The technology and operational readiness of students for mobile learning at a South African Higher Education Institution

by

NALINDREN KISTASAMY NAICKER

submitted in accordance with the requirements for
the degree of

MASTER OF SCIENCE

In the subject

INFORMATION SYSTEMS

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF T M VAN DER MERWE

OCTOBER 2013

DECLARATION BY CANDIDATE

I declare that ***the technology and operational readiness of students for mobile learning at a South African Higher Education Institution*** is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references.

____

Candidate Signature

Date: 22 October 2013

This work has not previously been accepted for any Masters Degree, and is not being concurrently submitted for any other Masters Degree.

____

Candidate Signature

Date: 22 October 2013

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the following people for their contribution during the course of this study:

- Firstly to God, for granting me the strength, health and courage to embark on such a significant milestone in my life;
- To my supervisor, Prof T. M. van der Merwe for his patience, guidance, support and constructive criticism during this project;
- To my parents the late Mr K. Naicker and Mrs D. Naicker for their inspiration, motivation, prayers and support throughout my life;
- To my wife Gayshree Naicker and daughter Thishalia Naicker for their patience, understanding and encouragement;
- To Durban University of Technology for giving me financial assistance encouragement and support to complete this study; and
- To the students at Durban University of Technology for taking time to answer the questionnaire and participate in interviews.

ABSTRACT

Recent accessibility drives and price wars between the major South African (SA) cell phone companies suggest that the landscape for the adoption of mobile learning (m-learning) at the Higher Education Institution (HEI) level may be changing. As such, there is a need to gauge the current mobile readiness of students for m-learning. Mobile technology readiness refers to the extent to which students have access to mobile devices (not only handsets), and can afford data bundles that meet or exceed the requirements of a base set of currently available m-learning applications (Naicker and Van der Merwe 2012). Mobile operational readiness refers to students' awareness of, attitude towards, support and training that is required for m-learning. This study conducted an assessment of the technology and operational readiness of students at a SA HEI.

An in-depth literature survey was undertaken to delineate technology and operational readiness of students for m-learning. For technology readiness, an investigation was conducted on m-learning applications that are currently available and the technology requirements of these mobile applications. This was undertaken to determine the extent that the current student mobile handset profile match these requirements. The literature review also included a search for mobile operational factors such as students' awareness of and attitude towards m-learning as well as m-learning support and training that students require.

The philosophical underpinning of this study was based on Activity Theory. The strategy of inquiry employed was a case study approach. Data was collected from students at the Durban University of Technology, a resident based SA HEI. A mixed methods data collection strategy was employed. The researcher used a field survey questionnaire as the primary research instrument to assess mobile technology and operational readiness. Focus group interviews were used as a secondary data gathering tool to triangulate and strengthen the results.

The results were presented using descriptive and inferential statistics and were analyzed using the lens of activity theory. In terms of technology readiness, despite a high level of ownership and reasonable compliance with application requirements, data costs remain prohibitive. In assessing operational readiness, despite a positive attitude, the majority of the students require awareness, ongoing support and training. Several recommendations based on the findings are offered. For example, one of the findings showed that mobile connectivity affordability was low amongst students and it is recommended that the HEI work around exorbitant connectivity costs by combining m-learning technologies to form meaningful m-learning approaches at a minimum *cost. Another finding showed low awareness of m-learning at the HEI. A recommendation advanced to combat this finding is for the HEI to encourage and support dialogue among key stakeholders. This study concludes that any m-learning endeavour to implement m-learning at this HEI is bound to fail as only a small percentage of students are aware of m-learning and can afford data bundles to implement m-learning in its true sense. As an implication of this study to other HEI's, the researcher suggests that regular mobile readiness surveys be conducted.*

Key Terms:

access; affordability; data bundle costs; graphic displays; global positioning systems; mobile learning applications; mobile device ownership; mobile internet connectivity; mobile learning; operational readiness; support; student handset profile; technology readiness.

LIST OF FIGURES **PAGE**

LIST OF TABLES **PAGE**

LIST OF TABLES **PAGE**

ABBREVIATIONS OR ACRONYMS

App/s	Application/s
CALL	Computer Assisted Language Learning
e-Learning	Electronic Learning
GPS	Global Positioning System
HEI	Higher Education Institution
IM	Instant Messaging
LMS	Learning Management System
MAC	Mobile Adaptive Call
mb	Megabyte
MIS	Management Information System
m-learning	Mobile Learning
MMS	Multimedia Message Services
No.	Number
PDA	Personal Digital Assistant
PIM	Personal Information Management
UNESCO	United Nations Educational, Scientific and Cultural Organization
UK	United Kingdom
USA	United States of America
RSS	Really Simple Syndication
SA	South Africa/South African
SMS	Short Message Service
WAP	Wireless Application Protocol
WLAN	Wireless Local Area Network

TABLE OF CONTENTS PAGE

TABLE OF CONTENTS PAGE

TABLE OF CONTENTS **PAGE**

Chapter Four

TABLE OF CONTENTS PAGE

1. INTRODUCTION

Contents **Page**

1.1 Introduction to the chapter

Statistics show mobile handset ownership in many parts of the world outweigh that of personal computers sometimes by as much as five or ten to one (Prensky 2004). This global trend is particularly evident in Africa, where mobile handset ownership is amongst the highest in the world (Andaleeb et al. 2010: 2768). In South Africa (SA), mobile handset penetration is the highest in Africa with seventy two percent of youth between the ages of fifteen and twenty four owning mobile phones (Beger and Sinha 2012). For the reason that ownership of mobile devices opens up opportunities to reach a wider audience for higher education (Zawacki-Richter, Brown and Delport 2009), most higher education intuitions (HEI's) have taken an active interest in mobile learning (m-learning) solutions.

In SA, however, m-learning has yet to progress to the point where it can be considered a conventional teaching and/or learning approach. Two reasons are advanced for the current status quo. Firstly, m-learning is a relatively new phenomenon, with its theoretical, educational and technological structure still in development (Brown 2004). As such, there is a research fixation on resolving the 'how' of m-learning. Secondly, as Esselaar and Stork (2005: 64) as well as Ford and Batchelor (2007) note, the rapid growth of mobile handset ownership in SA is, at least, partially due to the immense popularity of prepaid subscriptions and low-cost phones. Despite a high level of mobile handset penetration, SA remains a developing country and issues such as affordability and accessibility result in the average mobile handset having basic functionality only. The inferences we draw from their statements are that students do not own or have access to advanced mobile handsets and/or data bundles to purposefully engage in m-learning activities.

However, recent accessibility drives and price wars between the major SA cell phone companies suggest that the landscape may be changing. Not only are advanced mobile devices such as tablets and smart phones available on competitive contract terms, but the cost of data bundles are also decreasing at a rapid rate, for example, in 2010, the price of a 500 mb data bundle ranged from R150 to R189 (Muller 2010) while in 2013 the same size data bundle can be obtained for as little as R49 (Hellkom 2013). For these reasons, the adoption of m-learning at HEI's currently appears more viable than it has been the case in the past.

However, it is important for HEI's to evaluate the readiness of students for m-learning before implementation of this technology (Ford and Batchelor 2007). Other reasons for a m-learning readiness assessment, proposed by Basole and Rouse (2007: 484), are that a mobile readiness assessment will provide organisations with valuable information on the latest mobile technologies and how these technologies fit within the organization. Such knowledge will enable management to make decisions around infrastructure, costs and how suitable the technology is to the organisation's purposes.

Various other research studies have been conducted globally on m-learning readiness. In their investigation, Abas, Peng and Mansor (2009: 153) showed that a mobile readiness study should consider the extent of ownership of a mobile phone, willingness to purchase a mobile device and preparedness to subscribe to more mobile services. Attewell, Savill-Smith and Douch (2009: 4) advocate that careful planning, preparation and training are required when introducing mobile technology. In determining students' readiness for m-learning, Trifonova, Georgieva and Ronchetti (2006: 85,86) report that students' attitude to m-learning, ownership of mobile devices (not only mobile handsets) and students' use of mobile technology are important to consider. Stockwell (2008: 253) proposes attitude as a factor that can prevent a student from using a mobile phone for learning, while Cheng and Tsai (2011: 150) identify support provided for m-learning by the HEI as another factor that can promote m-learning readiness.

These research studies on m-learning readiness support the contention that there are a variety of factors that must be considered before any decision can be taken on the feasibility of m-learning implementation.

1.2 Statement of the problem

The dilemma facing HEI's is to determine the m-learning readiness of their students before implementing this flexible learning approach (Trifonova, Geotgieva and Ronchetti 2006). As such there exists a need to gauge the current mobile technology readiness of students for m-learning, where mobile technology readiness refers to the extent to which students have access to mobile devices (and not only handsets), and can afford data bundles that meet or exceed the requirements of a base set of currently available m-learning applications. Implicit to a mobile device in the context of m-learning is the ability of the hardware to achieve internet connectivity. These technology readiness factors can present a hindrance to m-learning readiness if they are not satisfied and thus require further examination.

Factors outside technology readiness factors are clustered as "operational readiness" factors. There exists a need to gauge mobile operational readiness, where operational factors such as students' awareness of, attitude towards, support and training required for m-learning are not known by HEI's. Although there are various other operational readiness factors for m-learning, such as willingness of staff to use m-learning, these four operational factors chosen represent the minimum initial indicators for m-learning readiness and therefore require further investigation. They can present very real obstacles to m-learning readiness and must be satisfied for successful implementation of this learning approach.

A search of the literature has revealed that, although a few mobile readiness studies that pertained specifically to one or more mobile readiness factors of students such as mobile services used, availability of mobile devices, attitude to m-learning and affordability have been conducted internationally, no research studies have been conducted on the technology and operational readiness of students for m-learning at any SA HEI. Ample scope thus exists for current research into this area.

1.3 Objective and research questions

The objective of the research can be stated as follows:

> ***To establish the technology and operational readiness of students for m-learning at a SA HEI.***

To achieve the above objective the following key research questions were formulated:

1. **Technology readiness**
    a. *What m-learning applications are currently available?*
    b. *What are the technology requirements of these m-learning applications?*
    c. *To what extent does the current student mobile handset profile match these requirements?*

2. **Operational readiness**
    a. *What are students' awareness of and attitude towards m-learning?*
    b. *What m-learning support and training do students require?*

    The literature review will elaborate on why these four variables were chosen as operational readiness factors for students.

1.4 Significance of the study

This study will assist HEI's to:

- Prepare m-learning programmes that take their students' level of technology and operational readiness into consideration.

1.5 Scope of study/delimitations

The scope of this study is on the necessary readiness conditions pertaining to students for successful m-learning implementation.

A delimitation that will confine the boundary of the research is that this research study excludes usability problems related to the use of mobile devices.

1.6 Research methodology

In order to find meaningful answers to the research questions described in section 1.3 above, a fitting research design and associated methodology is required. The purpose of the study is to determine the technology and operational readiness of students at a SA HEI for m-learning. While m-learning is part of an educational process, the research questions focus on issues related to students' readiness to use m-learning technology. This study, therefore, positions itself primarily in the field of Technology Education. The two main approaches available to the researcher in the field of Technology Education are a quantitative approach and a qualitative approach (Johnson and Daughterty 2008: 22). Both these approaches will be employed in this study.

The research approach is described in greater detail in Chapter 3.

1.7 Research output produced

Part of this study was presented by the researcher as a peer reviewed paper at the *14th Annual conference on World Wide Web Applications*, 7-9 November 2012 in Durban, SA. The paper was titled:

Mobile Learning in Higher Education: a Study of the Technology Readiness of Students at a South African Higher Education Institution (Naicker and Van der Merwe 2012).

1.8 Permission from the Higher Education Institution

The research setting was Durban University of Technology, a residential HEI based in Kwa Zulu-Natal. The researcher requested permission in writing from the Research Management and Development Directorate of the HEI to conduct the research study with the students. The Directorate was informed of the type of study being conducted. A letter granting permission to conduct the research was issued to the researcher by the Directorate. Once permission to conduct the research was granted by the HEI Directorate, ethical clearance was obtained. Thereafter, a subject information letter was distributed to the targeted population to create awareness.

1.9 Structure of the dissertation/thesis

This study is presented in five chapters, which are arranged in the following manner:

CHAPTER ONE provides a general background and orientation to the study. The problem statement, objective of this study, key research sub-questions, significance of the study, the scope of the study, research output produced, permission from the HEI, structure of the thesis as well as the roadmap for the research study are presented.

CHAPTER TWO will comprise the literature review of m-learning readiness as addressed by the main objective and the key research sub-questions. The chapter will review research studies from literature that are associated with technology and operational readiness of students for m-learning.

CHAPTER THREE will outline the research design and methodological paradigm. The underlying philosophical approach is interpretive, and particularly suited to the activity theory. A description of how the data collection and data analysis will be done is provided. This chapter will also deal with the reliability and validity of the research methods that will be used and will discuss the ethical issues that must be considered during data gathering.

CHAPTER FOUR will present the results of the data in response to the critical questions as collated and analysed by the researcher. The results will be discussed using the relevant literature and the underlying theoretical framework. Conclusions will be drawn on the basis of the empirical findings and pertinent recommendations will be made.

CHAPTER FIVE will first present a summary of the study. Thereafter, conclusions of the study, the implications of the study and the gaps for future research in this field of study will be identified and discussed.

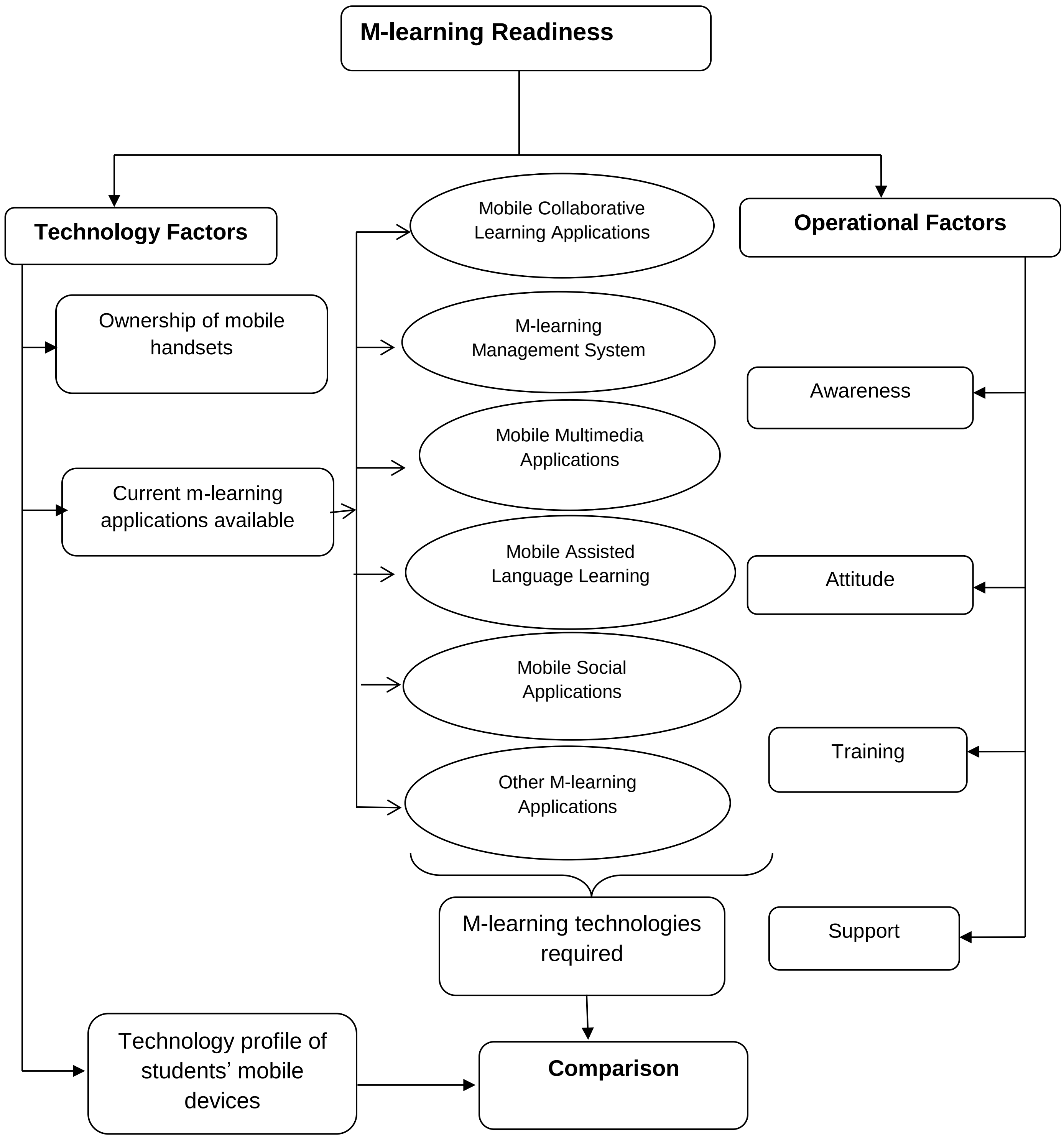
1.10 Referencing Style

The Harvard referencing style will be applied to the research writing. The version used will conform to the Australian Government standard guidelines presented in *Snooks & Co (eds) 2002, Style manual for authors, editors and printers, 6th edn, Wiley & Sons, Australia* as recommended by learning advisers and librarians at Unisa.

1.11 Roadmap for research study

The figure below illustrates the roadmap for the study. It identifies the factors involved in technology and operational readiness for m-learning (see chapter 2).

Figure 1: Roadmap for research study



2. LITERATURE REVIEW

Contents **Page**

2.1 Introduction to the chapter

Chapter 1 provided a general background and orientation to this study. Chapter 2 discusses the relevant literature as it relates to the research problem and key research sub-questions.

M-learning has evolved since its inception. Therefore, the definition of m-learning has transformed over time. As m-learning applications and technologies evolved, new and more advanced technologies became available, hence, it is important to observe changes in the definition of m-learning and the significance it has for this study. This chapter begins with a discussion of the evolution of the definition of m-learning.

Thereafter, the literature review continues with m-learning readiness. By the researcher's own classification, mobile readiness factors in this study are categorized according to technology and operational factors. A literature review on m-learning technologies and the key themes associated with technology and operational readiness of students for m-learning are presented. The purpose of the literature review is to identify the factors associated with m-learning technology and operational readiness in the context of the current study. The chapter concludes with a summary.

2.2 Evolution of the definition of m-learning

In early definitions, the emphasis was more on the technological device and the use of the mobile device, not on the nature of the learning. M-learning was automatically taken to mean electronic learning (e-learning) using a mobile device and, as it developed over the years it was seen as a continuation of e-learning as well as a reaction to the inadequacies and limitations of e-learning (Traxler (2005), cited in Guy (2009: 1)). Quinn (2000), cited in Liu (2009: 309), defined m-learning as "e-learning through mobile computational devices". Another definition of m-learning is that it encompasses any sort of learning that take place when the learner is mobile or learning that happens when the learner takes advantage of the learning prospects offered by mobile devices (O'Malley et al. 2003).

Later, greater emphasis was placed on the mobility of the learning. This definition further evolved as Sharples et al. (2007: 3) unpacked the 'mobile' in m-learning as follows:

- *Mobility in physical space:* people continually on the move trying to cram learning into gaps of daily life or to use those gaps to reflect on what daily life has taught them. The location may be relevant to the learning, or just a backdrop.
- *Mobility of technology*: portable tools and resources are available to be carried around, conveniently packed into a single lightweight device. It is also possible to alternate between different devices, moving from the laptop to the mobile phone, to the notepad.
- *Mobility in conceptual space*: learning topics and themes compete for a person's shifting attention. A typical adult …, so attention moves from one conceptual topic to another driven by personal interest, curiosity or commitment.
- *Mobility in social space*: Learners perform within various social groups, including encounters in a family, office, or classroom context.
- *Learning dispersed in time*: Learning is a cumulative process involving connections and reinforcement among a variety of learning experiences across formal and informal learning contexts.

Sharples, Taylor and Vavoula (2007: 222) proposed a definition of m-learning as any learning that takes place across multiple contexts amongst people through the use of interactive technologies. According to Li (2008), m-learning is ubiquitous where the learner interacts with the learning content and collaborates with peers and instructors through a mobile device. The benefits are convenience, effectiveness and flexibility of learning.

The world's largest and most diverse implementation of m-learning, the Molenet programme (2007-2009), provided a similar definition of m-learning to that of Li (2008), as "the exploitation of ubiquitous handheld technologies, together with wireless and mobile phone networks, to facilitate, support, enhance and extend the reach of teaching and learning" (Attewell, Savill-Smith and Douch 2009: 1).

Common themes in more recent definitions were always-on connectivity, ubiquity, networked communication, not being situated, collaborative learning, blended learning and personalization (Guy 2009: 81). Lominé and Buckhingham (2009) introduced phrases such as 'handheld learning' and 'handheld technology' which are encountered in recent definitions of m-learning. Their emphasis on the 'hand' highlighted the shift from e-learning to a more portable paradigm through mobile technological devices.

