish a system whereby lecturers could apply for access to *NetMeeting* (as it was established that *NetMeeting* is more suitable for the needs of the lecturers);
- a cost-benefit analysis should be conducted to establish the costs related to the purchasing of a *Microsoft Exchange Conferencing Server* that will facilitate effective group conferencing sessions;
- the US MOO should be launched and students should be given access to the MOO, with the purpose of facilitating a process whereby students will become used to the use of technologies for facilitating and enhancing the learning experience;
- sufficient support from the Department of Information Technology should be provided to ensure effective implementation and utilisation of the systems.

6.4 SHORTCOMINGS OF THIS STUDY

In this study a descriptive method of research was followed. This type of inquiry was considered to be appropriate for the purposes of this study, as a preliminary investigative study. It is, however, not without shortcomings. A descriptive method of research is generally employed for data that is derived from observational situations where the aim is to classify, discover and measure certain phenomena. The outcome of such a study is therefore a detailed description of the phenomena under investigation.

The major shortcoming of this type of research is, however, embedded within the lack of control over variables that may possibly influence the results. In this study no variables could be isolated or controlled (for example the internal system quality variables and the extent to which it influences the external system quality as well as the quality of use evaluation) and the researcher therefore recommends that future research, should seek to refine the nature of the relationships between the elements that were described (refer to figure 3.3).

Another definite shortcoming of this study was the limited sample size that the needs analysis research results are based upon, as well as the fact that the needs analysis was only conducted on two (student and lecturer) of the four role-player groups. No data about the information service suppliers' and researchers' needs could be obtained due to a lack of participants from these role-player groups. The researcher regards the needs analysis as a vital element of this study, due to the fact that the decision to implement either *NetMeeting* of Yahoo Messenger – will first and fore mostly be governed by the need that exists for these systems. The results should therefore be viewed with some caution and no definite decisions (regarding the implementation of *NetMeeting* or *Yahoo Messenger*) should be taken before a more comprehensive investigation has been conducted in this regard. The researcher recommends, however, that access to the systems should be granted in individual cases where the users have specific application scenarios and request the use of a video conferencing system. A bigger release of the products for use on campus, should however only be implemented after the more comprehensive needs analysis investigation, a cost –benefit analysis and an investigation into support requirements that will be needed, was conducted.

A possible shortcoming of this study pertains to the usability questionnaire. The questionnaire was developed by both the VIS Project researchers for the use of the subjective evaluations within the VIS project environment. The nature of the four software applications that were tested (by both studies in the VIS Project) varied considerably and for future purposes the researcher recommends that such a questionnaire should also incorporate dimensions related to the specific nature of video conferencing software (the synchronous aspect of it).

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

In terms of recommendations for future research, it has already been suggested that a thorough investigation should be conducted to establish the extent to which users' previous computer training and experience could possibly influence their perception of the usability of the system. Together with this, a more in-depth needs analysis investigation (focusing on all of the role-player groups) should be conducted. The reason for this has already been highlighted previously.

This study aimed to investigate the usability of the technological systems that would support the learning and information sharing processes in the VIS. It was established that a sufficient level of usability is prevalent in both the software applications (this conclusion is based on the usability results) and successful implementation should therefore result in an effective virtual learning and information sharing environment that support the development of elaborate collaborative conversational networks (within different communities of practice) between different role-players.

It is recommended that subsequent research should therefore focus on the value that the VIS could possibly add to the processes of knowledge creation, knowledge dissemination, learning, increased information sharing and communication at the US. Extensive empirical studies could therefore be conducted to investigate the elements within which the value of the VIS manifests itself.

These elements, such as the formation of COP whereby users would engage in collaborative conversational communication networks, are expected to add value to knowledge creation and sharing processes. A thorough investigation, conducted over a period of time to investigate the formation of these COP, as well as to establish the value of these virtual communities to learning and information sharing at the US, should therefore be executed.

6.6 CONCLUSION

This study investigated issues related to the usability and feasibility of synchronous CMC media, when implemented within the current technological infrastructure of the US, with the aim of enhancing information sharing between inter alia, information service suppliers, lecturers, students and researchers. A needs analysis was also conducted to establish the needs of the student and lecturer role-player groups, regarding the specific synchronous CMC media embedded within *NetMeeting* and *Yahoo Messenger*.

Based on the results, it is evident that the software applications display the necessary level of usability to be utilised effectively for the purposes of virtual learning and information sharing at post graduate level at the US. Some feasibility and viability issues regarding the implementation and support of the systems, however, require more investigation. The researcher would like to emphasise that this study was a first step in the investigation of the usability of such systems when utilised within the context of the US. Many unanswered questions remain and further research should most definitely be conducted to ensure the creation of an effective VIS environment for the US.

REFERENCES

A+ Certification Training Kit (2nd Edition). (2000). United States: Microsoft Press. World Wide Web (http://mspress.microsoft.com).

Alexander, S. & Boud, D. (2001). Learners still learn from experience when online. In J. Stephenson (Ed), Teaching and Learning Online: Pedagogies for New Technologies (pp.1-15). London: Kogan Page.

Allee, V. (undated). Knowledge Networks and Communities of Practice. OD Practitioner Online, 32 (4), pp.1-12. World Wide Web (http://odnetwork.org/odponline/vol32n4/knowledgenets.html).

American Association of Collegiate Registrars and Admissions Officers (ACCRAO) (1998). AACRAO Policy Summit: Virtual Learning Environments. Washington, United States: AACRAO.

Andrews, T. & Ferman, T. (2001). The flexible learning experience – how good is it really? In L. Richardson & J. Lidstone (Eds), Flexible Learning for a Flexible Society. Proceedings of ASET-HERDSA 2000 Joint International Conference (pp. 39-45). Toowoomba, Qld: ASET and HERDSA. World Wide Web (http://cleo.murdoch.edu.au/gen/aset/confs/aset_hersa2000/cd/pdfs/AndrewsT_012_LC.pdf).

Babbie, E. R. (1998). The practice of Social Research (8th ed.). Belmont: Wadsworth Publishing Company.

Barajas, M. & Owen, M. (2000). Implementing Virtual Learning Environments: Looking for Holistic Approach. Educational Technology & Society, 3 (3), pp.39-48.

Barclay, K. (2001). Humanizing Learning at a Distance. Unpublished doctoral thesis, Saybrook Graduate School, Holualoloa. World Wide Web (http://www.stratvisions.com/dissertation/dissertation.html/).

Benbunan-Fich, R. & Hiltz, S. R. (1999). Educational Applications of CMCS: Solving case studies through Asynchronous Learning Networks. Journal of CMC, 4 (3). World Wide Web (http://www.asusc.org/jcmc/vol4/issue3).

Bennet, J., Case, D., Sandelin, J. & Smith, M. (1984). Visual Display Terminals: Usability Issues and Health concerns. New Jersey: Prentice Hall, Inc.

Berg, G. A. (2000). Human Computer Interaction (HCI) in Educational environments: Implications of Understanding Computers as media. Journal of Educational Multimedia and Hypermedia, 9 (4), pp.349-362.

Bevan, N. & Macleod, M. (1994). Usability measurement in context. Behaviour & Information Technology, 13(1), pp.132-145.

Bevan, N. (1999). Quality of Use: Meeting user Needs for Quality. Journal of System and Software. World Wide Web (http://www.usability.serco.com/research/publications.htm).

Bevan, N., Kirakowski, J. & Maissel, J. (1991). What is Usability? Paper presented at the 4th International Conference on HCI, Stuttgart. World Wide Web (http://www.usability.serco.com/papers/whatis92.pdf).

Blatt, L., Jacobson, M. & Miller, S. (1994). Designing and equipping a usability laboratory. Behaviour & Information Technology, 13 (1), pp.81-93.

Bonaventura, S., Baldi, F., Alfano, M., Mirabelli, M., Antkowiak, J. & Dehnel, A. (1999). Testing user perceived multimedia communication quality using realistic tasks. European Institute for Research and Strategic Studies in Telecommunications (EURESCOM), Project P807 Report. World Wide Web (http://www.eurescom.de/~public-webspace/P800-series/P807/results/Acceptability/R2/D2-T4-Acceptability-R2-RealisticTasks.pdf).