This study adopts the more recent definition of m-learning proposed by Sharples et al. (2007) and Li (2008) on page 10 that emphasizes the mobility of learning. The mobility of learning is made possible through current m-learning applications and the technologies required to use m-learning applications.

These technologies required to use m-learning applications are outlined in the section below.

2.3 A review of mobile technologies

Attewell, Savill-Smith and Douch (2009: 39) assert that "there is a constant stream of new technology breaking into the mobile phone market" therefore better and more robust mobile applications can be built. These technologies are:

- Video delivery technologies;
- Audio delivery technologies;
- Text delivery technologies;
- Communication network technologies;
- Graphic displays;
- Downloadable programs;
- Internet browser (HTTP);
- Video recording camera;
- Picture camera;
- Global Positioning Systems (GPS);
- Java support;
- Hardware technologies;
- Multimedia technology; and
- Other smaller software applications.

Each of these technologies and their associated services are discussed in the following sections:

2.3.1 Video delivery technologies

Video delivery technologies used in mobile instruction environments offer video podcasting (vodcasting), screen recordings, screen casting, video files running from a website, still image display and video conferencing services (Dickerson and Browning (2009), cited in Guy (2009: 61).

From an online global survey, Zawacki-Richter, Brown and Delport (2009: 1) showed that video technologies are rated as an important technology on a mobile device for students. An example of the importance of this technology for m-learning could be seen in a ground-breaking project, Education through technology, operating in 150 Tanzanian schools (Kasumuni 2011). The programme enabled teachers to download educational videos to mobile handsets. Learners, who viewed the videos, attained better test results.

2.3.2 Audio delivery technologies

Audio delivery technology includes point-to-point calling, conference calling, internet protocol calling, audio podcasting, internet protocol streaming of content delivery and audio mail services (Dickerson and Browning 2009, cited in Guy (2009: 61)). The findings of the study by Zawacki-Richter, Brown and Delport (2009) showed that podcasting is a significant service on a mobile device for students. Podcasting and the voice/audio feature and their significance to m-learning are briefly discussed below:

2.3.2.1 Podcasting

According to Cebeci and Tekdal (2006: 47), podcasting can be characterised by two main features, namely, "it is an audio content delivery approach based on web syndication protocols such as [Really Simple Syndication] (RSS) and podcasting", which aims to circulate content to be used on mobile devices. McGarr (2009: 309) states:

> Podcasting has seen significant growth in education in recent years driven by claims of its value in supporting m-learning and enhancing the student's experience. In higher education, podcasts are used

> frequently to deliver information that was once the preserve of the traditional lecture.

The following benefits of podcasts in m-learning as highlighted by McGarr (2009: 310), namely, the distribution of content in audio formats provides greater flexibility to learners, course material is now more accessible to learners and increased use of podcasting can enhance academic results.

2.3.2.2 Voice/Audio

The voice/audio features on mobile phones enables users to make voice calls anywhere and anytime. This feature allows for direct interaction and communication among students in m-learning. More than this benefit, it allows students to learn about any subject through voice recordings, for example, in the UK, voice recordings were used to teach school dropouts with language problems and, in another example, one could dial a cell phone number in Japan for short English lessons (Prensky 2004). This technology available on mobile phones makes teaching and learning portable and suitable for busy students (Liu 2009).

2.3.3 Text delivery technologies

Text delivery services include text-based content via email, text messaging, instant messaging (IM), wikis, blogs/microblogs as well as text-based content via web pages (Guy 2009: 62). Text delivery technologies, such as email and IM, make online chatting on a mobile device possible (Liu 2009). There are various reasons for the popularity of text messaging, such as cost, convenience and time savings (Srivastava 2005: 121). Text delivery technologies, such as text messaging, have become very popular within the deaf community (Srivastava 2005: 122). Short Message Services (SMS), Multimedia Message Services (MMS) and IM are briefly discussed below:

2.3.3.1 Short Message Services and Multimedia Message Services

Mobile phones have facilities and features to "create, send, receive, view, edit and organize SMS [and] MMS" (Guy 2009: 83). SMS is a technology used for the delivery of short messages over the mobile networks. Using SMS technology one can store and forward text messages to and from mobiles. "The message (text only) from the sending mobile is stored in a central short message center which then forwards it to the destination mobile. This means that in the case that the recipient is not available, the short message is stored and can be sent later" (Gupta 2010). SMS's can be sent and received via the wireless network service. SMS technology is important to m-learning as it provides a convenient way for students to chat as well as send/receive notifications (Gupta 2010). Simple content can be delivered to the student and support for the interaction between students and lecturers or among students is provided by this technology (Liu 2009). Liu (2009) states that SMS technology integrated with the learning management system can be used to send course notifications to the user. Idrus and Ismail (2010: 2768) cited a South African study involving the use of SMS technology for course notification. The majority of the students had access to mobile phones. SMS's were successfully utilized for basic administrative support in the three teaching training courses offered by the teaching and learning unit at the HEI.

The Zawacki-Richter, Brown and Delport (2009: 8) study reported that SMS's are the highest rated service for communication and interaction for students on mobile devices when compared to other services such as voice and email. Srivastava (2005: 121) concurs with this finding when he observes that, among young people, there is a distinctive preference for SMS over voice calls. According to Srivastava (2005: 121), a survey conducted by an insurance company in the United Kingdom (UK) revealed that eight out of ten people under the age of 25 prefer to send someone a text message rather than call them because it is less intrusive and cost effective.

MMS is a technology that can deliver learning content and has multiple ways of presenting information. MMS can deliver packages of simple text, picture, sounds, animation or blended multimedia (Liu 2009). Liu (2009) advises that the drawback of MMS technology for m-learning is that older mobile phones cannot support this technology and it is expensive when sent and received via email. He asserts that Bluetooth offers a cheaper option to send and receive MMS's. The most common use of MMS technology is picture messaging. Camera phones are used increasingly to take photos for immediate delivery to a mobile recipient. Other possibilities include animations and graphic presentations of stock quotes, sports news, and weather reports (Rouse 2007).

SMS and MMS technology proves to be convenient ways of communicating. As such these technologies are extremely valuable to m-learning.

2.3.3.2 Instant Messaging

Rouse (2007) states that IM is the exchange of text messages amongst users through a software application in real-time using a computational device. According to Godwin-Jones (2005: 17), IM, a popular means of communication, is as ubiquitous to the youth as email. The benefits of IM for m-learning include savings on telephone costs, improved communication in real time, enhanced collaboration and information archiving (Messagelabs 2008). Kuittinen (2012) states that WhatsApp is an example of a very popular instant messaging application that delivers 10 billion messages each day of which 4 billion are inbound messages and 6 billion are outbound messages. IM has proven to be a popular way of communicating and interacting amongst people and is therefore an important technology for m-learning.

2.3.4 Communication network technologies

Mobile devices together with communication networks provide support for m-learning (Leung and Chan 2003). Georgiev, Georgieva and Smrikarov (2004: 1-5) advocates that communication technologies that are potentially valuable for m-learning are Bluetooth technology, Institute of Electrical and Electronic Engineers 802.11 (IEEE 802.11) standard and the Third Generation (3G) mobile telecommunications standard.

2.3.4.1 Bluetooth Technology

Bluetooth technology can be used to provide data transmission rates with ranges less than 100 meters between devices such as computers, mobile phones and other Bluetooth enabled devices (Georgiev, Georgieva and Smrikarov 2004: 3,4). Although Bluetooth can be considered as a wireless local area network (WLAN), it is more generally used to transfer data between devices (Caudill 2007: 9). There are no connectivity costs associated with this technology.

2.3.4..2 IEEE 802.11

IEEE 802.11 standard is the most widely used mobile networking technology and is commonly known as Wi-Fi (Caudill 2007). Wi-Fi uses a series of wireless access points referred to as hotspots, “which are transmitter/ receiver stations that wireless devices can connect to via their own Wi-Fi networking card” (Caudill 2007: 9). Georgiev, Georgieva and Smrikarov (2004: 3) state that Wi-Fi is a type of radio technology used for WLAN’s. Mobile devices can connect to

WLAN's at Airports, University Campuses, hotels and hospitals with a range of less than 100 metres (Zhang, Ansari and Tsunoda 2010: 32). Generally, the cost of Internet connectivity is paid by the provider of the WLAN. Thus, learning is cost effective, flexible and can take place in an environment that is comfortable (Caudill 2007: 10).

2.3.4.3 Third Generation (3G) mobile telecommunications

The 3G mobile standard, one of the most popular communications standards, allows download speeds of up to 144 megabits per second and the increase of 3G network coverage allows higher total internet connectivity (Pocatilu and Pocovnicu 2009: 63). According to Georgiev, Georgieva and Smrikarov (2004: 4), 3G systems provide true global mobility and global compatibility and are in widespread use. The aim of the 3G system is to provide a wide range of services, including telephony, paging, text messaging, multi-media messaging, voice messaging, video streaming and broadband internet with email capability (Caudill 2007). These services are potentially valuable for m-learning. The costs associated with this technology for m-learning is the purchasing of data bundles by the student for internet and email usage (Liu 2009).

Therefore, multiple communication network technologies are available to a user for m-learning. These communication network technologies have different transmission rates, network coverage and costs associated with them (Leung and Chan 2003). When utilising a communication network technology, one must select a network technology that is most suitable, for example, it is more suitable to transfer a file via Bluetooth when the receiver is in close proximity than using 3G because of the distance and cost savings considerations or when on a field trip it may be more suitable to use 3G than Wi-fi. However, Sarker and Wells (2003: 37) warn that the lack of responsiveness of the network (downtime) and reliability will contribute significantly towards users not being able to trust the wireless communication technology.

In summary, the choice of the communication network technology will depend on the availablity, suitability and cost.

2.3.5 Graphic Displays

Advanced graphic displays on mobile handsets provide support for m-learning. High-resolution displays allow for significant amounts of text accompanied with pictures and animation to be displayed (Prensky 2004). Owing to more advanced graphic displays, electronic textbooks (e-texts) are viewable on a mobile phone, thereby adding greater functionality than does an electronic-book reader (Guy 2009: 84).

2.3.6 Downloadable programs

Modern mobile phones, especially smart phones, have increased storage and memory capacities that allow mobile applications and learning content to be downloaded at the convenience of the user. These include voice, text, graphics, and multimedia (Prensky 2004).

2.3.7 Internet Browser (HTTP)

Mobile phones capable of internet connectivity have internet browsers installed to make educational applications, such as a thesaurus, dictionary, and encyclopedia, instantly available to every student (Prensky 2004).

Pocatilu and Pocovnicu (2009) state that some mobile internet browsers, such as Apple's Safari, are vendor specific. The following features of the iPhone Safari outlined by Pocatilu and Pocovnicu (2009: 65) are:

> Browse web pages as they were designed to be seen in computer-based browsers; zoom in and out; switch to wide view; built in search using Google and Yahoo; email, phone number and address links open mail, phone or maps on iPhone; play supported multimedia files and open multiple pages at the same time.

These features are potentially valuable for m-learning, since support for multimedia applications, such as YouTube, is provided (Nations 2013). Pocatilu and Pocovnicu (2009: 65) also identify popular non-vendor specific internet browsers such as Pocket Internet Explorer, Opera Mini, Skyfire and Iris.

Pocket Internet Explorer has features similar to the desktop version. It provides support for tables, frames and forms and can resize a web page on handheld devices to maximise viewing, preventing the user from scrolling across the page. Opera Mini has all the functionality of a desktop browser and allows support for video, upload and download of files, saving web pages for offline access and viewing web pages in landscape mode (Pocatilu and Pocovnicu 2009: 65).

Skyfire can be downloaded at no cost and has the look and feel of a desktop browser. The desktop user is given the similar experience in the mobile environment. The features of Skyfire as outlined by Pocatilu and Pocovnicu (2009: 65) which are useful for m-learning are: It can play any video, it can allow browsing of any page and it supports popular social networking sites like Facebook and Twitter. Finally, the Iris web browser is advanced, giving users on mobile devices the complete online experience. Core features of Iris are touch screen control, advanced html and cascading style sheet support, zoom and tap function, pop-up blockers, landscape mode, multiple windows and tabs (Pocatilu and Pocovnicu 2009: 65).

When looking for a browser, Nations (2013) advises that the good browsers can display most websites, offer page zoom and keyboard shortcuts and are distinguished from browsers that can only display websites optimised for mobile devices.

2.3.8 Video Recording Camera

Mobile phones have video recording facilities to capture video clips. According to Ulbricht (2010), students in the journalism and creative movie making fields will require this technology. He states that it is becoming the trend for a journalist to record video and transfer content from their mobile phones to their newsrooms via mobile network connections.

The video recording camera has great value in other areas of m-learning, especially in field trips. It allows students to record location specific data while they are in the field and later analyse and reflect on this data (Fitzgerald 2013). Another useful application of using video clips for m-learning is that it is an excellent way to learn and teach correct and incorrect behaviours in subjects such as ethics, science, negotiation and medicine (Prensky 2004).

2.3.9 Picture Camera

“The quality of digital images captured by camera phones has been substantially enhanced, from the original 110 kilobyte pixel camera to the 2 mega-pixel mobile camera phones in Japan and Korea” (Srivastava 2005: 117). Today, smart phones, such as the Samsung Galaxy S4, have a camera facility that offers higher resolutions of 13 mega-pixels (Spoonauer 2013). Students use a mobile phone with camera functionality in multiple areas for the purposes of m-learning such as documentation, visual journalism for gathering evidence, collecting and classifying images as well as following progressions over time (Prensky 2004). Photos taken on a mobile phone can inspire students' creative writing and oral presentations. The mobile phone camera can be used to great benefit in the teaching and learning of science, especially for scientific data collection (Wishart 2011: 16-30). A further application of this facility for m-learning is its use on field trips and presentations (Sharples et al. 2007).

2.3.10 Global Positioning Systems (GPS)

Global Positioning System (GPS) functionality available on mobile phones use satellites that orbit the earth's surface to calculate and display the accurate location, speed, and time information to the user (Zahradnik 2012). This technology, through its capabilities, is used to great effect in teaching and learning subjects like geography, science, mathematics, archeology, architecture and other subjects (Prensky 2004). This technology has great value in m-learning.

2.3.11 Java Support

Java capability on mobile devices is integrated by the device manufacturer (Fitton 2007). Java support on mobile phones means that some form of Java Platform Micro Edition (J2ME) run-time environment is provided (Fitton 2012). Java support enables interactivity which is used extensively in gaming applications playable on mobile phones (Godwin-Jones 2005: 18). There are hundreds of popular java applications (apps) that are valuable for m-learning, such as calculator apps, spreadsheets apps, mobile email apps, Skype apps, Instant messaging apps, maps and web browser apps (WapSoft.Net 2010).

2.3.12 Hardware technologies

According to Pocatilu and Pocovnicu (2009: 65), older model mobile phones have a screen size of between 1-2.5 inches, with minimum processing power and between 1-32 megabytes of memory. Recently, smart phones with advanced functionality have flooded the market.

A smart phone is characterised as a device with an operating system designed for installing additional software, on-demand connectivity to the World Wide Web (WWW) via a network provider, a memory slot for data and applications, touch screen interface and a miniature QWERTY keyboard (Cheung, B, McGreal and Tin 2010). The screen size of a smart phone can be between 2.5 to 4 inches with processing power between 144 to 620 megahertz and between 32 to 512 megabytes of memory (Pocatilu and Pocovnicu 2009: 65). Considering the features, smart phones are better suited for multimedia applications. Smart phones have bigger storage for movies and music; they can run educational software applications such as an electronic dictionary and are equipped with Personal Information Management (PIM) (Li 2008). Smart phones have become popular and a LMS can be integrated with smart phone technology providing greater support for m-learning (Forment, Guerrero and Poch 2009: 182).

A wide variety of smart phones offering impressive battery performance, great audio quality, large memory and storage, software maturity and other applications are available in the market place from various mobile phone manufacturers (Hellkom 2013). HEI’s must dictate what is required and what is feasible, based on a study like the current one.

2.3.13 Multimedia Technology

Multimedia refers to the combinations of audio, text, video, animation, still images and interactive features presented in electronic formats on computational devices (Loretto 2012). Students can pre-load multimedia learning content such as documents, pictures, audio and movie clips on their mobile device, and play it using a media content player at their convenience (Liu 2009). In this way learning can take place at any time, such as when waiting for a bus or on their way to campus or on a field trip.

2.3.14 Other Smaller Software Applications

Mobile phone manufacturers include smaller software applications on mobile phones in order to add extra value to their products (Liu 2009). Many of these smaller software applications can be used for m-learning. Such applications include the memo pad, calculator, word processor, spreadsheet, presentation software, voice recorder, reminders, alarm clock, games, phone book, calendars and media files (Nokia 2013).

Technology readiness factors are addressed next.

2.4 Technology Readiness

The m-learning literature abounds with frameworks and indices to gauge many forms of technology readiness. It is apparent that the term technology readiness holds different meanings for researchers. Parasuraman and Colby (2001: 308) provide the original taxonomy of technology readiness in the form of a Technology Acceptance Model (TAM) that focuses on the propensity to adopt or embrace technology in home life or work. Technology readiness for Wagner, ED (2005) means the provision of technology and support to educators, as well as the need to assess and consider the awareness of and acceptance of m-learning. Basole and Rouse (2007: 484) advocate a m-learning Technology Readiness Index (MLRI) that refers “to the ability of the underlying technology infrastructure (network services, hardware, software, and security) to support the adoption and implementation of mobile [Information and Communication Technology] (ICT)”. Abas, Peng and Mansor (2009: 151) propose technology readiness to mean the extent of ownership of mobile devices and the readiness to be a mobile learner. Andaleeb et al. (2010: 190) also advocate a technology readiness index that measures the extent of ownership of mobile devices.

The position that this research study takes with regard to technology readiness is aligned with Abas, Peng and Mansor (2009) as well as Andaleeb et al. (2010: 190), who describe device ownership as an important first requirement for m-learning readiness. Mobile device ownership is further elaborated in the next section.

2.4.1 Mobile device ownership

Naismith and Corlett (2006), as cited in Sharples et al. (2007), identify device ownership as a critical success factor for m-learning. Corbeil and Valdes-Corbeil (2007: 51-58) investigated students’ m-learning readiness at the University of Texas. The study examined device ownership amongst other m-learning readiness factors. Despite finding that most students own a mobile phone, they found that ownership itself does not mean that students or instructors are ready for m-learning and teaching. The mobile device should possess features and functionality such as internet and email that support m-learning approaches. Thus, ability of the mobile device to implement meaningful m-learning approaches needs to be questioned.

Thornton and Houser (2005: 218-219) conducted a survey among HEI students in Japan to determine their use of mobile devices. They found that all students owned a mobile phone, however, the type and models of students' mobile handsets varied, with some having more multimedia capabilities than others. They also reported that, in Japan, all newer models of mobile phones have internet and email facilities. Interestingly enough, email was the most used mobile phone feature in Japan. Considering that better support was shown for m-learning in terms of device ownership as well as features and functionality required by m-learning approaches, this study showed more positive signs for m-learning successes.

Although device ownership appears to be the first logical requirement for technology readiness, device ownership does not necessarily imply that the device is m-learning ready. 'Device readiness', as embodied in the use of the term 'technology readiness', stresses the capacity of a mobile device to run a required base set of available m-learning applications, as well as owner means to afford the data bundles required by m-learning approaches. For this reason, the establishment of the technology requirements for a base set of currently available m-learning applications is an important next requirement. The next section presents the technology requirements of available m-learning applications.

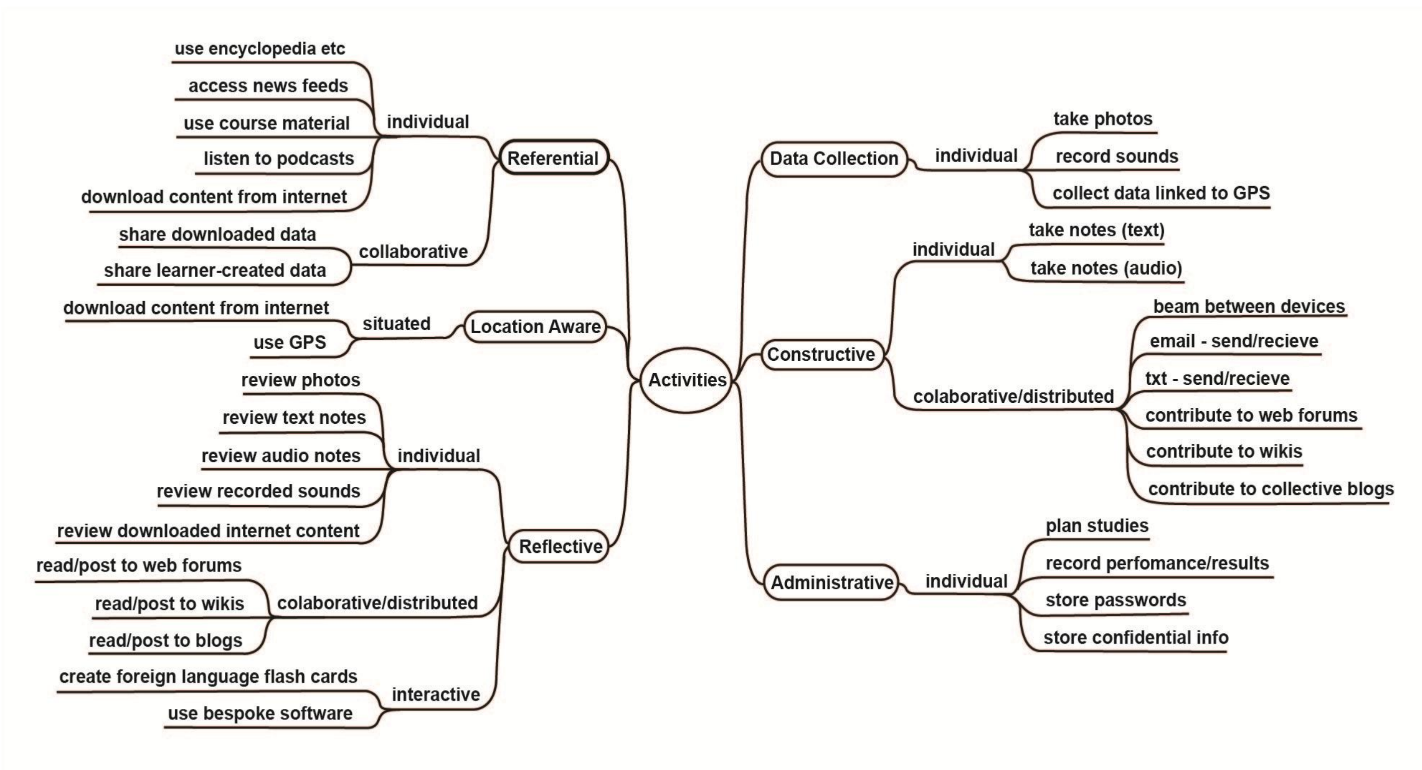
2.4.2 Technology requirements of available m-learning applications

Rapid advances in mobile device technologies have resulted in a continuous development of diverse and advanced m-learning applications, inclusive of collaborative learning applications, learning management systems, multimedia applications, assisted language learning, social applications, learning activity management, proactive learning management applications, mobile context-aware applications and mobile data collection applications (Trifonova, Georgieva and Ronchetti 2006).

Clough et al. (2008: 364) propose a framework (refer to figure 2) for categorizing mobile applications in terms of their ability to support formal and informal learning. They place m-learning applications into six categories based on their pedagogical function. The main categories identified are referential, location aware, reflective, data collection, constructive and administrative. They further identify five qualifiers within each category, namely: individual, collaborative, situated, distributed and interactive, with each category having a combination of qualifiers embedded in it. Qualifiers have informal learning activities associated with them, for example, an individual data collection activity can involve taking photos and a referential collaborative activity can involve sharing downloaded data.

Learning activities, characterized as referential, make use of referential applications such as e-books and dictionaries. Location aware applications, for example, use GPS to provide information relevant to a location. This application is useful when touring. Reflective activities allow learners the opportunity to reflect on something they encountered, for example, individual reflective activities involve reviewing content downloaded from the internet. Collaborative reflective activities include reading and contributing to groups such as wikis, web forums and group blogs. Data collection refers to recording data and information about the environment using a mobile device. The mobile device camera is an example of a device that can be used to support learning. The constructive category refers to activities in which knowledge is created or constructed by learners, either alone or in collaboration with others. Recording of thoughts, impressions, experiences and ideas using voice recorders to later reflect upon and structure them is an example of how ideas are sorted into a coherent representation. Administrative activities allow users to organize themselves, for example, the calendar functionality can be used by students on a daily basis as a reminder for meetings/consultations with supervisors and mentors.

Figure 2: Framework for categorizing mobile applications



Source: Clough et al. (2008: 364)

The Clough et al. (2008) framework is extended in the following section by considering various types of m-learning applications required to participate in the activities, as shown in the framework model above.

2.4.2.1 Types of m-learning applications

The review of m-learning applications harvested from various literature resources is ordered under 'types of m-learning applications'. These 'types of m-learning applications' are a base set of mobile applications categorized according to the framework of Clough et al. (2008: 364), framework shown in figure 2 above.

2.4.2.1.1 Mobile Collaborative Learning Applications

The first type of m-learning applications, *Mobile Collaborative Learning Applications,* allows students to engage in learning through interaction using a mobile device (Martin et al. 2010: 1). In collaborative learning, discussions among participants is essential and tools for synchronous and asynchronous communication must be available (Lundin and Magnusson 2003). Collaborative synchronous tools, such as Voice Over Internet Protocol (VOIP), IM and collaborative asynchronous tools such as web forums, chats, blog entries, email, texting built into applications or as standalones, offer ample opportunities for communication and learning among groups (Clough et al. 2008: 361). Generally, mobile collaborative tools are extensively used by students to support intentional informal learning (Clough et al. 2008: 361, 364).

Mobile Collaborative Learning Applications also provide opportunities for discussion and collaborative knowledge construction. In a study by Wei and Chen (2006: 923), a novel e-book interface allowed students to collaborate by entering queries on text where questions arose. These questions were sent to a mobile web forum. According to the level of students learning progress and based on the type of queries they posted, a mentor could answer questions or locate peers to answer the questions. Students could access the mobile discussion forum anywhere and anytime. The results showed that the increased interaction of students with peers and mentors benefitted them considerably. The mobile technologies required in mobile collaborative learning applications are email clients, IM, Short Message Services (SMS), wikis, blogs and chats (Martin et al. 2010).

2.4.2.1.2 M-learning Management Systems

According to Forment, Guerrero and Poch (2009: 183), a conventional *Learning Management System (LMS)* is software used by HEI's to provide a common educational platform where all academic services, online content and learning applications are centralised and managed, while Cavus (2011: 1469) describes a LMS as a software application that instructors use to create and support learning in respect of a particular course or learning programme. Learning takes place remotely at the convenience of the student. Example of tasks that students engage in when using a LMS are taking online tests, sharing resources with instructors and peers, uploading assignments, collaborating with peers, accessing their marks and accessing course content.

A m-learning management system is ubiquitous and interoperates with electronic learning platforms (Martin et al. 2010: 1). A mobile LMS application accesses the functionalities of the institution's LMS through a specific application or a mobile web browser (Trifonova and Ronchetti 2003). Blackboard Mobile Learn is a proprietary LMS that is compliant with Blackboard's e-learning LMS (Forment, Guerrero and Poch 2009: 182). The Blackboard Mobile Learn application gives HEI students access to course notifications and learning content on a variety of mobile phones including Android, Blackberry and iPhone (Blackboard website 2011). Moodle is an example of an open source e-learning LMS. When using Moodle on a smart phone, usability is reduced since a mobile Moodle page is rendered as a one-column layout because of the screen size constraint (Cheung, SKS, Yuen and Tsang 2011). Forment, Guerrero and Poch (2009) cautions that, with regard to a LMS, a mobile device is only suitable to perform specific tasks such as retrieving specific information or making updates when there are small amounts of data entry from the mobile device.

Any mobile LMS must also manage learner activities that take place in environments outside the classroom setting, for example, on field trips such as visits to a museum to observe artifacts or collect specimens on a science expedition. The student must be connected to the m-learning activity management system so that he/she can be updated on his/her location, can have access to course material and have access to information on demand, such as on an unknown artifact or specimen (Leung and Chan 2003). A student, when changing from one location to another during a field trip, can retrieve real-time information about the weather and traffic (Leung and Chan 2003).

The success of m-learning activity management is dependent on cost, wireless infrastructure reliability and students' level of comfort with the new technology (Leung and Chan 2003). Learning can take place independently of other people. Knowledge-based databases used to troubleshoot typical problems and study-flow maps that guide routine actions are examples of m-learning activity management systems. A m-learning activity management system provides performance support on demand and supplies the steps required to accomplish a learning task (Leung and Chan 2003).

A further development in LMS's is *Proactive Learning Management Applications*. According to Leung and Chan (2003), proactive learning management applications collect information on students' needs and then alert the learning system to proactively provide information and knowledge to prepare the student for skills needed in future lessons. This is achieved by collecting information about the student when he/she is accessing and interacting with the learning management application on the mobile device. Information on what a student is doing, including areas of weakness, is collected by the application. This kind of information can be used by Instructors to better manage lecture content in the future via the learning system. Students who may need a specific kind of skill and knowledge can be targeted (Leung and Chan 2003). Advanced communication and collaboration technologies are necessary to utilize this technology.

Forment, Guerrero and Poch (2009) states that, in order for mobile LMS's such as mobile Moodle, Blackboard, Sakai to work successfully, a student would need a mobile phone that has J2ME, a mobile web browser, email clients, text messaging, MMS or a smart phone.

2.4.2.1.3 Mobile Multimedia Applications

The third type, Multimedia Mobile Applications, is applications that require a large amount of memory. The speed together with the memory capacity of the mobile device are important for the application's performance (Pocatilu and Pocovnicu 2009: 66). The memory capability is measured in terms of Random Access Memory (RAM) and storage. Pocatilu and Pocovnicu (2009: 65,66) confirmed that smart phones tend to be better suited to mobile multimedia applications, as opposed to older models of mobile phones.

According to Pocatilu and Pocovnicu (2009: 64), a multimedia mobile application uses a combination of audio, video, text and images to provide more benefits to the end user and are used mostly in applications like simulations, animations and games.

Mobile multimedia applications require the following mobile technology profile, namely: mobile internet browsers, mobile content media players, sufficient phone memory, additional storage, internet connectivity and large enough screen sizes (Pocatilu and Pocovnicu 2009: 65,66).

2.4.2.1.4 Mobile Assisted Language Learning (MALL)

The fourth type of mobile application is *Mobile Assisted Language Learning Applications* which create interaction between the user and the learning content. It allows the user to listen to sound tracks, watch short video clips and read electronic-books (Liu 2009). Multimedia cell phones promote language learning applications (Chinnery 2006: 9). In language learning, features such as mobile internet, voice and text messaging, audio playing and recording as well as video playing and recording are required on a mobile phone to enable access to content, uploading a completed task and language learning practise (Chinnery 2006: 10).

Uther et al. (2005) developed a mobile application in the field of Computer-Assisted Language Learning (CALL) called Mobile Adaptive CALL (MAC) designed for assisting Japanese students to learn how to speak English. In the design of mobile applications for language learning, they identified three main critical technological areas, namely: the user interface, handset selected and audio encoding software.

According to Liu (2009: 309), m-learning is very suitable for language learning as language learning takes place over time and requires practise to enhance learning. Using mobile devices language learning can take place at leisure, informally in places such as hotels and trains where students can practise independent of space and time. Mobile language applications help to improve students' language ability as it focuses on grammar, speaking, reading, listening and writing skills (Liu 2009: 310).

Audio and video technologies, such as podcasts and vodcasts, are useful for foreign language learning as it helps students understand meaning within certain contexts through sound and animation (Thornton and Houser 2005: 224). M-learning language applications create interaction between the user and the learning content, allowing the user to listen to sound tracks, read electronic-books and watch short video clips (Liu 2009).

Mobile language applications require the following mobile technologies on mobile devices: text messaging, MMS, Wireless Application Protocol (WAP), email clients, internet connectivity, media players and access to the institution's mobile portal on the web (Liu 2009: 311).

2.4.2.1.5 Mobile Social Applications - Mobile Web 2.0

The fifth m-learning application type is *Mobile Social Software Applications*. Web 2.0 applications such as Facebook, YouTube, Skype and Twitter are actively used in e-learning (Brett 2009: 282). There has been an evolution from web 2.0 to mobile web 2.0 (M-web 2.0) where similar applications are available for use in a m-learning environment. Popular examples of such mobile applications are facebook, twitter, blogs, wikis and podcasts.

M-web 2.0 is the era of m-learning that emerged from traditional m-learning which focused on m-learning through mobile social software (MoSoSo) applications (Guy 2009: 88). It is read, think, write, talk and infotainment / edutainment platforms that support students' mobility. This form of learning is in a constant state of flux. It consists of technologies that enable mobile learners to generate their own content and engage in multiple participatory social learning services and practices. These advanced services include moblogs, podcasts, mobile social networks, mashups and Really Simple Syndication (RSS) (Guy 2009: 88).

Moblogs mentioned above are "websites on which anyone can post pictures taken with mobile phones, instantly, with or without descriptive text or comment" (Srivastava 2005: 118). Srivastava (2005: 118) states that many students are using moblogs for learning amateur photo journalism, especially after major events. RSS allows students to subscribe to learning content, download them to their mobile phones and view them offline (Liu 2009).

Another mobile social application, Mobile Video Experience (MoViE) is an application where video stories can be created by users on their mobile phones (Multisilta et al. 2010: 216). The video clips can be uploaded using a mobile phone allowing students to share their experiences with peers and instructors.

M-web 2.0 has a wide range of educational value and marks the trend towards lifestyle learning (Guy 2009: 79). It conveniently satisfies learning 'anytime and anywhere'.

2.4.2.1.6 Mobile Context-Aware Applications

The sixth type of m-learning application is *Mobile Context-Aware Applications*. One major application of context-aware applications is to act as personal guides to support tours through various venues (Raento, Oulasvirta, Petit & Toivonen 2005:51). Museums can use these applications to assist users when they take tours to see exhibits in the order they desire (Long et al. 1996). Other uses of context-aware mobile applications, elaborated by Long et al. (1996), are for the handheld devices to act as multilingual dictionaries which provide assistance to tourists in foreign countries. The mobile phone can be used as electronic guidebooks during walking tours of cities or historical sites. According to Raento et al. (2005: 51), smart phones are the best platform for using context-aware applications because they are programmable and often use well known operating systems. Context-Aware Mobile Applications require the following technology on the mobile device (Raento et al. 2005: 52,53): Connection to external services via standard internet protocols using General Packet Radio Service (GPRS), Bluetooth transfers, SMS, MMS and GPS.

2.4.2.1.7 Mobile Data Collection Applications

The final type of m-learning application is *Mobile Data Collection Applications*. "Unlike bulk messaging and general information services that target the general public as recipients of standardized messaging, mobile data collection applications are often used internally in an organization, and are customized to fit with existing organizational processes" (Loudon 2009). He advocates that mobile data collection applications can be used to handle large quantities of data. In this way they can replace manual processes and represent a new organisational process. As an example, flexible forms with different types of fields represent a data collection set, and are stored in a repository as templates. On the mobile device, these templates could be queried and opened for data collection. In the study by Loudon (2009) during an outdoor activity students filled forms and the results were stored on the mobile device. The collected data using the mobile data collection application on the mobile phone was then uploaded into the HEI repository and used for further processing (Loudon 2009). Mobile Data Collection Applications require the following technology on the mobile phone (Giemza, Kunte and Hoppe 2010): internet connectivity, J2ME application, SMS, Bluetooth and GPS.

Following the review of mobile applications available, table 1 on page 30 represents an updated version of the framework of the Clough et al. (2008). The columns for 'Category', 'Qualifier' and 'Activities' were imported directly from the framework of Clough et al. (2008) in figure 2. The 'Category' column was amended to include the type of mobile application available based on the literature review in section 2.4.2.1. It should be noted that some applications can fit into more than one category, for example, multimedia mobile applications and mobile social software could be appropriately placed in the category constructive application (see table 1).

The 'technologies required' column added to the table was extracted from the literature review on each type of mobile application discussed in section 2.4.2.1. For example, collaborative mobile applications require technologies such as email, Bluetooth and SMS for the activities. Finally, the 'Data bundle requirements' column was added to estimate the size of the data bundle for the technologies required, for example, email requires a medium sized data bundle.

In summary, based on the above review and on the researcher's perception of data bundle requirements per activity/application, table 1 is synthesized to offer an updated version of the framework of Clough et al. (2008: 364) presented in tabular format.

Table 1: Updated version of Clough et al. (2008) framework

Category	Qualifier	Activities	Technologies required	Data bundle requirements
Referential **Type:** ***Collaborative mobile application***	Individual	Use encyclopaedias, access news feeds, use course material, listen to podcasts etc.	*PDF-readers, e-book readers, audio player, dictionaries*	*Medium data bundle, Medium data bundle, Medium data bundle, Medium data bundle*
	Collaborative	Share downloaded data, Share learner created data	*email facilities, Bluetooth, SMS*	*Medium data bundle, Low data bundle, None*
Location aware **Type:** ***Context-aware mobile application***	Situated	Download content from internet, Use GPS	*GPS, media player*	*Large data bundle, None*
Reflective **Type:** ***Collaborative mobile application, m-learning language applications***	Individual	Review photos, Review test text notes, Review audio notes, Review recorded sounds, Review downloaded internet content	*Adv. Graphic Display, Audio recording, Audio player, Memo pads, Presentation Program*	*None, None, None, None, None*
	Collaborative/ Distributed	Read/post to web forms, Read/post to wikis, Read/post to blogs	*MMS, Mobile Web 2.0 tools*	*None, Large data bundle*
	Interactive	Create foreign language flash cards, Use bespoke software	*e-book readers, memo pads*	*Large data bundle, None*

Category	**Qualifier**	**Activities**	**Technologies required**	**Data bundle requirements**
Data Collection **Type:** ***mobile data collection applications***	Individual	Take photos, Record sounds, Collect data linked to GPS	*Audio recording ,* *Camera facility,* *Java Support*	*None,* *None,* *Medium data bundle*
Constructive **Type:** ***multimedia mobile applications, mobile social software***	Individual	Take notes(text), Take notes(audio)	*Audio recording,* *Memo pads*	*None,* *None*
	Collaborative/ Distributed	Beam between devices, Email-send/receive, Contribute to web forums, Contribute to wikis, Contribute to collective blogs, Use bespoke software	*Email,* *Instant messaging,* *SMS,* *Video conferencing,* *Conference Calling,* *Mobile Web 2.0 tools,* *bespoke software*	*Large data bundle,* *Large data bundle,* *None,* *Large data bundle,* *None*
Administrative **Type:** ***m-learning management systems***	Individual	Plan studies, Record performance/results, Store passwords, Store confidential information	*Calendars & Contacts,* *Memo pads,* *Spread sheets,* *Presentation Program*	*None,* *None,* *None,* *None*

The interpretation of the data bundle requirements was based on the researcher's experience in using the majority of applications presented here on smart phones, tablets and personal computers in non m-learning settings. It is acknowledged that the m-learning approach selected ultimately determines the final data bundle requirements. For example, downloading a Word document, as opposed to a compressed PDF file, greatly increases data usage and cost. For this reason, the data bundle requirements stated presents an absolute minimum.

Device readiness furthermore stresses the owner's means to afford data bundles. In the next section, the cost of locally available data bundles is examined.

2.4.2.2 Data bundle costs

While research studies show that mobile device ownership amongst students is generally high, the exorbitant costs associated with mobile technology and device ready handsets is an expected deterrent to m-learning (Trifonova, Georgieva and Ronchetti 2006). By correlating the data bundle requirements in table 1 to cost, one can see in table 2 the medium to large data bundle costs from available network operators in SA, as extracted from the Hellkom (2013) website on the 12 May 2013. Hellkom is a website designed to educate people locally and globally on the state of telecommunication in South Africa. In this regard, they make public factual, statistical and financial information.

Table 2: Data bundle costs

Network	Bundle	Type	Cap	Speed	Price	OOB	IBR	Spread
8ta	**8ta-Internet 1** No device included.	1	650MB	3.6Mbps	R150.00	R0.30	R0.23	21.67MB
8ta	**8ta-Internet 1** Includes 3G USB Modem. Free SIM and connection.	12	650MB	3.6Mbps	R165.00	R0.30	R0.25	21.67MB
Cell C	**Cell C-Smartdata 250MB** Data bundle for Contract, Top-up and Prepaid customers.	prepaid	250MB	21.6Mbps	R100.00	R0.40	R0.40	8.33MB
MTN	**MTN-300MB** Includes 3G USB Modem.	24	300MB	21.6Mbps	R149.00	R0.50	R0.50	10.00MB
Neotel	**Neotel-NeoConnect Prime 1GB**	prepaid	1GB	2.4Mbps	R279.00	R80.00	R0.28	33.33MB
Telkom	**Telkom-Do 3G 500MB**	prepaid	500MB	7.2Mbps	R149.00	R0.30	R0.30	16.67MB
Telkom	**Telkom-Do 3G 500MB + Huawei E220 Modem**	24	500MB	7.2Mbps	R178.58	R0.30	R0.30	16.67MB
Virgin Mobile	**Virgin Mobile-Prepaid 250MB**	prepaid	250MB	21.6Mbps	R150.00	R0.60	R0.60	8.33MB
Virgin Mobile	**Virgin Mobile-Prepaid 500MB**	prepaid	500MB	21.6Mbps	R300.00	R0.60	R0.60	16.67MB
Vodacom	**Vodacom-MyMeg 250 Standard** Out of bundle rate on prepaid is R2/MB.	prepaid	250MB	21.6Mbps	R99.00	R2.00	R0.40	8.33MB
Vodacom	**Vodacom-MyMeg 175 Advanced** In-bundle and out-of-bundle rates are the same. Contract, Top Up and Prepaid customers pay the same rate per bundle.	24	175MB	21.6Mbps	R129.00	R0.74	R0.74	5.83MB
Vodacom	**Vodacom-MyMeg 175 Advanced** In-bundle and out-of-bundle rates are the same. Contract, Top Up and Prepaid customers pay the same rate per bundle.	prepaid	175MB	21.6Mbps	R129.00	R0.74	R0.74	5.83MB
Vodacom	**Vodacom-MyMeg 500 Standard** Out of bundle rate on prepaid is R2/MB.	prepaid	500MB	21.6Mbps	R149.00	R2.00	R0.30	16.67MB

Source: Adapted from Hellkom (2013)

The columns in the table above represent the network operators, the bundle offered, the type of data bundle (1, 12, 24 months or prepaid), the size of the bundle (Cap), the network speed, the price of the bundle, the Out of Bundle Rate (OOB), the In Bundle Rate (IBR), and the number of megabytes available per day if the bundle was to last for 30 days (spread).