Bowman, D. A., Gabbard, J. & Hix, D. (2002). A Survey of Usability Evaluation in Virtual Environments: Classification and Comparison of Methods. In Presence: Teleoperators and Virtual Environments, 11 (4), pp.435-455.

Brooks, D. W. (1997). Web-Teaching: A Guide to Designing Interactive Teaching for the World Wide Web. New York: Plenum Press.

Carroll, J. M. (1997). Human Computer Interaction: psychology as a science of design. Annual Review of Psychology, 48 (1), pp.61-76.

Centre for Higher Education (CHED) (Monash University). (undated). Flexible Learning Guide nr 1. World Wide Web (http://www.adm.monash.edu.au/ched/resources/reports/reports.html).

Church, G. M. (1999). The Human-Computer Interface and Information Literacy: Some basics and Beyond. Information Technology and Libraries, 18 (1), pp.3-31.

Clegg, S. & Steel, J. (2002). Flexibility as Myth? New Technologies and Post-Fordism in Higher Education. Paper presented at the Networked Learning Conference, University of Sheffield. World Wide Web (http://www.shef.ac.uk/nlc2002/proceedings/index.htm).

Cooper, J., Genturk, N. & Lindley, R. A. (1996). A sociotechnical approach to smart card systems design: an Australian case study. Behaviour & Information Technology, 15(1), pp.3-13.

Coventry, L. (undated). Video Conferencing in Higher Education. Institute for Computer Based Learning, Heriot Watt University, Edinburgh. World Wide Web (http://www.agocg.ac.uk/reports/mmedia/video3/video3.pdf).

Czerwinski, M., Cutrell, E. & Horvitz, E. (undated). Instant Messaging: Effects of Relevance and Timing. Microsoft Research. World Wide Web (http://www.research.microsoft.com/users/marycz/hci2000.pdf).

Davis, A. J. (2001). Online News and Views on Visual Collaboration and Rich Media. The Wainhouse Research Bulletin, 2 (29), pp.1-7.

De Jager, M. (2002). Usability within the Digital Battlefield: Usability Issues As Applied To the Digitised Battlefield Within A Southern African Military Context, Unpublished masters thesis, University of Stellenbosch.

Edwards, C. (2002). Discourses on collaborative networked learning. Paper presented the Networked Learning Conference, University of Sheffield. World Wide Web (http://www.shef.ac.uk/nlc2002/proceedings/index.htm).

Evard, R. (1993). Collaborative Networked Communication: MUDs as Systems Tools. Paper presented at the Seventh Systems Administration Conference, California.

Fath, J. L., Mann, T. L. & Holzman, T. G. (1994). A practical guide to using software usability labs: lessons learned at IBM. Behaviour & Information Technology, 13 (1), pp.94-105.

Gabbard, J. L., Swan, J. E., Hix, D., Lanzagorta, M., Livingston, M., Brown, D. & Julier, S. (2002). Usability Engineering: Domain analysis Activities for Augmented Reality Systems. Paper presented at the Conference on the Engineering Reality of Virtual Reality 2002, San Josec, California.

Gergle, D., Brinck, T. & Wood, S. D. (2002). Usability for the Web: designing web sites that work. San Diego: Academic Press.

Gongla, P. & Rizzuto, C. R. (2001). Evolving Communities of Practice: IBM Global Services Experience. IBM Systems Journal, 40 (4), pp. 842-862.

Gornall, L., Pengelly, S. & Shearn, D. (1999). Videoconferencing in the Valleys: A case study of the ALPs Projects. University of Glamorgan: Joint Information Systems Committee Technology Applications Programme (JTAP) Report 035. World Wide Web (http://www.jisc.ac.uk/jtap/htm/jtap-o35.html).

Greenberg, S. & Chang, E. (1989). Computer Support for Real-Time Collaborative Work. Paper presented at the Conference on Numerical Mathematics and Computing, Winnipeg, Manitoba.

Haddad, W. D. (2002). Virtual Education: Between Virtuality and Reality. TechKnowLogia, April-June, pp.5-6. World Wide Web (http://www.TechKnowLogia.org).