The above table shows listings of data bundles for 8ta, Cell C, MTN, Neotel, Virgin Mobile and Vodacom. Data bundle types are listed as monthly contracts and prepaid. The largest data bundle is 500mb. Both Vodacom and Telkom offer the cheapest 500mb data bundle at a cost of R149. The smallest data bundle is 175mb. Vodacom offers this data bundle at a cost of R129. Vodacom also offers the cheapest data bundle from the list provided. This is a 250mb bundle at a cost of R99 on a prepaid option with a daily spread of 8.33mb.

It is important to note that the spread appears to be extremely low across bundles with the average spread being 14.6 mb, with the exception of Neotel (33.3mb), which, besides a limited coverage area, is the most expensive bundle. The researcher's immediate concern, based on personal data usage experience, is that the daily bandwidth available (spread) is severely limited. Keeping with the example of a PDF file, and despite best efforts at optimization, it is not uncommon for file sizes to approach 5mb when complex images are included. This is more than two-thirds of the spread available on the most inexpensive package. Data bundle cost is a critical factor in this study to assess whether the mobile connectivity is affordable for students and can be a major determinant for m-learning readiness.

The next section summarizes important criteria for technology readiness, as highlighted in the preceding literature review.

2.4.3 Summary of technology readiness

Mobile technology readiness for the HEI's would refer to the extent to which students have access to mobile devices (not only handsets), and can afford data bundles that meet or exceed the technology requirements of a base set of currently available m-learning applications (Naicker and Van der Merwe 2012). Implicit to the context of m-learning is the ability of the mobile device/hardware to achieve internet connectivity. Students that have mobile handsets with no internet connectivity cannot engage in advanced m-learning activities such as browsing information from websites or downloading content or collaborating using email and Instant Messaging (IM). The next section explores operational readiness factors for m-learning.

2.5 Operational Readiness

Operational readiness relates to mobile readiness factors other than technical factors that are considered important for m-learning. In order to identify such factors, the next section of the literature review evaluates the m-learning readiness for non-technical factors.

2.5.1 Attitude and Awareness of Students

Various research studies have shown that attitude and awareness are important non-technical m-learning readiness factors. Trifonova, Georgieva and Ronchetti (2006: 85) reported two critical findings related to the awareness and attitude of students towards m-learning. They found that students indicated a willingness to use m-learning and further, students that utilized the HEI's e-learning platform were more positive towards m-learning.

Mobile Education (MobilED) was a three-year international collaborative project conducted in SA to create meaningful learning environments using mobile phone technologies and services (Ford and Batchelor 2007). The study wanted to measure the attitude and awareness of school going learners from different socio-economic backgrounds. The use of mobile phones was investigated in an advantaged private school and a poor government school. The study found that learners from both socio-economic backgrounds had a positive attitude towards m-learning and spontaneously engaged with the mobile device. Their positive attitude also enabled them to significantly reduce the time required to familiarize themselves with the mobile device provided (Ford and Batchelor 2007).

Ozdamli (2012: 44) investigated student attitudes towards m-learning according to geographic area and socio-economic status in North Cyprus. He concluded that students are positive about m-learning and there are no significant differences in attitude between students from different socio-economic backgrounds. However, students' attitude towards m-learning differed according to geographical locations. He attributed this to m-learning and mobile technology competencies of students being better in one area compared to the other. He has encouraged further research in this area.

An online international survey was conducted by Zawacki-Richter, Brown and Delport (2009: 41) on student awareness and attitude to m-learning. A significant finding of the study was that the general attitudes of respondents were very positive towards m-learning enhancing their academic performance. Students were also of the opinion that m-learning makes learning more convenient and spontaneous than e-learning. When mobile technologies are used effectively, learning can take place in different environments. Zawacki-Richter, Brown and Delport (2009: 42) reported that students perceive the following activities as being most important to m-learning: being connected anywhere, anytime; accessing learning content; assisting with notifications; collaborating with others; and assistance provided in field work.

Cavus (2011: 1470), in a study carried out at Near East University, in Cyprus, wanted to find out what student perceptions were on new learning technologies. The results showed that students displayed a positive attitude towards new technologies in learning such as m-learning. The majority of students found the m-learning environment enjoyable and revealed that, to improve student awareness of m-learning, it is important for them to collaborate. The study also reported that collaborative learning can only take place if communication tools are provided. The benefits of mobile technologies such as MMS, email and video conferencing can only be felt if the device is in the hands of students. Furthermore, the study showed that the more mobile technologies presented to students the better their motivation.

In summary, the literature review indicates that, although mobile phones are widely possessed, students' awareness of its capabilities and a positive attitude towards m-learning would motivate them to use the device. In conclusion, awareness and a positive attitude from students are important for m-learning to be successful.

Other non-technical readiness factors such as training and support are reviewed below.

2.5.2 Training and Support for Students

Various research studies have highlighted the importance of training and support. Naismith et al. (2006), in providing guidelines for effective implementation of m-learning, identified training and support as factors for the effective implementation of m-learning. They further advised that it is important for institutions to provide training and support by having designated staff other than academic staff to deliver ongoing training and support for m-learning.

Hackemer and Peterson (2005), cited in Kukulska-Hulme (2007: 7) asserted that most software applications lack formal usability testing and documentation and this results in very few students being willing to explore applications in order to understand how they could be used. Scholars seem to agree that one can have the best technology, but what must go hand in hand with this technology is technical support (Kukulska-Hulme 2007: 8).

It is incumbent on the institution to ensure that support is provided for the student before embarking on m-learning programmes. Naismith and Corlett (2006), as cited in Sharples et al. (2007), identified institutional support as a critical success factor for m-learning. In this regard, Corlett et al. (2005: 163) described the trial of a m-learning organiser that was used by HEI students in Birmingham. The primary uses of the organiser were communication, time-management and accessing content.

In a survey, students were asked questions about the features and functionality of the organiser for m-learning. The results of the survey revealed that students felt that the institution should provide support and training sessions for use of the organizer for m-learning. Naismith and Corlett (2006) identified that the areas for support and training were in accessing content, communication and receiving administrative information. Training on the usability of mobile devices, tools and technologies was identified as being important.

Support can also be made possible by the mobile application software. Economides (2008: 468) advises that Institutions designing m-learning programmes should ensure that mobile applications have built-in support mechanisms for students. In this regard Economides (2008: 468) states:

> M-learning applications should react to the students' actions appropriately and at the right moment. The feedback provided by the application would aim at informing (eg. advising on content, helping on assessment, guiding or navigation, supporting on collaboration, notifying on events and activities), alerting (eg. reminding on deadlines, warning on danger), or motivating (eg. attracting learner's attention, stimulating, challenging, provoking, building confidence, assuring, encouraging, praising, relaxing) the learner. There should be a variety of support facilities within applications [for example], searching, communication, collaboration, sharing, glossary, dictionary, Frequently Asked Questions (FAQ), bibliography, references, links, help and documentation.

Over and above the support m-learning applications can provide, Cheng and Tsai (2011:155) suggest that HEI students should be encouraged to seek help through the internet when they encounter problems. They advocate that the institution provide online help to enhance students' motivation and give students an opportunity to make enquiries when they experience difficulties.

According to Attewell (2005), proactive support plus ongoing access to advice is helpful when implementing m-learning. In the Trifonova, Georgieva and Ronchetti (2006: 89) readiness study, it was reported that all students expect strong support for a wide variety of services.

Corlett (2005:23) propose that, as the focus shifts from conventional classroom teaching, it is the responsibility of the institution to ensure the success of m-learning by providing students with the required skills and opportunities to succeed as mobile learners. Trifonova, Georgieva and Ronchetti (2006: 89) agree that the future of m-learning is bright, though lots of support is required to satisfy students' high expectations to ensure a high rate of utilization.

In summary, the review revealed that support and training must be offered to students who are new to m-learning. The literature review has shown that support and training to address non-technical factors are important for m-learning implementation. Hence, in this study, it is important to assess if the student requires help desk support and/or online support and if the student requires training on handset functionality and/or use of m- learning tools.

The summary of operational readiness is presented in the next section.

2.5.3 Summary of operational readiness

The operational readiness factors as highlighted in the extant of literature in this study are summarized below:

- Awareness of m-learning;
- Attitude towards m-learning;
- Training required for m-learning; and
- Support needed for m-learning

This study will assess m-learning readiness by taking into account the current operational readiness of students. The next section concludes with a summary of the chapter.

2.6 Chapter Summary

A survey of the literature into the technology and operational readiness of students for m-learning was presented. The focus of this chapter was to highlight the literature as it relates to the research objective and key research sub-questions. The chapter began with a look at the definition of m-learning and how it has evolved. The recent definitions of m-learning that have been adopted by this study are those of Li (2008) who reported that although m-learning takes place through a mobile device its focus is on the nature of the learning. Thus, the mobility of the learning is highlighted.

As such an in-depth analysis on the various mobile technologies available was conducted. These technologies were listed and briefly discussed. The literature also pointed out the different services associated with each technology and how they are related to m-learning. Thereafter, the different types of m-learning applications currently available were reviewed and the technologies that these applications require were outlined. Mobile technologies such as text, audio, video and communication technologies featured prominently as requirements of m-learning applications.

To assess technology readiness, the literature review investigated mobile device ownership and the survey showed that the mobile device is widely possessed both locally and globally. While mobile phone ownership was high, the exorbitant costs associated with mobile technology could be a deterrent to m-learning as some studies suggest. Data bundle costs of the different mobile network operators were compared and this showed that not only ownership of a mobile device was important but affordability is also an important factor that affects the technology profile of students and, hence, technology readiness.

Mobile phones, with advanced features and functionalities, could be utilized as multi-purpose teaching and learning devices. The features and functionality of mobile handsets are important for m-learning and this study **compares** the technology profile of students' handsets to the technology profile of what is required by mobile applications before conclusions could be drawn on student's m-learning readiness. Therefore, technology readiness was summarized as ownership being the first and foremost technology requirement followed by the fit between the technologies required of mobile applications currently available and the technological profile of student handsets. Implicit are owner means to afford data bundles.

The various factors that influence operational readiness, such as awareness, attitude, support and training were highlighted in the literature survey. In terms of awareness and attitude, the literature review showed that although mobile devices are widely possessed devices, student awareness of its capabilities and a positive attitude towards m-learning would motivate them to use the device. Awareness and a positive attitude by students are important for the success of m-learning and, therefore, must be assessed in this study. Also, to improve operational readiness, the survey showed that it is important to offer training and support to students on the use of mobile technologies related to m-learning.

The literature scan revealed that no local research was conducted on m-learning readiness for students at any SA HEI. Having defined the context of technology and operational readiness as outlined in the literature review, the next chapter describes a programme of research aimed at determining the technology and operational readiness of students at a SA HEI.

3. Research Design and Theoretical Framework

Contents **Page**

3.1 Introduction to the chapter

The previous chapter focused on the literature review as it relates to the purpose of this study by highlighting relevant studies on m-learning readiness. The aim of this study is to establish the technology and operational readiness of students for m-learning at a SA HEI. This chapter focuses on setting out the research design which, according to Creswell (2009), has three components: *a philosophical world view*, *strategies of inquiry* and *research methods*.

In the next section, the philosophical framework is presented.

3.2 Philosophical framework

3.2.1 Activity Theory Overview

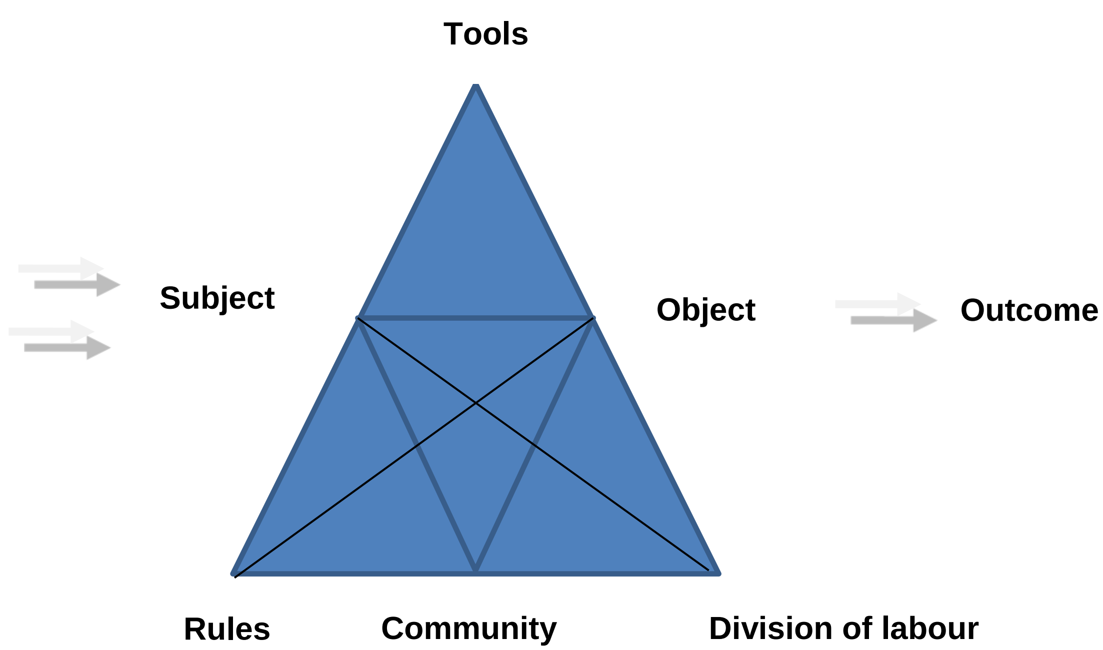
Activity theory is used as the underlying philosophical approach for this study. Two reasons are advanced as to why this theory is well suited to the study. Firstly, the theory "provides a framework for studying different forms of human practices as development processes, with both individual and social levels interlinked at the same time" (Kuutti 1995). The individual and wider social relations underpinning m-learning readiness at HEI's are studied to explain the restrictive and non-transformatory nature of the system towards m-learning readiness. Secondly, activity theory focuses on "contextualized activity of the system as a whole" (Uden 2007: 86). Activity theory considers all people involved in the system within a certain context and not just the learner. Contextualization is achieved by describing the components of the activity system and how they interact (Murphy and Rodriguez-Manzanares 2008: 449). The lens of activity theory was used to analyze the study results and provide insight into the technology and operational readiness of students for m-learning.

Activity theory was postulated by Vygotsky (1978) and Leont'ev (1978) in the Soviet Union as a psychology that focused on analyzing human behaviour in the context of people's daily lives and work practices (Uden 2007: 85). Engeström (1987) formulated and modelled the structure of the activity system as cited by Murphy and Rodriguez-Manzanares (2008: 443) and includes the subjects that interact with other components, namely, object, tools (instruments or artefacts), division of labour, community, rules, and outcomes. The activity system is represented by the classical mediational triangle (figure 3). At each apex of the triangle are the 'tools', 'rules' and 'division of labour'. The 'tools' mediates the relationship between subject and object. The 'rules' mediate relationship between subject and community. The 'division of labour' mediates the relationship between object and community (Kuutti 1995: 23). By analyzing an activity system the researcher is able to view how activities are constantly shaped and reshaped in the context in which they take place therefore activities are not static or given, but are dynamic (Lim and Hang 2003: 51).

The following explanation pertains to the model of the activity system presented in figure 3 below (Blin and Munro 2008: 477):

> The activity of the *subject* is directed towards the object that is then 'moulded and transformed' into outcomes with the help of tools. The *tools* through which the subjects interact with the world are dependent on his/her *object* in the activity system, and this shapes his/her interpretation of the tools. The subject exists in a *community* comprising of other individuals and subgroups that share the same general object. In the community, there is a *division of labour (DOL)* with the continuously negotiated distribution of tasks, powers, and responsibilities among the participants of the activity system. *Rules* are the explicit and implicit regulations, norms and conventions that constrain actions and interactions within the activity system. The model of the activity system is dynamic. There are continuous constructions and re-constructions between its components.

Figure 3: Engeström's model of an activity system



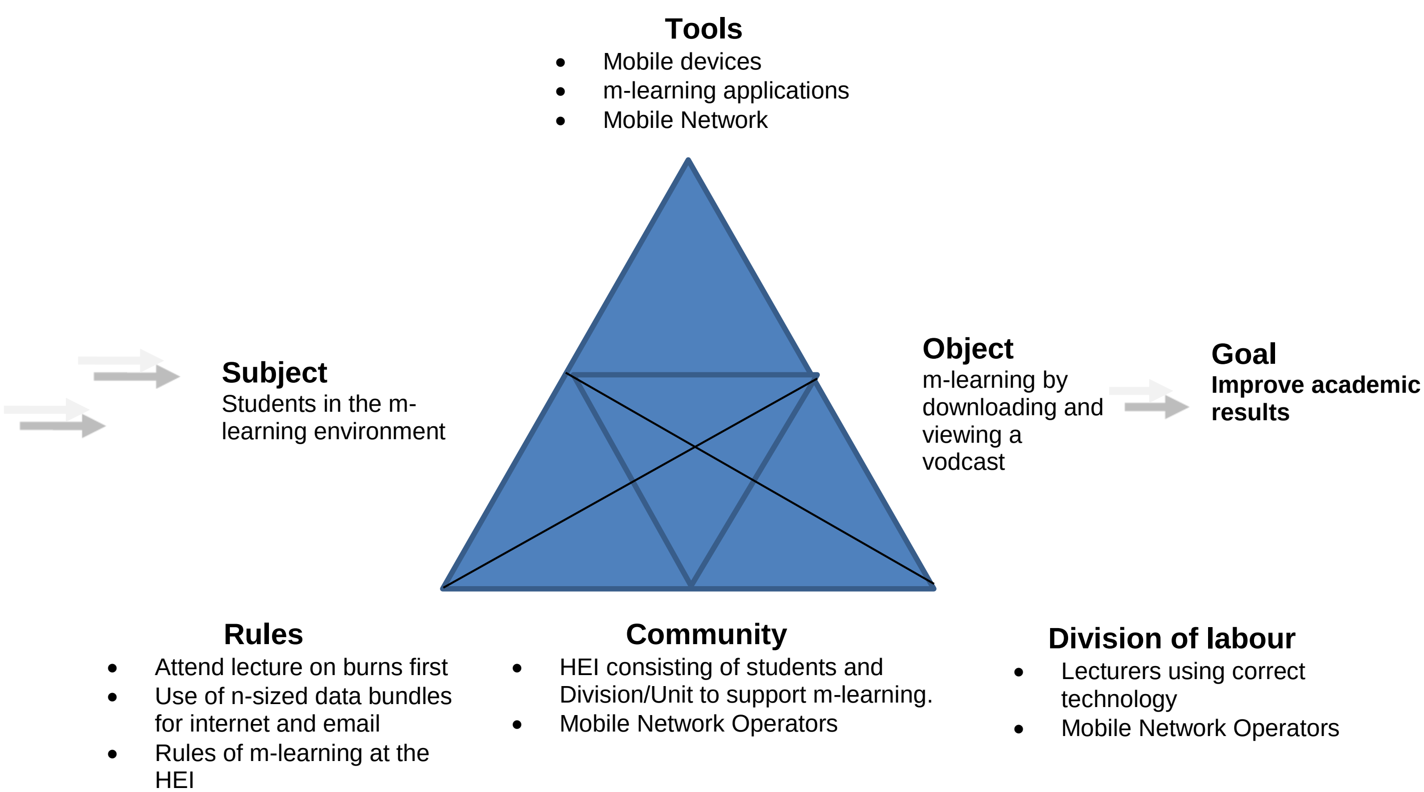
Source: Lim and Hang (2003: 52)

The Engeström (1987) triangle presented below is adapted to a hypothetical example within the context of the current study.