Harris, R. A. & Niven, J. (2002). Retrofitting theory to practice – a reflection on the development of an e-learning community. Paper presented at the Networked Learning Conference, University of Sheffield. World Wide Web (http://www.shef.ac.uk/nlc2002/proceedings/index.htm).

Hartson, H. R., Andre, T. S. & Williges, R. C. (2001). Criteria for Evaluating Usability Evaluation Methods. International Journal of Human-Computer Interaction, 13(4), pp.373-385.

Haynes, C. & Holmevik, J. R. (2000). MOOniversity: A student's guide to Online Learning Environments. USA: Allyn & Bacon.

Heiman, G. W. (1999). Research Methods in Psychology (2nd edition). Boston, United States: Houghton Mifflin Company.

Hendricks, H. W (1996). Good Ergonomics is Good Economics. Proceedings of the Human Factors and Ergonomics Society 40th annual meeting, South Africa.

Heydenrych, J. (2002). Global Change and the Online Learning Community. TechKnowLogia, April – June, pp.14-17. World Wide Web (www.TechKnowLogia.org).

Hildreth, P. & Kimble, C. (2000). Communities of Practice in the distributed International Environment. Journal of Knowledge Management, 4 (1), pp.27-38.

Hildreth, P. M., Kimble, C. & Wright, P. (1998). Computer Mediated Communications and International Communities of Practice. Proceedings of Ethicomp'98 (pp.275-286). The Netherlands: Erasmus University.

Hill, J. R. (1997). Distance Learning Environments Via the World Wide Web. In B. H. Khan (Ed), Web-Based Instruction (pp.75-80). New Jersey: Educational Technology Publications.

Hix, D. & Hartson. H. R. (1993). Developing User Interfaces: Ensuring Usability through Product and Process. United States: John Wiley & Sons, Inc.

Horton, W. (2000). Designing Web-Based Training: How to teach anyone anything anywhere anytime. New York: John Wiley & Sons, Inc.

Imel, S. (2001). Learning Communities / Communities of Practice. Trends and Issues Alert, 26, pp.1-2. World Wide Web (http://ericacve.org/textonly/tia.asp?sort=year).

JISC Technology Applications Programme (JTAP). (1998). JTAP Project 305 Human-Computer Interface Aspects of Virtual Design Environments for Engineering Education: Application of MUSiC to the evaluation of an existing virtual environment – EDF nuclear power plant demonstration implemented on desktop and panoramic platforms: Experiment 2: Experimental Plan. Loughborough University: Advanced VR Research Centre. World Wide Web (http://www.avrc.lboro.ac.uk/jtap305/reports/JTAP305Expt2Plan.PDF).

Jordan, P. W. (1998). An Introduction to Usability. London: Taylor & Francis.

Kalawsky, R. S. (undated). VR Usability Questionnaire. Loughborough University Advanced VR Research Centre. World Wide Web (www.avrrc.lboro.ac.uk/jtap305/reports/VRUSE.PDF).

Kerlinger, F. N. & Lee, H. B. (2000). Foundations of Behavioural Research (4th edition). New York: Harcourt College Publishers.

Khan, B. H. (1997). Web-Based Instruction (WBI): What Is It and Why Is It?. In B. H. Khan (Ed), Web-Based Instruction (pp.5-18). New Jersey: Educational Technology Publications.

Kies, J. K. (1997). Empirical Methods for Evaluating Video-mediated collaborative work. Unpublished doctoral thesis, Virginia Polytechnic Institute and State University.

Krawchuk, C. (2000). Usability Requirements for Collaborative Environments. Internet Research Institute, HP Laboraties Bristol. World Wide Web (http://www.hpl.hp.com/techreports/2000/HPL-IRI-2000-2.html).

Laister, J. & Kober, S. (2002). Social Aspects of Collaborative Learning in Virtual Learning Environments. Paper presented at the Networked Learning Conference, University of Sheffield. World Wide Web (http://www.shef.ac.uk/nlc2002/proceedings/index.htm).

Lander, R., Burns, J., & Spence, M. (1999). De Montford University Case Studies in the use and evaluation of Videoconferencing in Teaching and Learning. De Montfort University: Joint Information Systems Committee Technology Applications Programme (JTAP) Report. World Wide Web (http://www.jisc.ac.uk/jtap/htm/jtap-046.html).

Lind, A. (1998). USE (SUMI) questionnaire resource, World Wide Web (http://www.mindspring.com/~alind/USE/IntroductionToUse.html).

Lindsay, M. & Grant, M. (1998). Video Conferencing over Scotland's Metropolitan Area Network. University of Strathclyde: Joint Information Systems Committee Technology Applications Programme (JTAP) Report 024. World Wide Web (http://www.jisc.ac.uk/jtap/word/jtap-035.html).

Marwick, A. D. (2001). Knowledge Management Technology. IBM Systems Journal, 40 (4), pp.814-830.

Mayes, T. (2001). Learning technology and learning relationships. In J. Stephenson (Ed), Teaching and Learning Online: Pedagogies for New Technologies (pp.16-26). London: Kogan Page Limited.

Mayhew, D. J. (1999). The usability engineering Lifecycle: A Practitioner's handbook for user interface design. United States: Morgan Kaufmann Publishers.

Merriam, S. B. & Simpson, E. L. (1984). A Guide to research for educators and trainers of adults. United States: Krieger.

Microsoft Windows *NetMeeting* 3, Resource Kit. (2001). United States: Microsoft Corporation.

Moallem, M. (2001). Applying Constructivist and Objectivist Learning Theories in the Design of A Web-Based Course: Implications for Practice. Educational Technology & Society, 4(3), pp.113-125.

Moran, L. & Myringer, B. (1999). Flexible learning and University change. In K. Harry (Ed), Higher Education through Open and Distance Learning (pp. 57-71). New York, United States: Routledge.

Muirhead, B. (2001). Interactivity Research Studies. Educational Technology & Society, 4(3), pp.108-112.

Mulder, I., Swaak, J. & Kessels, J. (2002). Assessing group learning and shared understanding in technology-mediated interaction. Educational Technology & Society, 5(1), pp. 35-46.

Nachmias, C. & Nachmias, D. (1981). Research Methods In Social Sciences. London: St. Martin's Press.

Nardi, B. A., Whittaker, S. & Bradner, E. (2000). Interaction and Outeraction: Instant Messaging in Action. Paper presented at the AMC 2000 Conference on Computer Support Collaborative Work, Philadelphia, United States. World Wide Web (http://portal.acm.org/citation.cfm?id=358975&dl=ACM&coll=portal).

Naudé, A. M. E. (2001). Interactive Public Relations: The World Wide Web and South African NGOs. Unpublished doctoral thesis, Potchefstroomse University for Christian Higher Education.

Neuman, W. L. (1997). Social Research Methods: Qualitative and Quantitative Approaches. Boston: Allyn and Bacon.

Nielsen, J. & Mack, R. L. (1994). Usability Inspection Methods. United States: John Wiley & Son, Inc.

Nielsen, J. (1993). Usability Engineering. New York: Academic Press.

Oxford dictionary: Readers Digest Illustrated. (1998). Oxford: Oxford University Press.

Pallant, J. (2001). SPSS Survival Manual. Buckingham: Open University Press.

Palloff, R. M. & Pratt, K. (1999). Building Learning Communities in Cyberspace: effective strategies for the online classroom. California: Jossey-Bass Inc.

Patrick, A. S. (1999). The Human Factors of Mbone Videoconferences: Recommendations for Improving Sessions and Software. Journal of Computer Mediated Communication, 4(3), pp.1-37.

Podoski, C. H. (2001). Instant Messaging for Collaborative Learning Environments. Unpublished masters thesis, University of Florida. World Wide Web (www.cise.ufl.edu/~cpodoski/Thesis/thesis.ppt).

Relan, A. & Gillani, B. B. (1997). Web-Based Instruction and the Traditional Classroom: Similarities and Defferences. In B. H. Khan (Ed), Web-Based Instruction (pp.41-46). New Jersey: Educational Technology Publications.

Rengger, R.E. & Turner, M. C. R. (1988). Employing usability engineering concepts in the evaluation of a CBT/IV workstation. National Physical Laboratory Report, NPL Report 117/88.