Assume an activity for a nursing student who has to download and view a vodcast that demonstrates how to treat a patient with burns as preparation for a practical assessment. The *subject is* represented by the student in the m-learning environment. The *tools* are represented by mobile devices, m-learning applications and mobile networks. The *object* is to download and view the demonstration. The *goal* of the activity is to improve academic results. One of the rules is to download and view the demonstration only after the formal lecture on burns has been completed. The *community* is represented by the HEI and the mobile network operators. The *division of labour* is the role of lecturers to utilize the appropriate technology.

The *subject* (student) uses *tools* such as mobile handsets to download and view the vodcast (*object*) by following the rules, thus transforming it into the *outcome* of improved academic results. The *community, rules and division of labour* denote the situational social context within which collective activities are carried out. Figure 4 illustrates the example using the Engëstrom (1987) triangle.

Figure 4: Engeström's triangle adapted for a m-learning activity



While the components of an activity system interact, contradictions emerge within components and between activity systems (Lim and Hang 2003: 52). These contradictions are discussed in the next section.

3.2.2 Activity Theory and Contradictions

A contradiction is the term given to “misfits within and among elements, different activities or different development phases of the same activity” (Murphy and Rodriguez-Manzanares 2008: 445). “They manifest themselves as problems, ruptures, breakdowns and clashes. Activity theory sees contradictions not as problems but as sources of development” (Blin and Munro 2008: 477). “Activities are virtually always in the process of working through contradictions that subsequently facilitate change” (Blin and Munro 2008: 477).

One of Engeström’s (1987) original motivations for developing this model is to “allow researchers to identify the contradictions [problems, ruptures, breakdowns and clashes] that impose tensions on participants’ settings and help them change the nature of an activity to overcome those tensions”. According to Engeström (1987), activity systems have four levels of contradictions.

Primary contradictions are conflicts that appear in each component of the activity system (Lim and Hang 2003: 52), eg., if students do not perceive m-learning as valuable, a tension exists in the activity system. *Secondary contradictions* are conflicts that appear between each component of the activity system (Lim and Hang 2003: 53), eg., a tension is created when students need to decide which tools of m-learning to use. *Tertiary contradictions* “arise between an existing activity and what is described as a more advanced form of that activity” (Uden 2007: 87), eg., lecturers resent providing feedback to students using mobile social applications like Whats App. *Quaternary contradictions* are conflicts between a central activity and neighbouring activities (Uden 2007: 87), eg., there is a fundamental contradiction between use of mobile technology and traditional classroom teaching. Quaternary contradictions are external contradictions that exist between components of different activity systems, when tensions occur between the objects of the two activity systems (Lim and Hang 2003: 54).

It can be deduced that primary, secondary and tertiary contradictions may occur within the activity system. Regardless of the level of contradiction, a tension brings instability to an activity system. By zooming in on the various tensions, valuable insights can be derived. Basharina (2007: 39) asserts that, through the resolution of tensions, change is facilitated.

In the next section, the strategy of inquiry is discussed.

3.3 Strategy of inquiry

3.3.1 Case Study

Hung and Chou (2005) assert that "the case study research method is well suited to Information Systems research, since the object of the discipline is to study information systems in organisations". Case studies are used to investigate the dynamics of a bounded system, typically of a social nature, such as an institution (Welman and Kruger 2001). Yin (1999) advises that "the all-encompassing feature of a case study is its intense focus on a single phenomenon within a real-life context". He advocates that a case study approach is chosen on the basis of the study design and researchers should not automatically associate a case study with any data collection method.

The selected strategy in this study is a case study approach (Creswell, 2009) of the technology and operational readiness for m-learning at a SA HEI. Durban University of Technology, a resident HEI in KwaZulu-Natal, is the chosen case study and research setting. According to Wagner, C, Kawulich and Garner (2012: 166), the approach comprises both qualitative and quantitative techniques. One of the strengths of the case study approach is that it allows the researcher to use a variety of data collection methods as part of the investigation, for example, a case study can mix interviews and questionnaires (Denscombe 2012: 54). Yin (1999) advocates that the more data collection methods used in the same study, the stronger the case study evidence would be. The goal is to triangulate evidence from the various methods of data collection to reinforce a single point. Case study research is aimed at gaining greater insight and understanding of the dynamics of a specific situation (Maree 2007: 76).

Punch (2005: 145) points out four characteristics of case studies. Firstly, the case is a 'bounded system'. Secondly, the case is of something. Thirdly, there is an explicit attempt to preserve the wholeness, unity and integrity of the case. Lastly, multiple sources of data and multiple research methods are likely to be used, typically in a naturalistic setting.

3.3.2 Undertaking the Case Study

The unit of analysis which is the HEI under study is a critical factor in the case study (Maree 2007: 75). The researcher determines in advance what evidence to gather and what analysis techniques to use with the data to answer the research question. The data gathered can be both quantitative and qualitative. Tools to collect the data can include surveys, interviews, documentation review, observation and even the collection of physical artefacts (Maree 2007: 75).

In the next section, research methods chosen for this case study are discussed.

3.4 Research Methods

The two research methodologies that could be used for data collection is the quantitative approach and the qualitative approach (Leedy 1993: 139). He states that, the nature of the data will dictate the methodology.

Quantitative Approach

The methodology is quantitative if the data collected is numerical (Leedy 1993: 139). The quantitative researcher attempts to measure the properties of phenomena like attitudes of people towards a certain topic, by collecting data that could be presented in the form of numbers (Babbie 2001: 3, 283). This approach is generally used when '**width'** is required. In a large population size, as in this study, the researcher uses the quantitative method to generalize results beyond the confines of the research sample. The quantitative research in this study was in the form of a survey conducted by drawing a sample from the population of students at the HEI and analyzing the results. Conclusions made could then be generalized to the rest of HEI. Constructs (variables) are the central focus in quantitative research (Struwig and Stead 2001: 4). In this study various constructs such as accessibility, affordability, student mobile handset profiles, awareness, attitude, training and support, as highlighted in the literature review, formed part of the quantitative research.

Qualitative Approach

The methodology is qualitative if the data collected is verbal (Leedy 1993: 139). Qualitative research refers to the collection of data that is in the form of words and images from photographs, videotapes, documents, observations, and transcripts (Struwig and Stead 2001: 13). The approach is generally used to create greater **'depth'** and to enhance the validity of the study. "Qualitative research seeks to understand phenomena in context-specific settings" (Struwig and Stead 2001: 11). In this study, focus group interviews formed the qualitative research.

By combining qualitative and quantitative methods, a form of triangulation results which enhances the reliability and validity of the study (Moutan 1996: 56). Triangulation is based on the principle that it is better to look at something from several angles than to look at it in only one way. The triangulation method includes various data collection methods such as Likert-type questionnaires and focus groups (Struwig and Stead 2001: 19). Hence, this research study combines both research methods to form a **mixed methods research design** (Day, Sammons and Gu 2008: 330, 331).

3.4.1 Research Setting and Data Collection

The research setting was Durban University of Technology. This SA HEI under study is currently experiencing low student throughput rates in their programmes. Throughput rate tracks a cohort of students registering for the first time at the HEI and complete their programmes in minimum time (Strydom, Mentz and Kuh 2010: 2). The statistics obtained from the institution's Management Information System (MIS) Directorate show that the overall throughput rate of students who registered in 2010 and graduated in 2012 (2010 cohort) was twenty six percent. To improve the throughput rate, the HEI has taken a decision to adopt a more flexible approach for delivery of instruction to increase the level of academic support to its students as informed by the institutional strategic plan (2013). Further to this decision, the variety of interrelated pressures at HEI's around the globe, such as the ever increasing scarcity of trainers, escalation of cost of education and rapid growth of technology (Alam, Kabir, & Elizabeth, 2006), has created a need for change in existing educational techniques and approaches.

Management at the HEI have identified m-learning through mobile devices as a strategic tool to assist with all these challenges. As such, in the context of this study, there exists a need for the HEI to conduct a mobile readiness assessment of students before implementing m-learning.

Using the quantitative approach, the survey questionnaire was selected as the primary data collection tool and in the qualitative approach the focus group interview was selected as the secondary data collection tool in this study. The primary (quantitative) data collection tool and the secondary (qualitative) data collection tool are discussed in detail in this section.

3.4.1.1 Quantitative Research: The Survey Questionnaire

In a survey questionnaire, a variety of questions are listed in printed format which respondents are asked to answer. According to Babbie (2008), survey questionnaires are excellent vehicles for measuring attitudes and orientations in a large population. Most often, surveys are viewed as snapshots or pictures of a particular point or period in time (Maree 2007: 9). Babbie (2008: 303) maintained "that survey research is the best method available when the researcher is interested in collecting original data for describing a population too large to observe directly".

Distinct advantages offered by questionnaires outlined by Struwig and Stead (2001: 90) are listed below:

- It is a cost effective method of data collection;
- It offers greater anonymity;
- The questionnaire could be completed at a time suitable to the respondent; and
- Used when dealing with a large number of respondents.

Whilst questionnaires are a popular way of obtaining data, Struwig and Stead (2001: 89) caution that poor questionnaires "might result in low response rates, unreliable or invalid data, or inadequate or inappropriate information". They advocate that quality questionnaires require "well-worded questions, clear responses and attractive layouts". Struwig and Stead (2001: 89-91) list the following guidelines for a good questionnaire:

- Asks questions that fully cover the topic under investigation;
- Questions can be answered within a short period of time;
- Relevant questions are only asked;
- Instructions given are clear;

- Questions are precise and understandable;
- Questions do not include subjectivity;
- The questionnaire starts with general questions;
- Questions asked are appropriate; and
- Use mostly closed questions, often with a 4-point scale.

It is important to take cognizance of the guidelines for a good questionnaire in the design of the research questionnaire. In the next section, the questionnaire design, type of questions, sampling procedures for the questionnaire, sample size and sampling framework are discussed in detail.

3.4.1.1.1 Questionnaire Design

In a survey, completion of a questionnaire is voluntary. Therefore, it is important that the interest of the respondent should always be maintained. Struwig and Stead (2001: 90) propose important guiding principles to consider when designing a questionnaire. They outline the following elements of a good questionnaire, namely, instructions are clear and concise, the questionnaire is divided into logical sections by subject, simple language is used and the questionnaire must start with simple questions (Struwig and Stead 2001: 90). In addition, the layout of the questionnaire must be systematic with sufficient space between questions and answers (Struwig and Stead 2001: 90). Meeting these requirements ensures that understandability and readability of the questionnaire is enhanced.

In this study, a concerted effort was made to ensure that the design of the questionnaire was aligned to the above guidelines to maintain the interest of the respondents. The questionnaire was formulated and aligned to the research objectives, the theories and models established in the literature survey. Respondents were asked to complete a self-administered questionnaire written in English, as this is the official medium of instruction at the HEI under study.

The questionnaire comprised six sections, namely: Section A, which consisted of five demographic information questions; Section B consisted of four questions on accessibility and affordability; Section C consisted of twenty-one questions on mobile device profile that students own; Section D consisted of five questions on students' attitude and awareness; Section E consisted of four questions on training and support and Section F consisted of five general open-ended questions. The respondents' level of fatigue was considered in the size and length of the questionnaire (Struwig and Stead 2001: 96). See appendix A for a sample copy of the survey questionnaire.

3.4.1.1.2 Types of Questions

According to Welman and Kruger (2001: 165), two types of questions can be used in the survey questionnaire, namely, closed-ended questions and open-ended questions. Closed-ended questions typically ask the respondent to make choices from a set of alternatives (Welman and Kruger 2001: 165). Open-ended questions allow subjects to openly and freely express their thoughts and opinions. No choices or alternatives are offered (Struwig and Stead 2001: 92).

In this study, both closed-ended and open-ended questions were used. The closed-ended questions were included in Section A to Section E, which required a scaled response. "A rating scale asks subjects to choose one response category from several arranged in hierarchical order" (Friedman and Amoo 1999: 115). This type of question was deemed most appropriate, given the large population size and sample size.

More specifically, a Likert-type scale is a type of rating scale "usually linked to a number of statements to measure attitudes or perceptions" (Maree 2007: 9). Closed-ended questions are asked using a Likert-type rating scale. Maree (2007: 9) cautioned that use of the Likert scale requires proper instructions to be given to subjects on how to complete the questionnaire.

Friedman and Amoo (1999: 122) generally recommend a five point or seven point rating scale and contend that one should be guarded against assuming that they are appropriate in all situations. They concluded that the number of points of the rating scale depended on the stimulus being evaluated. In this study, the closed-ended questions used a five point Likert-scale namely, *strongly agree, not sure, agree, disagree, strongly disagree* and a three point Likert-scale, namely *agree, not sure, disagree*. The five point scale increases reliability of responses while the three point scale, although less reliable, is necessary to force a decision (Friedman and Amoo 1999: 123).

The open-ended questions, contained in Section F of the questionnaire, allowed respondents to answer the questions in any way they chose.

3.4.1.1.3 Questionnaire Sampling Procedures

This section describes the sampling methods used in this study to avoid bias. Melville and Goddard (1996: 30) state that, “a sample is a subset of the population” and advocate that samples must be representative of the population of concern. They further state that elements of a sampling unit are the elements about which information is sought. Therefore, the chosen sample must not be biased where it represents only a specific subgroup of the population or particular subgroups are over or under-represented.

Probability sampling is the primary method of data collection. “In probability sampling every element in the population has a non-zero probability of selection” (Struwig and Stead 2001: 112). “Random selection is a type of probability sampling that ensures that each member of the population has the same chance as any other of being included in the sample” (Melville and Goddard 1996: 31). A variation of this method called stratified random sampling was the chosen sampling technique used in this study. Melville and Goddard (1996: 32) assert that stratified random sampling is preferred over simple random sampling when members within each stratum are fairly similar (homogeneous) but there are marked differences between members of one group and those of another.

“In stratified random sampling the researcher uses simple random sampling within each group (stratum) or section, ensuring that appropriate numbers are selected from each group so that the overall sample reflects each group in known proportions” (Melville and Goddard 1996: 32). The researcher considered the faculties and departments of the students as important stratification variables. In the HEI under study, students were grouped into six available faculties and further sub-divided into various departments. The six faculties were **Accounting and Informatics, Applied Sciences, Arts and Design, Engineering and the Built Environment, Health Sciences and Management Sciences.**

3.4.1.1.4 Questionnaire Deployment

Questionnaires were distributed and collected at the different departments and faculties by the researcher. The faculty Deans as well as the various Heads of Departments assisted by administering the questionnaire to students during lectures. The researcher ensured that the process was conducted in an ethical and morally sensitive manner and that participants were not coerced into submitting questionnaires.

A cover letter was enclosed with the questionnaire, which explained the following:

- The purpose of the research questionnaire;
- An assurance that the responses would be treated in the strictest of confidence. The researcher felt that this was the best way of obtaining responses that would be honest;
- Return information;
- Contact information, should the respondent need to contact the researcher with queries or questions; and
- The need for a prompt response.

The next section discusses the sample size for the study.

3.4.1.1.5 Sample Size for the Study

Sekaran (1992: 253) developed a table for determining the sample size from a given population. Table 3 below depicts the Sekaran (1992) table for determining sample size.

Table 3: Determining sample size from a given population

POPULATION SIZE	SAMPLE SIZE	POPULATION SIZE	SAMPLE SIZE
10	10	1 100	285
20	19	1 200	291
50	44	1 300	297
100	80	1 400	302
150	108	1 500	306
200	132	1 600	310
250	152	2 000	322
300	169	5 000	357
500	217	10 000	370
1 000	278	100 000	384

Source: Adapted from Sekaran (1992: 253)

The KZN HEI had 23 277 students registered for programmes in 2012. “Population validity refers to the degree to which the results obtained for a sample might be generalized to the total population to which the research hypothesis applied” (Welman and Kruger 2001: 118). The researcher administered the questionnaire to a stratified random sample of undergraduates of the HEI to ensure population validity.

Using table 3 above as a reference guide and based on a population size of 23 000 (rounded off), the researcher calculated a sample size of 372. A population size of 10 000 show a sample size of 370. By inference, for every 6500 students (rounded off), 1 more student must be added to the sample. Therefore, for 13000 more students, 2 additional students were added to the sample size. The researcher, therefore, was required to sample no less than 372 students at the HEI. A high response rate of students from the survey must be achieved to ensure validity of the study.

3.4.1.1.6 Sampling Framework for the Study

"The sampling framework is a list of all the sampling units in the population" (Struwig and Stead, 2001:109). In this study, the sampling framework was established from the HEI's faculties and departments.

In order to determine the number of students to be sampled in each faculty, the proportion of students in the faculty, relative to the total number of students in the HEI, was determined using the following formula:

$$\textbf{Proportion of students in faculty} = \frac{\textbf{No. of students in faculty}}{\textbf{Total enrolment}}$$

The proportion obtained was then multiplied by the sample size to yield the number of students to be sampled in each faculty (rounded off).

Similarly, in order to determine the number of students to be sampled in each department, the proportion of students in each department relative to the number of students in the faculty in which they are located was determined using the formula:

$$\textbf{Proportion of students in department} = \frac{\textbf{No. of students in department}}{\textbf{No. of students in faculty}}$$

The proportion obtained was then multiplied by the number of students to be sampled in each faculty to yield the sample size of each department (rounded off).

In summary, based on the recommendations of Leedy (1993: 211), a proportional stratified sampling design was employed and a sample size of 372 was derived. Table 4 below illustrates how sample sizes for each faculty and department were obtained. The data regarding enrolment in each department was supplied by the Department of Information Management from the HEI under study on 3 February 2012.

Table 4: Proportional stratified sampling by faculty and department

Faculty	No. of Students	Proportion relative to pop. size	No. of students relative to proportion	Department	No. of Students	Proportion relative to no. in faculty	No. to be sampled relative to proportion
Accounting and Informatics	5655	0.25	93	Auditing and Taxation	796	0.14	13
				Finance and Information Management (Midlands)	568	0.1	9
				Financial Accounting	882	0.16	15
				Information and Corporate Management	858	0.15	14
				Information Technology	1658	0.29	27
				Management Accounting	893	0.16	15
TOTAL							**93**
Faculty	**No. of Students**	**Proportion relative to pop. size**	**No. of students relative to proportion**	**Department**	**No. of Students**	**Proportion relative to no. in faculty**	**No. to be sampled relative to proportion**
Applied Sciences	**1620**	**0.07**	**26**	Biotechnology and Food Technology	380	0.23	6
				Chemistry	198	0.12	3
				Clothing and Textile Studies	131	0.08	2
				Food and Nutrition Consumer Studies	201	0.12	3
				Horticulture	131	0.08	2
				Maritime Studies	194	0.12	3
				Sport Studies	385	0.24	6
TOTAL							**25**

Faculty	No. of Students	Proportion relative to pop. size	No. of students relative to proportion	Department	No. of Students	Proportion relative to no. in faculty	No. to be sampled relative to proportion
Arts and Design	**2313**	**0.1**	**37**	Fashion and Textiles	180	0.08	3
				Fine Art and Jewellery Design	168	0.07	3
				Media, Language and Communication	495	0.21	8
				School of Education	823	0.36	13
				Television, Drama and Production Studies	241	0.1	4
				Visual Communication Design	406	0.18	7
TOTAL							38

Faculty	No. of Students	Proportion relative to pop. size	No. of students relative to proportion	Department	No. of Students	Proportion relative to no. in faculty	No. to be sampled relative to proportion
Engineering and the Built Environment	**5567**	**0.24**	89	Architectural Technology	317	0.06	5
				Chemical Engineering	497	0.09	8
				Civil Engineering and Surveying DBN	734	0.13	12
				Civil Engineering PMB	698	0.13	12
				Construction Management and Quantity Surveying	485	0.09	8
				Electrical Power Engineering	702	0.13	12
				Electronic Engineering	1029	0.18	16
				Industrial Engineering	271	0.05	4
				Mechanical Engineering	641	0.12	11
				Town and Regional Planning	193	0.03	3
TOTAL							**91**

Faculty	No. of Students	Proportion relative to pop. size	No. of students relative to proportion	Department	No. of Students	Proportion relative to no. in faculty	No. to be sampled relative to proportion
Health Sciences	**2156**	**0.09**	**33**	Nursing	329	0.15	5
				Biomedical and Clinical Technology	430	0.20	7
				Chiropractic and Somatology	381	0.18	6
				Community Health Sciences	356	0.17	6
				Dental Sciences	171	0.08	3
				Emergency Medical Care and Rescue	154	0.07	2
				Homoeopathy	108	0.05	2
				Radiography	227	0.11	4
TOTAL							**35**
Faculty	**No. of Students**	**Proportion relative to pop. size**	**No. of students relative to proportion**	**Department**	**No. of Students**	**Proportion relative to no. in faculty**	**No. to be sampled relative to proportion**
Management Sciences	5946	0.26	97	Applied Management (Midlands)	819	0.14	14
				Business Studies Unit	45	0.007	1
				Entrepreneurial Studies and Management	723	0.12	12
				Hospitality and Tourism	704	0.12	12
				Human Resources Management	705	0.12	12
				Marketing, Retail and Public Relations	1064	0.18	17
				Operations and Quality Management	733	0.12	12
				Public Management and Economics	491	0.08	8
				Regional Governance and Development (Midlands)	662	0.11	11
TOTAL							99

3.4.1.2 Qualitative Research: Focus Group Interviews

Krueger (1998), cited in Struwig and Stead (2001: 11), contends that focus group interviews on a research topic are used to obtain perceptions in a permissive and non-threatening environment. Participants who are selected through purposive sampling generate data through discussions in a small group (Rabiee 2004: 655).

Purposive sampling, according to Babbie (2008: 204), "indicates that the researcher selects a sample on the basis of knowledge of a population, its elements and the purpose of the study". In selecting the informants for the focus group interviews in this study, the purposive sampling technique was used. Groups to be observed were selected on the basis of the researcher's judgment about which ones would be the most useful or representative.

Lincoln and Guba (1985), as cited in Struwig and Stead (2001: 122), advise that when conducting purposeful sampling the researcher must not draw the sample in advance. More samples must be drawn only after the previous samples have been analysed. This allows the researcher to choose the type of sample based on the information that is required. They further advocate that the researcher continue sampling until the information becomes redundant.

A key feature of focus-group interviews is its group dynamics, hence, the type and range of data generated through the social interaction of the group are often deeper and richer than those obtained from one-to-one interviews (Rabiee 2004: 656). Focus groups can provide information about individual's attitudes, awareness and knowledge about a topic as well as highlight the differences in perspective between groups of individuals.

Using focus groups, large amounts of data can be generated in a relatively short time span, and the findings can be used to reinforce the findings of quantitative studies. In a focus group, better data can be generated if there exists synergy within the group and group members are prepared to engage fully in the discussion. It is important for group members to be comfortable with each other and trust each other when engaging in discussion (Rabiee 2004: 656). It is for this reason that Rabiee (2004: 656) recommends investing time and effort in selecting members of the group.

Rabiee (2004: 657) states that a skillful facilitator can create an environment in which the participants feel relaxed and encouraged to engage and exchange feelings, views and ideas about an issue. The facilitator must be attentive and willing to listen, show an interest in what is being said, encourage a wide range of opinions, assist participants to explore their ideas further, avoid belittling participants, and tactfully redirect the conversation when people become repetitive or stray from the topic (Rabiee 2004: 657).

Rabiee (2004: 657) advocates that a note taker be present at focus group interviews to assist the facilitator. The role of the note taker is to document important ideas and views that emerge from the discussion (Rabiee 2004: 657). He states that the note taker must be very systematic so that it is clear which statement is made by which individual. The note taking will supplement the oral text and enable an in-depth analysis of data. In this study, a note taker was present, kept notes to identify participants and recorded observations of their reactions during discussions.

Some advantages of focus group interviews offered by Struwig and Stead (2001: 100) are, namely, there is no fear of criticism as a safe, secure and open environment is provided for informants; in-depth discussions on a topic can take place; information obtained from the focus group can be useful in the construction of the survey questionnaire.

In focus group interviews all participants must be made to feel that their contributions are worthwhile and that they are free to disagree with each other (Rabiee 2004: 657). Wagner, C, Kawulich and Garner (2012: 136) advocate continuing running focus groups until a clear pattern emerged and subsequent groups produced only repetitious information (theoretical saturation).

Wagner, C, Kawulich and Garner (2012) recommend that for a research study, a number of focus group interviews are needed to explore possible alternative perspectives. Three focus group interviews were chosen for this study, namely, one part-time and two full time groups. The focus group interviews were held in a comfortable environment that was free from noise.

A potential problem in using focus groups is the number of informants who do not attend. The recommendation made by Rabiee (2004: 658) is to over-recruit by 10–25%, based on the topic and groups of participants. According to Struwig and Stead (2001: 99), focus groups generally comprise four to eight participants. In this study, ten participants were invited to each focus group interview with the expectation of six to eight students actually attending. To assure attendance, participants agreed on the focus group date well in advance of the interviews and were reminded a few days before the day of the interview.

Each group interview should last approximately 1–2 hours, based on the complexity of the topic under investigation, number of questions and the number of participants (Rabiee 2004: 656). In this study, the average duration of focus group interviews was 1.5 hours. In keeping with good ethics and practice, participants were warned in advance about their time commitment.

Focus group questions were carefully developed to initiate the discussion. They started from general and non-threatening and progressed gradually to the specific. Participants granted permission for the discussions to be tape recorded so that they could be transcribed accurately.

In the next section, data analysis is discussed in detail.

3.4.2 Data Analysis

3.4.2.1 Data Analysis for Quantitative Research

The quantitative data generated from the questionnaires were captured and analysed for descriptive and inferential statistics using a statistical software package called Statistical Package for the Social Sciences (SPSS).

3.4.2.1.1 Descriptive Statistics

Welman and Kruger (2001: 208) state that, "descriptive statistics is concerned with the description and/or summarisation of the data obtained for a group of individual units of analysis". Descriptive statistics involves transformation of raw data into a form that provides information to describe a set of factors in a situation. The most popular tools of descriptive statistics include frequency distributions, measures of central tendency and measures of variability. Descriptive statistics help to describe and summarise the information that has been gathered through research (Wagner, C, Kawulich and Garner 2012: 177).

3.4.2.1.1 Inferential Statistics

Inferential statistics involves the use of those statistical techniques that allow researchers to draw inference from a sample that could be applied or generalized to the population from which the sample was drawn (Maree 2007: 198). The internal reliability test and correlation tests, which are popular inferential statistical tests, were used in this study.

3.4.2.1.1.1 Internal Reliability Test

Cronbach's alpha coefficient, which is based on inter-item correlations, was used to measure internal reliability. To measure how well a set of questions or items measures a single construct, Cronbach's alpha coefficient is used (IDRE 2013). Cronbach's alpha coefficient could be written as a function of the number of test items and the average inter-correlation among the items. Below, for conceptual purposes, the formula for the standardized Cronbach's alpha coefficient is shown, as extracted from IDRE (2013):

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Here N is equal to the number of items, c-bar is the average inter-item covariance among the items and v-bar equals the average variance.

From this formula, if the number of items (N) increases, Cronbach's alpha coefficient increases. Additionally, if the average inter-item correlation is low, alpha would be low. As the average inter-item correlation increases, alpha increases as well.

If the inter-item correlations are 'high' or 'good', then there is evidence that the items are measuring the same underlying construct. When there is 'high' or 'good' reliability, items measure a single unidimensional latent construct well (IDRE 2013). When the inter-item correlations are poor amongst a set of items, Cronbach's alpha coefficient is low.

The value for Cronbach's coefficient ranges from 0 to 1. If the items are strongly correlated with each other; their internal consistency would be high and the alpha coefficient would be close to one. The following values are generally accepted by researchers (Maree 2007: 216), namely, a value for Cronbach's coefficient of 0.90 is accepted to mean high reliability, a value for

Cronbach's coefficient of 0.80 is accepted to mean moderate reliability and a value for Cronbach's coefficient of 0.70 is accepted to mean low reliability.

Depending on the purpose of an instrument, different degrees of internal reliability are required. Reliability estimates of 0.80 are regarded as acceptable in most applications while values lower than 0.60 are regarded as unacceptable.

The reliability results for this study are presented below:

Table 5: Reliability statistics on student handset profile

Cronbach's Alpha	N of Items
0.960	21

An alpha value of 0.960 suggests a high degree of internal consistency, indicating that items under "Section C: Student Handset Profile" from the survey questionnaire were strongly correlated with each other.

Table 6: Reliability statistics on awareness and attitude

Cronbach's Alpha	N of Items
0.660	5

The 5 items under "Section D: Awareness and Attitude" in the survey questionnaire have a Cronbach alpha coefficient value of 0.660 which is slightly less than an acceptable value. There is slightly less than acceptable evidence that items in this section are measuring the same underlying construct (awareness and attitude).

Table 7: Reliability statistics on support and training

Cronbach's Alpha	N of Items
0.791	4

A Cronbach's alpha coefficient value of 0.791 for "Section E: Support and Training" in the survey questionnaire indicates acceptable reliability.

Table 8: Reliability statistics on overall reliability

Cronbach's Alpha	N of Items
0.904	30

The overall reliability score for the components of the ordinal section is high (0.904). This indicates a high degree of acceptable, consistent scoring for the different statements of the ordinal data for this research. The ordinal category has (high) acceptable reliability values.

3.4.2.1.1.2 Correlation Analysis

Chi-square tests (Chi^2)

Chi^2 tests are used when the researcher wants to examine if there is a "significant relationship between two variables" (Welman and Kruger 2001: 205). The calculation in this kind of analysis is based on the two-way cross-tabulation of the two variables (Punch 2005: 113). Chi^2 must be less than 0.05 for a significant relationship (Rice 1989: 224). In this study, Chi^2 tests are used to determine if there exists a correlation between students' awareness of m-learning and their attitude towards m-learning.

Bivariate Spearman's correlation

Bivariate Spearman's correlation is also performed on ordinal data. The Spearman correlation coefficient determines the strength of the relationship between two variables (Welman and Kruger 2001: 205). According to Dunn (2013), the correlation coefficient is a number between +1 and -1. This number describes the magnitude and direction of the association between two variables. The MAGNITUDE is the strength of the correlation. The closer the correlation is to either +1 or -1, the stronger the correlation. If the correlation is 0 or very close to 0, there is no association between the two variables. Furthermore, Dunn (2013) states that the DIRECTION of the correlation tell how the two variables are related. If the correlation is positive, the two variables have a positive relationship (as one increases, the other also increases). If the correlation is negative, the two variables have a negative relationship (as one increases, the other decreases).

3.4.2.2 Data Analysis for Qualitative Research

Wagner, C, Kawulich and Garner (2012: 136) assert that audiotapes and/or video tapes taken from discussions of the focus group interviews are the main source of data analysis A diary kept by the facilitator containing reflective and observational notes after each focus group interview is another source of data (Rabiee 2004: 657). In the current study, audio recording of focus group interviews was used as a source for data analysis. Wagner, C, Kawulich and Garner (2012: 136) advocate that, in the construction and analysis of data, the settings and non-verbal communication of respondents also provide valuable input.

In this study, each interview was transcribed from the audio recording verbatim. After the transcription process, the researcher engaged in minor editing, to improve the readability of the transcript. The transcripts were subjected to qualitative content analysis by identifying key substantive points in the transcript and then grouping them into themes and categories (Denscombe 2012: 281). The central idea in content analysis is that the many words of the text are classified into fewer content categories.

Krueger (1994), cited in Rabiee (2004: 657), propose a ‘framework analysis’ for analysis of content. Five key stages outlined are, namely, familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation. The first stage is familiarization with the data, which can be achieved by listening to tapes, reading the transcripts in their entirety several times and reading the observational notes taken during interviews and summary notes written immediately after the interviews. The next stage involves identifying themes from data collected. At this stage, descriptive statements will be formed and an analysis can be carried out on the data under the questioning route. The third stage, indexing, comprises of sifting the data. The fourth stage, charting, involves lifting the quotes from their original context and re-arranging them under the newly-developed appropriate thematic content. The final stage of analysis is mapping and interpreting. The task here is to make sense of the individual quotes and also to be imaginative and analytical enough to see the relationship between the quotes, and the links between the data as a whole.

The next section of this study discusses how measures of validity can be achieved.

3.5 Validity

The term validity implies that the measurements are correct. This means that an instrument measures what it is intended to measure, and that it measures it correctly (Melville and Goddard 1996: 37).

Some researchers use direct observation of behaviour as a criterion for the validity of the questionnaire after responses are obtained. Observations are made to assess whether the actual behaviour of the subjects agrees with expressed attitudes and opinions (Mahlangu 1987: 83).

The validity of the questionnaire cannot be assumed, it must be established. In this regard, content validity and internal validity were established in this study, as discussed below:

3.5.1 Content Validity

In order to establish content validity, one must compare the content of items in the measurement tool with the relevant content domain for the construct being measured (Wagner, C, Kawulich and Garner 2012: 81). In this study, content validity was established by conducting an in-depth literature review of the construct.

3.5.2 Internal Validity

Welman and Kruger (2001: 98) assert that the purpose of experimental research is to identify causal relationships and, hence, internal validity. "The internal validity of an experimental design addresses the issue of whether the independent variables, and not other extraneous variables are responsible for variations in the dependent variable" (Leedy 1993: 41). Extraneous variables are sometimes known as confounding variables. In this study, it is important to ensure that all conclusions are reached without any bias created by confounding variables. For example, in assessing students' attitude towards m-learning, the results could show that students who have physical and mental disabilities may have a negative attitude towards m-learning.

Internal validity of the research was established by a panel of experienced researchers who reviewed and assessed the questionnaire.

The next section provides an explanation of how reliability was achieved.

3.6 Reliability

The term "reliability means that measurements made are consistent and that if the same experiment is performed under the same conditions, the same measurements will be obtained" (Melville and Goddard 1996: 37). In other words, reliability measures if the test measures what it sets out to measure. Another definition, according to Struwig and Stead (2001: 131), is that "reliability of an instrument means that if the same instrument is used at different times or administered to different subjects from the same population, the findings should be the same". Welman and Kruger (2001: 139) state that, "if a research tool is consistent and stable, and hence, predictable and accurate, it is said to be reliable". This means that a questionnaire consistently produces similar results repeatedly. These definitions of reliability are fairly consistent and suggest that the test-retest method is the only practical approach to establish reliability.

An application of the concept of reliability, of the researchers above, to this study meant that for the survey questionnaire to be considered reliable it must be given to different students from the HEI, at different times and produce similar findings. The survey questionnaire was piloted to ensure reliability before distribution. The answers given on two separate occasions was compared for consistency (Mahlangu 1987: 84).

In the next section ethical considerations for the study are discussed.

3.7 Ethical considerations

The research instruments were submitted for ethical clearance before commencement of the study. Prior to administering the survey questionnaire (Section 3.4.1.1.4) and conducting the focus group interviews, respondents and informants were briefed on the purpose of the study and were assured that any information furnished by them would be used solely for purposes of research. Further, they were assured that their names would not be quoted.

3.8 Chapter Summary

The chapter began by outlining the research approach used in this study, namely, the philosophical world view, the strategy of inquiry and the data collection methods. The philosophical framework used is the activity theory. A brief discussion of the theory was presented from the literature. The strategy of inquiry employed was the case study approach. A mixed method data collection strategy was used. The survey questionnaire and the focus group interview were chosen as data gathering tools for the quantitative research and for the qualitative research, respectively. The chapter concluded by discussing issues related to validity and reliability of the study.

The next chapter focuses on the presentation and discussion of results.

4. RESULTS AND DISCUSSION

Contents **Page**

4.1 Introduction to the chapter

The previous chapter outlined the research design employed in this study. The objective of this study is to assess the technology and operational readiness of students at a SA HEI. The purpose of this chapter is twofold. Firstly, it presents the results of this research in relation to other research studies conducted. Secondly, there is a discussion of the results under the critical themes of the study using the theoretical framework.

The survey results are presented in tables, graphs and cross tabulations. The presentation is ordered according to the survey questionnaire (see appendix A) as follows: In Section A, biographical details are reported on. In Section B, data is presented in terms of accessibility and affordability. In Section C, the results for student handset profiles are presented. Section D deals with operational readiness factors such as awareness and attitude. Section E presents the results of support and training. In Section F, the results for the open-ended questions are presented.

The results are further analysed using activity theory in the discussion section. Conclusions drawn from the survey are strengthened by triangulating with the findings from the focus group interviews.

4.2 Results

4.2.1 Response Rate

Gilham (2000:14) recommends that a questionnaire response rate of 30% to 50% is acceptable. A total of 332 students responded from the 372 survey questionnaires distributed. Therefore, a response rate of 89 % (332/372) was achieved for this study.

4.2.2 Section A: Biographical Details

The profile of students is described in terms of the faculty, type of qualification, mode of study, age and gender.

4.2.2.1 Faculty

The table below depicts the percentage of respondents per faculty.

Table 9: Percentage of students per faculty

	Frequency	Percent
Accounting and Informatics	80	24.1
Engineering and the Built Environment	70	21.1
Management Sciences	86	25.9
Arts and Design	40	12.0
Applied Sciences	25	7.5
Health Sciences	31	9.3
Total	332	100.0

Respondents were drawn from all six faculties. However, the majority of the respondents were in the faculties of Accounting and Informatics (24.1%), Engineering and the Built Environment (21.1%) and Management Sciences (25.9%) with a total contribution of 71.1% respondents.

The remaining faculties contributed a smaller percentage of respondents ranging from 7.5% for Applied Sciences and 12.0% for Arts and Design.

4.2.2.2 Type of qualification

The table below shows the qualification for which the respondents were registered.

Table 10: Percentage of students per programme registered

	Frequency	Percent
National Certificate	1	0.3
National Diploma	278	83.7
B. Tech.	50	15.1
Postgraduate Studies	2	0.6
Other	1	0.3
Total	332	100.0

Registration figures for 2012 showed that 18843 students were enrolled for the National Diploma, 3580 students were enrolled for the Bachelor of Technology degree (B. Tech.), 306 students were registered for post graduate qualifications, 62 were registered for the National Certificate and 846 students were enrolled for other programmes such as the Bachelor of Health Sciences and Bachelor of Education from a population of 23277 students. The National Diploma was the most populated programme and equates to approximately 81% of the total enrolment and the B.Tech., the second most popular programme, equates to approximately 15% of the total enrolment.

Table 10 shows approximately 84% of the respondents from the sample drawn were registered for National Diplomas and approximately 15% of the respondents were registered for the B. Tech. degree. These percentages are more or less in line with the actual registration percentage within the institution. The programmes in table 10 were attempted by full-time, as well as part-time students.

4.2.2.3 Mode of study

The table below shows the frequency distribution of the mode of study.

Table 11: Frequency distribution of the mode of study

	Frequency	Percent
Full-time	287	86.4
Part-time	45	13.6
Total	332	100.0

Approximately 87% of the respondents were full-time students and approximately 14% of students were part-time. This finding is in keeping with the full-time and part-time enrollment at the HEI under study which was 85% and 15%, respectively, as obtained from the MIS Directorate of the HEI.

4.2.2.4 Age (in completed years)

The table below shows the spread of the ages amongst the respondents.

Table 12: Spread of ages within each age group category

Age (years)	Frequency	Percent
15 - 20	132	39.8
21 - 25	167	50.3
26 - 30	20	6.0
31 - 35	5	1.5
Other	8	2.4
Total	332	100.0

It is noted that 9 out of 10 respondents were below the age of 25 years. This can be attributed to the nature of the HEI as a full-time, contact, resident based institution.

A cross tabulation between the mode of study and the age group is presented below. It shows the split between full-time and part-time students and their age group.

Table 13: Cross tabulation of the mode of study by age group

			Indicate your mode of study?		Total
			Full-time	Part-time	
What is your age group? (In completed years)	15 - 20	Count	124	8	132
		% of Total	37.3%	2.4%	39.8%
	21 - 25	Count	143	24	167
		% of Total	43.1%	7.2%	50.3%
	26 - 30	Count	17	3	20
		% of Total	5.1%	0.9%	6.0%
	31 - 35	Count	1	4	5
		% of Total	0.3%	1.2%	1.5%
	Other	Count	2	6	8
		% of Total	0.6%	1.8%	2.4%
Total		Count	287	45	332
		% of Total	86.4%	13.6%	100.0%

There were 86.4% full-time respondents and 13.6% part-time respondents. This is as a result of the HEI positioning itself as a full-time institution for undergraduate students. The majority of the respondents (90.1%) were 25 years and below because most students enter higher education directly after school. This is significant in this study as younger people are the most enthusiastic users of mobile phones (Srivastava 2005: 120).

4.2.2.5 Gender

The table below shows the gender split between males and females.

Table 14: Frequency distribution of male and female students

	Frequency	Percent
Male	157	47.3
Female	175	52.7
Total	332	100.0

The results of the study showed that there are more females than males as 52.7% respondents were female and 47.3% were male. This is a significant finding as mobile phone manufacturers are experiencing increased sales in the female market by selling mobile phone products that look more like jewellery. In cities like Tokyo, the sales of mobile phones to Japanese girls reached nearly 100% (Srivastava 2005: 120,128).

4.2.3 Section B: Accessibility and Affordability

This section reports on m-learning operational readiness factors. The results presented below show how accessible and affordable m-learning is to students.

4.2.3.1 Mobile handset ownership

The table below shows mobile handset ownership with internet connectivity.