Romiszowski, A. J. (1997). Web-Based Distance Learning and Teaching: Revolutionary Invention or Reaction to Necessity? In B. H. Khan (Ed), Web-Based Instruction, (pp.25-37). New Jersey: Educational Technology Publications.

Rubin, J. (1994). Handbook of Usability Testing: How to plan, design and conduct effective tests. New York: John Wiley & Sons, Inc.

Ryan, S., Scott, B., Freeman, H. & Patel, D. (2000). The Virtual University: The Internet and Resource-based Learning. London: Kogan Page.

Schnetler, J., Stoker, D. J., Dixon, B. J., Herbst, D. & Geldenhuys, E. (1989). Survey Research Methods and Practice. A Revised Edition. Pretoria, South Africa: Human Sciences Research Council.

Schweigert, W. A. (1998). Research Methods in Psychology: A Handbook. Pacific Grove, United States: Brooks/Cole Publishing Company.

Sempsey, J. (1995). The Psycho-social Aspects of Multi-User Dimensions In Cyberspace: a review of the literature. World Wide Web (http://www.netexas.com/~james).

Shackel, B. & Richardson, S. (1991). Human Factors for Informatics Usability. Cambridge: Cambridge University Press.

Shackel, B. (1981). The Concept of Usability. IBM Software and Information Usability Symposium, 15-18 September, 1981.

Shneiderman, B. (1987). Designing the User Interface: Strategies for Effective Human-Computer Interaction. USA: Addison-Wesley Publishing Company.

Smola, K. Schwager, P. Sutton, C. & Uzumeri, M. (1999). A design for encouraging communities of learners in a combined on-campus and distance-learning MBA classroom. World Wide Web (http://www.paulschwager.com/pubs/SMA1999.pdf).

Stenmark, D. Turning Tacit Knowledge Tangible. (2000). Paper presented at the 33rd Hawaii International Conference on Systems Sciences (HICSS33), Muai, Hawaai. World Wide Web (http://www.viktoria.se/results/result_files/140.pdf).

Stephenson, J. (2001). Learner-managed learning – an emerging pedagogy for learning online. In J. Stephenson (Ed), Teaching and Learning Online: Pedagogies for New Technologies (pp.218-224). London: Kogan Page Limited.

Synnes, K., Soderstrom, T. & Parnes, P. (2001). Learning in Desktop Video-Conferencing Environments. http://www.cdt.luth.se/pvt/publications/2001/WebNet2001.PDF

Tam, M. (2000). Constructivism, Instructional Design, and Technology: Implications for Transforming Distance Learning. Educational Technology & Society, 3(2), pp. 50-60.

Technikon SA (TSA) (2001). From Correspondence to Flexible Learning: Thoughts on Educational and Institutional Change at Technikon SA. Johannesburg: Technikon SA.

Tiffin, J. & Rajasingham, L. (1995). In search of the Virtual Class: Education in an Information Society. London: Routledge.

Ubon, A. N. & Kimble, C. (2002). Knowledge Management in Online Distance Education. Paper presented at the Networked Learning Conference, University of Sheffield. World Wide Web (http://www.shef.ac.uk/nlc2002/proceedings/index.htm).

University of Stellenbosch (US) (2000). The University of Stellenbosch: A Strategic Framework for the Turn of the Century and Beyond. Stellenbosch: University of Stellenbosch.

University of Stellenbosch (US) (2001). Universiteit van Stellenbosch: 'n Kwantumsprong in die verdere ontwikkeling van die e-kampus. Stellenbosch: University of Stellenbosch.

University of Stellenbosch (US) (2002). Report of the Proposed Programme and Qualification mix for the years 2002-2006. Stellenbosch: University of Stellenbosch.

US Kampusnuus (2002). E-Kampus Projek van die US. 8 Augustus, p.4.

Wade, W. (1994). Introduction to Wade, W., Hodgkinson, K., Smith, A. & Arfield, J. Flexible Learning in Higher Education. London: Kogan Page.

Webb, B. R. (1996). The role of users in interactive systems design: when computers are theatre, do we want the audience to write the script? Behaviour & Information Technology, 15 (2), pp.76-83.