Table 15: Mobile handset ownership with internet connectivity

			I own a mobile handset		Total
			Disagree	Agree	
I own a mobile handset with internet connectivity	Disagree	Count	6	39	45
		% of Total	1.8%	11.7%	13.6%
	Not sure	Count	0	11	11
		% of Total	0.0%	3.3%	3.3%
	Agree	Count	0	276	276
		% of Total	0.0%	83.1%	83.1%
Total		Count	6	326	332
		% of Total	1.8%	98.2%	100.0%

The result of handset ownership in this study was 98.2%, which is consistent with many other studies conducted internationally. It exceeded the ownership percentage reported by Kreutzer (2009) of 77% amongst low-income urban SA youth and the 90% handset ownership reported by Corbeil and Valdes-Corbeil (2007) in a mobile readiness study conducted in the United States of America (USA). In fact, the results are similar to that reported by Andaleeb et al. (2010) which revealed 100% ownership amongst Malaysian distance education students. A possible reason for this, advanced by Iqbal and Qureshi (2012: 148), is the decreased costs of mobile devices in recent times.

A total of 83.1% of students indicated their handsets had internet capabilities. This reduction from 98.2% of handset ownership is significant as 17.9% of students are immediately excluded from m-learning approaches that require internet connectivity.

The table below shows the results of the cross tabulation between ownership and mode of study.

Table 16: Cross tabulation of ownership and mode of study

			Indicate your mode of study		Total
			Full-time	Part-time	
I own a mobile device	Disagree	Count	6	0	6
		% of Total	1.8%	0.0%	1.8%
	Agree	Count	281	45	326
		% of Total	84.6%	13.6%	98.2%
Total		Count	287	45	332
		% of Total	86.4%	13.6%	100.0%

Table 16 shows that 86.4% full-time students and 13.6% part-time students own a mobile device. Table 13 reports that 80.4% from the 86.4% full-time students and 9.6% from the 13.6% part-time students are 25 years and below. Hence, the majority of the students are 25 years and below. This correlates with statistics in other parts of the world such as USA where approximately 80% of young people between the ages of 18 and 29 owned cell phones (Koszalka and Ntloedibe-Kuswani 2010: 140).

4.2.3.2 Affordability

Table 17 shows the mobile connectivity affordability patterns of students inclusive of cost of data bundles and ownership of mobile handsets.

Table 17: Mobile connectivity affordability patterns

Amount available	%
< R100	67.2%
R101 – R300	21.4%
R301 – R500	5.7%

Amount available	%
R501 – R1000	2.7%
> R1000	3.0%

The majority of students (67.2%) can afford a maximum of R100 per month (pm) for mobile connectivity; 21.4% can afford R101-R300 pm; 5.7% can afford R301-R500 pm; 2.7% can afford R501-R1000 pm and 3.0% can afford more than R1000 pm. The maximum amount of R100 pm for mobile connectivity affordability was further confirmed by the focus group. This follows the trend of the study by Trifonova, Georgieva and Ronchetti (2006) which reported that more than 75% of Bulgarian students found the cost of the mobile device and wireless connectivity extremely high.

The results of the cross tabulation between affordability and mode of study is presented below:

Table 18: Cross tabulation of affordance and mode of study

			Indicate your mode of study?		Total
			Full-time	Part-time	
I can afford a mobile phone with Internet connectivity that costs (per month) on average …	< R100	Count	203	20	223
		% of Total	61.1%	6.0%	67.2%
	R101 - R300	Count	58	13	71
		% of Total	17.5%	3.9%	21.4%
	R301 - R500	Count	12	7	19
		% of Total	3.6%	2.1%	5.7%
	R501 - R1000	Count	5	4	9
		% of Total	1.5%	1.2%	2.7%
	> R1000	Count	9	1	10
		% of Total	2.7%	0.3%	3.0%
Total		Count	287	45	332
		% of Total	86.4%	13.6%	100.0%

Table 18 shows that 61.1 % of full-time students indicated that they can afford less than R100.00 for m-learning connectivity costs. Full-time students are generally unemployed, hence, their total connectivity affordability is expected to be lower. It is also interesting to note that

20/45 part-time students also fall into this affordability bracket. Ozdamli (2012: 41) attributes the low affordability to socio-economic problems experienced by students.

4.2.3.3 Ownership of other mobile devices

Mobile devices are not limited to handsets only. Table 19 shows other types of mobile devices that students own.

Table 19: Ownership of other mobile devices

Device	Percentage
ipad	3.3
ipod	6.9
Smart phone	21.1
Mp3 player	12.7
PDA	0.6
Other device	13.0
No other device	42.5

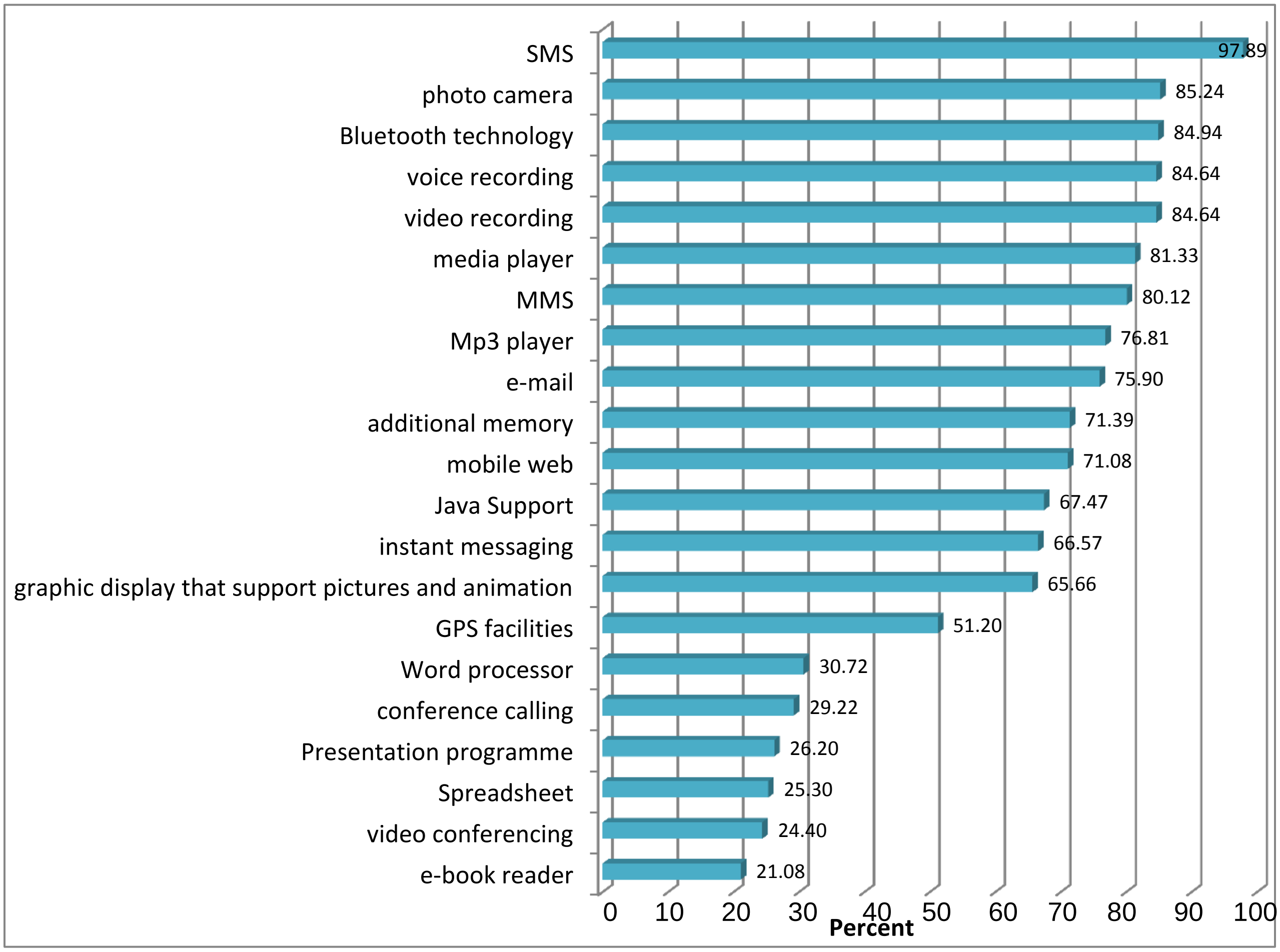
More than half of the students (57.5%) have access to, or own, other types of mobile devices. These results mirror other studies conducted globally. The Corbeil and Valdes-Corbeil (2007) study in the USA showed a high percentage of ownership of other mobile devices such as lap tops (92%) and pen drives (71%). In the Trifonova, Georgieva and Ronchetti (2006) study, other mobile devices owned were notebooks (55%), video phones (7.0%), PDA's (7.0%) and smart-phones (3.7%). The high percentage of ownership of other mobile devices shows greater support for m-learning and the readiness of m-learning.

4.2.4 Section C: Student Handset Profile

This section looks at features that are available on respondents' mobile phones. In this section, a three point Likert-scale was used to ensure students made the correct response. This measurement depended on the subjects' understanding of their phone's capabilities and their comprehension of the questionnaire (see section C in survey questionnaire-appendix A).

The results show that less than one third of respondents' mobile devices have the following features and functionality: word processor; spreadsheet; video conferencing and e-book readers. More than two thirds of the respondents indicated that they have the following technology features available on their mobile phone: SMS, photo and video camera, Bluetooth technology, MMS, Mp3 player, email client, internet connectivity, additional memory slots, IM, advanced graphics displays and java support. More than 50% of the respondents have GPS facilities.

Figure 5: Student mobile handset compliance



The Trifonova, Georgieva and Ronchetti (2006) study reported 93% SMS usage and 10.8% mobile web usage. The popularity of SMS's in this study is similar to that in other parts of the world like the United Kingdom (UK), where it is observed that more than eight out of ten people under the age of 25 are more likely to send someone an SMS than to call (Srivastava 2005: 121). The Corbeil and Valdes-Corbeil (2007: 56) study reported the following results for mobile activities in rank order: email (98%), pen drives (82%), movies/video clips (64%), IM (56%), photo camera (47%), SMS (45%), games (31%), podcasts (27%), e-book reader (29%).

It is interesting to note that when one compares the results of other studies to this study there are vast differences in popularity of features. It is best for HEI's to assess which features are most prevalent at their institution. In this study, for example, based on the results in figure 5 more than 80% of the students have SMS, photo and video camera, Bluetooth technology, voice recording and MMS technologies on their mobile handsets. Therefore, It is more feasible for m-learning programmes at this HEI to focus on using these technologies instead of using a word processor, spreadsheet, video conferencing function or e-book readers which are underrepresented on students' mobile phones.

The results for awareness and attitude towards m-learning are presented in the next section.

4.2.5 Section D: Awareness and Attitude

This section reports on m-learning operational readiness factors, namely, awareness and attitude. The results of awareness and attitudinal factors in the study are presented.

The table below shows the results for awareness and attitude of students.

Table 20: Percentage of student awareness and attitude

	Disagree	Not sure	Agree
1. I have used e-learning before	54.82	21.69	23.49
2. I am aware of mobile learning	35.24	21.39	43.37
3. I have used mobile learning before	63.25	18.37	18.37
4. I would like to use mobile learning for academic support	7.83	12.35	79.82
5. I think that usage of mobile learning will increase the quality of instruction	7.83	18.37	73.80

Even though there are slightly more respondents who are aware of m-learning than those who are not, (43.37% compared to 35.24%), more than half of the respondents have not used either e-learning or m-learning. More than three-quarters (79.82%) of the respondents indicated that they would support the use of the m-learning method, with a similar percentage (73.80%) believing that the quality of instruction will improve by using m-learning.

In a study on student attitudes to m-learning, Stockwell (2008:255) reported that although students owned mobile phones and had the necessary skills to use them, they did not want to use the mobile device when they were presented with a choice of using a desktop or a mobile device. Their negative attitude towards using a mobile device prevented them from using it. This result contrasts with this study that show that although majority had a positive attitude towards m-learning only 18.37% used m-learning before.

More positive results related to students' awareness and attitude were reported in other studies around the world. The Abas, Peng and Mansor (2009) study conducted to determine students' readiness for m-learning revealed a high percentage (84.84 %) of students had a positive attitude to learning through mobile devices. It was reported that 63.71% of the students indicated that they would be ready for m-learning within the next 12 months. Further, consensus of students' positive attitude to m-learning was found in the study of Corbeil and Valdes-Corbeil (2007: 56) where 94% of students indicated that they were ready for m-learning.

The Trifonova, Georgieva and Ronchetti (2006: 85) readiness study found that students indicated a willingness to use m-learning and, further, students that utilized the HEI's e-learning platform were more positive to m-learning. This is significant because, in this study, 54.82% of the respondents had not used e-learning before.

4.2.6 Section E: Support and Training

This section deals with the support and training required for m-learning. The table below depicts findings for the types of support required for m-learning.

Table 21: Percent of the types of support required

	Disagree	Not sure	Agree
1. Help desk support	10.54	19.28	70.18
2. Online support	9.04	12.35	78.61

There were nearly similar levels of agreement (8% difference) for the types of institutional support required. Less than 11% of respondents disagreed with the statement that they required online or help desk support. These findings show clearly that both online support (78.61%) and help desk support (70.18%) are required by students. Furthermore, these findings concur with the observations of Barker, Krull and Mallinson (2005) in their model for m-learning. They advocate that dedicated support staff are key stakeholders to be involved in the day-to-day support and maintenance of the m-learning infrastructure within their particular learning institution.

The table below report on the findings for the different types of training required by students.

Table 22: Percent of the different types of training required by students

	Disagree	Not sure	Agree
3. Use of mobile learning tools	16.27	14.46	69.28
4. Mobile handset functionality	21.69	15.96	62.35

Almost two-thirds of respondents agreed that training would be required for handset functionality and m-learning tools. This finding is supported by relevant literature presented in the literature review in chapter two.

4.2.7 Section F: Open Ended Questions

In this section, the results of the open-ended questions are presented. Open-ended questions were used to confirm the results of the closed-ended questions, as well as to give respondents more latitude to express their thoughts and opinions.

4.2.7.1 Do you think that m-learning can enhance your learning experience? Motivate.

The table below shows the results of students' attitude towards m-learning.

Table 23: Frequency distribution of whether m-learning can enhance student learning experience

	Frequency	Percent
Yes	296	89.2
*Missing System	36	10.8
Total	332	100.0

**Missing System indicates that respondents did not answer the question*

The majority of the respondents (89.2%) agreed that m-learning could enhance their learning experience. This finding supports and strengthens the results in table 20 on the students' attitude and awareness. Many students, in their motivation, indicated that the ubiquity and increased collaboration offered by m-learning would greatly benefit them academically. Approximately 10% of the respondents did not answer this question.

4.2.7.2 List the most important service that you think a m-learning system must provide.

The table below summarises the results for important services of m-learning.

Table 24: Important services m-learning systems can provide

Service	Percent
Learning Applications	10.6
SMS	4.2
Email	31.4
Podcasts	0.4
Learning Material	41.0
Other	12.4

Respondents listed the provision of learning material (41%) and access to email facilities (31.4%) as being the most important. Testing, practice exercises, GPS, access to research and journal articles were among the responses for other services.

4.2.7.3 What in your opinion is the major weakness of mobile devices that might hinder m-learning?

The table below shows the results for the weaknesses of mobile devices.

Table 25: Factors that can hinder m-learning

Factors hindering m-learning	Percent
Cost	25.7
Speed	12.1
Small	6.8
Training	11.1
Other	44.3

The results are in agreement with table 17 that shows affordability as a problem (25.7%). Further agreement with table 22 on training required shows that 11.1% required training in m-learning.

Other responses for factors hindering m-learning in table 25 above included: viruses, high cost, battery life of mobile devices, theft, distractions, network connectivity problems, files can be easily lost or deleted, cell phones can easily get lost and network reliability.

4.2.7.4 In your opinion, do you think that mobile devices and mobile applications, in future, will be used more extensively for academic support? Give a reason.

The table below shows the results for the future of m-learning.

Table 26: Frequency distribution of future use of mobile devices and mobile applications

	Frequency	Percent
Yes	290	87.3
Missing System	42	12.7
Total	332	100.0

**Missing System indicates that respondents did not answer the question*

A large percentage (87.3%) agreed that mobile technology would be used more extensively for academic support. The reason presented by the majority of the respondents showed that they were very positive about m-learning and are very aware of the benefits m-learning can provide them. Some respondents stated that, based on their limited exposure to m-learning, it is easy to use and, therefore, will be extensively used in the future. Many respondents were positive that costs associated with mobile connectivity will decrease in the future. Approximately 12% of the respondents did not answer this question.

4.2.8 Inferential Statistics

4.2.8.1 Students who used m-learning before and online support needed

The result of the chi square tests was p = 0.0036 ($p<0.05$). This indicates that there is a significant relationship between the two variables being compared, i.e., students who are familiar with m-learning will still require online support.

4.2.8.2 Correlation Analysis

The results for Spearman's correlation coefficient are reported in the table below.

All significant correlations are highlighted with an *.

Table 27: Spearman's correlation coefficient

	Help desk support	Online support	Use of m-learning tools	Mobile handset functionality
e-mail	.094	.048	-.009	-.025
mobile web	.072	.068	-.040	-.028
SMS	.015	-.001	.050	.008
MMS	.085	.061	-.033	-.026
instant messaging	.062	.043	-.039	-.013
media player	.035	-.010	-.057	-.067
photo camera	.020	-.049	-.026	-.036
video recording	.025	-.019	-.056	-.054
video conferencing	.088	.033	-.090	-.078
voice recording	.015	-.052	-.026	-.034
conference calling	.069	.042	-.038	-.005
e-book reader	.008	-.006	-.101	-.143**
Bluetooth technology	.011	-.051	-.065	-.061
graphic display that support pictures and animation	.108*	.058	-.017	-.019
additional memory	.077	.063	.043	.030
GPS facilities	.077	.042	-.056	-.062
Mp3 player	.067	.054	-.058	-.062
Java Support	.066	.020	-.026	-.040
Word processor	.098	.056	-.108*	-.152**
Spreadsheet	.079	.046	-.135*	-.165**
Presentation programme	.091	.058	-.144**	-.190**

The correlation value between “graphic display that support pictures and animation” and “help desk support” was 0.108. This is a directly related proportionality. Respondents agreed that the more institutional help desk support they received, the better they would be able to use the graphic features.

The correlation value between “mobile handset functionality” and “word processor” is -0.152. The negative correlation implies that as one variable increases, the other decreases. This suggested that the better the respondent became with word processing, the less support they would require.

In the next section the results are discussed using activity theory as the analytical tool.

4.3 Discussion

Using activity theory as an analytical tool, this study examines the relationship between the subject (student) and object (m-learning readiness) as mediated by other components of the activity system, namely, tools (both technological and human), community (HEI), division of labour (lecturer roles) and rules of the activity system (informal, formal, technical) over a period. By firmly placing the lens of activity theory on the components of the activity system, the intention of this study is to discover any contradictions that may exist. These contradictions are important in the understanding of the activity system and provides a gauge to determine if the achievement of the object and, hence, outcomes can be met. For example, an object for students is to own a mobile device that can perform advanced m-learning activities. If there is no resistance in the activity system to achieve this object, the transformational outcomes is that the student is ready for m-learning and through the use of m-learning can achieve improved academic results. It is, therefore, vital to understand contradictions as they can impede progress in the activity system. The following key questions are used to guide the discussion:

1. What are the systemic tensions or contradictions within the activity system?
2. How can these tensions or contradictions be resolved and will the resolution of tensions or contradictions lead to the m-learning readiness of students?

In the next section, internal and external contradictions are identified and discussed.

4.3.1 Internal and External Contradictions

Activity systems are characterized by system tensions, hence, the first step is to identify and clarify the tensions within the system (Barab et al. 2002: 85). Once identified, these systemic tensions can assist in understanding what changes need be made to the system to achieve the object. Using the critical themes of the study, as indicated below, possible tensions are identified from the results of data collected from the survey questionnaire and the focus group interviews. The themes are identified as follows:

- Theme 1: Ownership of mobile devices to engage in advanced m-learning activities;
- Theme 2: Mobile connectivity affordability;
- Theme 3: Ownership of other types of mobile devices;
- Theme 4: Mobile phone profile for successful m-learning approaches;
- Theme 5: Awareness and attitude towards m-learning; and
- Theme 6: Ongoing support and training for m-learning.

The transformation of the object into outcomes is based on the extent of possible contradictions that might exist within each of the themes and the resolution thereof. These tensions can be thought of as system dualities, and it is through understanding the interplay within and among these dualities that one can best understand and support the continued innovation of the system (Barab et al. 2002: 80). Tensions have been identified by analysing the results of the study. Relevant literature from other studies provide a comparative analysis as discussed below.

Theme 1: Ownership of mobile devices to engage in advanced m-learning activities

The results show that a primary inner contradiction manifests at the **subject node** since 17.9% of students have handsets with no internet connectivity and are immediately excluded from more advanced m-learning approaches. This finding correlates closely with the results of the focus group interviews where 19% (4/21) had no internet connectivity. Students were in conflict within themselves regarding ownership of mobile devices with internet connectivity as opposed to meeting other important commitments they may have with limited income. Hence this inner contradiction is bound to hinder the ownership of a mobile device that could be used in advanced m-learning activities **(object)**.

According to activity theory discussed in chapter three, rather than focusing on the object that cannot be achieved, a new activity and a new object is born, that of ensuring subjects gather enough income to afford internet enabled handsets. The outcomes, namely, achieving readiness for m-learning and improving academic results can only be achieved once all students are in possession of internet enabled mobile handsets. Similar results were reported in the Kreutzer (2009) study conducted on low income SA youth that showed approximately 75% of students had technically more advanced mobile phones with features such as inbuilt camera, music player, file sharing via Bluetooth or infrared. With regard to internet connectivity, this study showed that 83.1% students own a mobile handset with internet connectivity while the Kreutzer (2009) study showed that internet access was 79% among low income SA youth from urban areas.

The resolution of this contradiction in the **subject node** would enable a shift in the activity system towards the attainment of the object and, hence, outcomes.

Recommendation 1: Ownership of mobile devices with internet connectivity

The researcher presented a peer reviewed paper related to this study titled *"Mobile learning in Higher Education: a study of the technology readiness of students at a South African Higher Education Institution*" at the ZAWWW 2012 conference held in Durban. Delegates recommended that a vendor be sourced by the HEI to provide free mobile handsets to students as part of their social responsibility. Alternatively, delegates also suggested that a mobile device with internet connectivity be provided by the HEI (factored in their budget) as part of their m-learning programme.

These devices should be provided to all students when they register so that they can have access to the same features and functionality. This would guarantee 100% mobile phone ownership and the HEI can design sustainable m-learning programmes around a base set of features and functionality to resolve the inner contradiction of the subject node under theme 1.

While this recommendation provides accessibility of mobile handsets to all, it will not ensure affordability of exorbitant connectivity costs. Abas, Peng and Mansor (2009) concur with low affordability of connectivity costs as they advocate that HEI's form a smart-partnership with industry players such as mobile telecommunication operators and manufacturers of mobile devices who have an interest in m-learning to assist with connectivity costs. According to them, the smart-partnerships would bring richer and more meaningful learning opportunities to students and resolve technical issues as well. Establishment of such smart partnerships is expected to contribute positively to the teaching and learning environment.

Theme 2: Mobile connectivity affordability

The object of the students (subjects) is to afford mobile connectivity costs. The results showed that the majority of students (67.2%) can afford a maximum of R100 pm towards mobile connectivity. Only 11.4% of students are in a position to afford data bundles to fulfill the promise of m-learning, as intended. The study results showed that a secondary contradiction exists between the student (**subject)** and the HEI (**community).**

The focus group interviews confirmed similar tensions between the **subject** and the **community** as 71% of students (15/20) indicated that they could afford no more than R100 pm. The focus group interviews revealed that students had the perception the HEI has an expectation that they must use m-learning, be it formally or informally, without considering affordability. The students at the focus group interviews revealed that they would prefer to use less costly mediums for academic support like tutorial support provided by the HEI. This is at no extra cost to them. The duality persists. In keeping with the principles of activity theory, the tension related to the mobile connectivity affordability must be resolved in order to achieve m-learning readiness (outcome).

The connectivity affordability costs presented in table 17 showing the mobile connectivity affordability patterns of students include allowance for voice call and text messaging costs which are the first and most important uses of mobile handsets. In reference to table 2 which discusses the cost of data bundles, the cheapest data bundle available is R99 for 250 MB. It is evident that the majority of students (67.2%) will not be in a position to afford data bundles over and above their voice call and text messaging costs. In the next affordability bracket R101 – R300 of table 17, only 21.4% students are able to afford data bundles in the range of 175 – 500 mb. However, the spread available in this bracket (5.53 – 16.67 mb per day) is modest in terms of data usage, even if services such as internet and email are used sparingly. The results indicate that for the majority of students, data bundles are too costly. The other alternative to the purchase of data bundles is a more expensive out of bundle rate (refer to table 2), which is not feasible either, as it offers less data than bundles.

According to students who attended the focus group interviews, they incur other costs imposed by the HEI such as textbooks, lab fees, etc. This puts a strain on students' budgets making mobile connectivity unaffordable. Sarker and Wells (2003: 38) advocate that even though the advantages of mobile phones are apparent and desirable, for many, the convenience is not worth the additional expense, especially for students.

The results show that students are overtaken by mobile affordability issues that are constrained by the community, as stated in the above paragraph, and now students need to focus on this as an object for a new activity. The object of this new activity must first be achieved for the system to move forward.

A further quaternary contradiction exists under this theme between the **community** represented by the mobile network operators and **components of other activity systems,** such as government relating to prices. Mobile network operators would like to keep prices as affordable as possible to enable m-learning for students, but prices are regulated by the government. This duality persists.

Recommendation 2: Work around exorbitant connectivity costs

The results show that the majority of students can afford up to a maximum of R100 pm in mobile connectivity costs. Taking this into consideration, do the results then imply that m-learning is not feasible? Not necessarily. Cost cutting practices in m-learning could mean the design of m-learning programmes using non-paying mobile services such as recording, or playing audio and videos, taking or viewing photos, or taking notes and using calendars. Making electronic resources available via Bluetooth broadcasting and Wi-Fi on campus, for example, appears to be a particularly workable solution.

Table 28 offers a few suggestions on m-learning approaches based on the available data. In particular, it suggests various combinations of applications, which together, form meaningful m-learning strategies at a maximum monthly cost of R15 to the student, as extracted from the Vodacom (2013) website. The percentages of students that have the feature/application available on their mobile handsets in this study are also indicated.

Table 28: Combined m-learning technologies to form meaningful m-learning approaches under a maximum cost of R100

Application	%	M-learning Strategy	Cost
Bluetooth technology Media Player/ MP3 player	85% 81% 77%	They can download content with Bluetooth in class. Maybe a sound file of the lecture as presented and recorded and made available immediately after the lecture. Students can exchange diary dates, telephone numbers and other contact information from one device to another. Lecturers can share files and information with students (Meighan, Doolan and Tabirca 2007).	Nil
Photo camera MMS	85% 80%	Students can take a picture, type a long message, record sound or send an animation – or do it all at once. A standard sized MMS (300 KB or less) costs just 80 cents (Lin et al. 2010).	25 MMS's bundled at the cost of R15.00
Voice recording Media Player MP3 Player	85% 81% 77%	Language assisted m-learning	Nil
Video recording Bluetooth technology Media Player	85% 85% 85%	Make a video of some practical task/demonstrations on complicated procedures and allow students to view. The iPod portable media player from Apple allows users to download music, audio books, podcasts, photos, and video. (Corbeil and Valdes-Corbeil 2007)	Nil
SMS	98%	SMS can be used in direct or indirect teaching. Useful to provide feedback, updates and reminders (Lominé and Buckhingham 2009).	20 SMS's bundled at R10.00
SMS/MMS Additional Memory	98% 0%	Make a video, take a picture, type a long message, record sound or send an animation – or do it all at once. Feedback can be given via SMS. MMS's utilize phone memory so additional memory can be used. Multimedia form of presentation having a great potential in motivating the learners and helping them to better understand the content (Lin et al. 2010).	25 MMS's bundled at the cost of R15.00 20 SMS's bundled at R10.00
Bluetooth Media Player Advanced Graphics Display	85% 81% 67%	Download Multimedia content from a PC and use media player to display on phone with advanced graphic display.	Nil
Java support & Advanced Graphics Display	67% 67%	Mobile games using advanced graphic display.	Nil
GPS Word processor SMS	51% 31% 98%	Use GPS for location aware exercises. Make notes on memo pad and share information or receive feedback via SMS/Email (Lominé and Buckhingham 2009).	20 SMS's bundled at R10.00

Minimizing costs using no or low cost services can provide meaningful m-learning approaches, provided that features and functionality are available on student handsets. Adhering to these recommendations will help resolve conflicts identified by the subject and the community under theme 2 and result in an expansive transformation of the activity system.

Theme 3: Ownership of other types of mobile devices

The results show that 57.5% of students have other types of mobile devices. This immediately excludes 42.5 % of students who do not own other mobile devices and represents a contradiction. Hence, a tension exists between the **subject** and **community** since students, who do not possess other mobile devices, prevents the HEI from allowing greater flexibility in m-learning approaches.

Interestingly, of these other types of devices owned, 20.2% do not require data bundles for use (iPod, mp3 player, PDA), but are potentially useful in novel m-learning approaches. A further 24.3% have access to advanced mobile devices like iPads, tablets and smart phones. These devices are intuitively more suited and configurable to m-learning approaches than handsets, particularly given the rapidly growing market for, and availability of, secondary mobile device applications, many of which are free downloads. Students' ownership of other mobile devices, whether it requires data bundles or not, can clearly benefit them for m-learning.

In the context of this study, the **subject** must not only consider the mobile handset as the medium for the delivery of m-learning programmes, but ownership of other mediating tools are required. It has already been shown that students' affordability of a primary mobile device is low (theme 2). The contradiction created here is that students cannot afford another type of mobile device and, in the focus group interviews, many students reported that the HEI expects ownership of other types of mobile devices to promote greater flexibility in m-learning approaches.

Recommendation 3: M-learning for other types of mobile devices

Owing to cost factors, the HEI cannot provide ownership of other types of mobile devices to students considering that there is still a gap in student ownership of a primary mobile device. However, for wider access to m-learning, delegates of the ZAWWW 2012 conference recommended that HEI's ensure that m-learning approaches are available in formats that could be displayed on other mobile devices. This will ensure increased motivation and flexibility in student preferences for those that own and can afford other mobile devices. For example, Wishart and Green (2010) found that PDA's are used extensively by students for email, calendar and spreadsheets.

Theme 4: Mobile phone profile for successful m-learning approaches

The results of this study showed that the majority of students have access to email facilities (75.90%) and SMS's (97.89%). The results of the focus group interview showed that 100% of students have access to SMS while 81% have access to email. These results suggest that any m-learning approach adopted by the HEI that uses SMS technology is bound to be more successful than one that uses email. A contradiction thus exists here between the **subjects** and the **tools**. Students are unclear on what low cost mobile technologies are required for meaningful m-learning and their decision is complicated by the variety of tools of choice. At the **tool node,** advanced mobile handsets come with lucrative fixed term contracts or at high cost on the pay as you go option (Vodacom 2013). Very little choice on the features and functionality are given to students and, most often, the type of mobile device chosen is based on affordability of either the contract or pay as you go plans (Chigona, Kamkwenda and Manjoo 2008: 11).

Successful m-learning approaches should consider the features found on most students' handsets. Email and SMS are the two popular collaboration technologies, however, the email functionality is available in later models of mobile devices such as smartphones. Although email is available on student handsets, many students in the focus group interview revealed that they do not enable this facility on their phones as they cannot afford internet connectivity.

Sarker and Wells (2003: 38) found that the pricing plans of various service providers encouraged and discouraged different types of behaviour. The popularity of SMS's in Norway, compared to Thailand, for example, was attributed to the relative costs associated with this form of communication in the two countries. On the other hand, Corbeil and Valdes-Corbeil (2007) in the USA, confirmed greater popularity for email (98%), as compared to SMS's (45%).

A secondary contradiction exists between the student (**subject)** and the **tools** as clearer guidelines on mobile phone profiles are required by students to assist them when purchasing mobile devices for m-learning.

Arising from the results above, secondary tension also exists between the **community** and the **rules.** The duality presented here is that the HEI **(community)** must ensure that students possess mobile phones with a base set of functionality. They cannot expect students to buy what is needed but must adapt to what students currently have. Students, at the focus group interview, revealed that there are no **rules** to prescribe or advise them as to what features and functionality are necessary on the mobile handset. The HEI should provide minimum rules to students. In this study, features such as photo camera, Bluetooth technology, video recording, voice recording, media player and MMS technology are available to 80% and more students. It is evident that features such as internet and email are absent from this list. The HEI could choose an m-learning approach that requires features such as internet and email to be used. This will definitely result in the failure of m-learning at the HEI. A shift is required among the components **community** and **rules** to achieve the object.

The next section proposes recommendations on how the contradiction between the **community** and the **rules,** as well as the **subject** and the **tools,** discussed earlier, could be resolved towards the attainment of the object.

Recommendation 4: M-learning approaches utilizing popular m-learning technologies

The conflict between the subject and tools and the community and the rules can be resolved if students are clear as to what mobile technologies are required for successful m-learning. The HEI should choose m-learning approaches that utilize the popular mobile technologies. The HEI under study should conduct annual surveys on the features and functionality on students' mobile handsets. Table 29 is synthesized by extracting from table 1 (in chapter two) the mobile technologies required and data bundle requirements in combination with the results from figure 2 (in chapter four). This table provides useful guidelines for the HEI under study on what m-learning approaches are most likely to be successful. It can also be used to advise students on the features and functionality of mobile handsets they can purchase for m-learning programmes.

Table 29: Mobile technologies required, activities available to students and data bundle requirements in rank order

Mobile technologies required	Activities	Data Bundle requirement	Percent Students
SMS	Share downloaded data, Share learner created data	None	97.89
Photo camera	Take photos	None	85.24
Bluetooth technology	Share downloaded data, Share learner created data	None	84.94
Video recording	Record sounds	None	84.64
Voice recording	Record sounds, Take notes(audio)	None	84.64

Mobile technologies required	Activities	Data Bundle requirement	Percent Students
Media player	Download content from internet	Medium	81.33
MMS	Read/post to web forms, Read/post to wikis, Read/post to blogs	None	80.12
Mp3 player	Review audio notes, Review recorded sounds, Review downloaded internet content	None	76.81
Email	Share downloaded data, share learner created data	Medium	75.9
Additional memory	Use Multimedia Applications	None	71.39
Mobile web	Contribute to web forums, Contribute to wikis, Contribute to collective blogs, Social Networking, Use Email, Download Content	Large	71.08
Java support	Collect data linked to GPS	None	67.47
Instant messaging	Collaborate with others	Medium	66.57
Advanced graphic display	Review photos, Review test text notes, Review audio notes, Review recorded sounds, Review downloaded internet content	None	65.66
GPS facilities	Use GPS	Large	51.2
Word processor	Plan studies, Record performance/results, Store passwords, Store confidential info, Take notes(text) , Use bespoke software	None	30.72
Presentation programme	Create foreign language flash cards	None	26.2
Spread sheet	Record performance/results	None	25.3
Video conferencing	Use bespoke software	None	24.4
E-book reader	Use encyclopedias, use course material	Medium	21.08

Table 29 serves as a useful sliding scale for the type of m-learning activities that can be incorporated into any m-learning approach based on the features and functionality present on students' mobile handsets. Two examples are provided below, based on the results of table 29, to illustrate m-learning approaches that can be considered by the HEI under study.

In the first example, most mobile handsets have SMS capability (97.89%) while a low percentage of students have access to an e-book reader (21.08%)– the latter ostensibly more useful for both advanced m-learning approaches as well as basic learning activities such as reading an electronic text book. In this example, it will be more useful to design m-learning approaches that make use of SMS's than e-book readers.

In the second example, 85.24% students have access to the photo camera facility. This feature, in conjunction with the popular MMS feature (80.12%), can be used effectively in collaborative m-learning. An innovative application of the photo camera is the ability to do visual searches. According to Low (2013), Google has created an application called Goggles that enable students to perform visual searches in conjunction with the mobile web. The results show that the majority (70.08 %) have access to the mobile web. Goggles will enable students to find information about the physical world assuming they don't have any prior knowledge. Low (2013) explains that if a student is unfamiliar with an object, say for example, while on a field trip, a student requires information on a particular chair. The student can take a photo of the chair and let Google's servers find information about the chair such as who manufactured it or designed it. The same will apply to unusual insects, species of tree, graphic designs, sculptures, or whatever the student might happen to be interested in learning. If cost issues around mobile internet are negated, approaches like these in m-learning programmes will be more successful than trying to implement m-learning approaches that rely heavily on features such as instant messaging, GPS facilities or using a word processor to which fewer students have access.

HEI's who want to implement m-learning, but are constrained by factors such as cost and functionality, can choose m-learning approaches that incorporate the principle of technological minimalism advanced by Collins and Berge (2000). This principle dictates that readily available mobile technologies, such as SMS clients (98%), photo camera (85%) and Bluetooth (85%), should be incorporated in m-learning approaches. Such minimalistic approaches have been used with success in the past. Andaleeb et al. (2010) quote research conducted by the University of Pretoria on students based in remote South African rural areas where SMS's were effectively used when providing basic administrative support in three teacher training programmes.

In summary, m-learning approaches must be designed according to the features and functionality that are available on students' mobile handsets. The principle of technological minimalism can be employed when there are cost and/or functionality constraints.

Theme 5: Awareness and attitude towards m-learning

In the focus group interviews, many respondents (10/21) articulated that they are not fully aware of the benefits of m-learning. So, it is not clear to students, why they should have a positive attitude towards m-learning. The survey results confirmed that only 43.37% are aware of m-learning. In the attitudinal survey, 79.82% displayed a positive attitude towards using m-learning. Only 26.2% of students needed to improve their attitude towards m-learning. The focus group interviews confirmed these results as the majority of the students indicated that, although they never used m-learning before, they were willing to try it. The HEI expects the students to have a positive attitude towards m-learning because of the many benefits associated with it. A tension thus exists between the **subject** and the **community** regarding awareness and attitude.

It is important for this tension to be resolved as studies concur that a positive attitude towards m-learning is required for this learning technology to be used successfully. Corbeil and Valdes-Corbeil (2007: 57) reported that 94% of the students, in their study, have a positive attitude towards m-learning. Motiwalla (2007: 592), who conducted an attitudinal and awareness survey amongst higher education students in the USA, reported that students are generally positive about m-learning. Over 60% of respondents agreed that m-learning added value to learning and foresaw the strong role of mobile devices in improving the flexibility and efficiency of the learning environment. Furthermore, the MobilED project conducted in SA showed that students who are positive about mobile phones in the classroom, more readily used mobile phone technologies and services (Ford and Batchelor 2007).

The tension that exists between the **community** and the **subject** regarding their attitude must be overcome (26.2%). More effort, however, is required to improve the students' awareness of m-learning. By the HEI increasing awareness, the chances of students improving their attitude will be better (Trifonova, Georgieva and Ronchetti 2006). A shift within or among these components of the activity system could see tensions resolved and the object being achieved.

The next section proposes recommendations on how this contradiction between the **subject** and the **community** could be resolved towards attainment of the object.

Recommendation 5: Improving awareness and attitude for m-learning

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO 2013) Policy Guidelines for m-learning, people tend to view mobile phone devices as portals to entertainment, not to education. The tension between the **community** and the **subject** can be resolved if the HEI takes the following steps to ensure that students are aware of m-learning and that they develop a positive attitude towards m-learning:

- Use marketing material to highlight and model how mobile technology can improve teaching, learning, and administration (UNESCO 2013);
- Share research findings and evaluations of m-learning programs with students (UNESCO 2013);
- Encourage dialogue among key stakeholders including lecturers, students, parents and community-based organisations about m-learning (UNESCO 2013);
- Provide a coherent vision of how technology, including mobile technologies, will further learning goals (UNESCO 2013);
- Encourage lecturers to incorporate m-learning into their teaching and curriculum;
- The HEI's management must commit to utilizing this technology and this must be advertised in all faculties; and
- The HEI can provide training on m-learning to interested students on a voluntary basis.

Theme 6: Ongoing support and training for m-learning

The results show that over 70% agreed that support is necessary for m-learning and over 62% agree that training is necessary. The results of the focus group interview show that 67% of students (14/ 21) require support and 57 % of students (12/ 21) require training in m-learning. These results represent the majority and confirm that a tension exists. The results show that students would like training and ongoing support to be available for m-learning and require the HEI to make provision for it. In an interview with the director from the centre for learning and teaching (CELT) of the HEI, it was revealed that the HEI would like to make provision for support and ongoing training for students, but are constrained by other factors such as funding, staffing, timetabling and budgets for support programmes. Hence, a secondary tension exists between the student **(subject)** and the HEI **(community)**.

Kukulska-Hulme (2007: 8) asserts that the Manolo Project (2005), in its published summary of lessons learned from the project, emphasized the need for various types of support including technical support. A resolution of the contradiction in terms of support and ongoing training will shift the activity system towards achieving the object.

In order for students **(subject)** to achieve m-learning readiness **(outcome),** the tension around support and training required must be resolved.

Recommendation 6: Ensuring training and ongoing support

The development of staff and students in mobile technology and m-learning is important to ensure that mobile devices are used responsibly in institutions (Wishart and Green 2010).

This recommendation is responsible for resolving the contradictions highlighted between the subject and the community. The following guidelines are provided to ensure that any tension that exists between the community and the subject regarding training and ongoing support is resolved:

- The HEI must ensure that budgets are in place for ongoing training and support for students;
- Schedule training for academic staff on m-learning on how to incorporate m-learning into the classroom and curriculum using appropriate mobile technologies; and
- The HEI must find some way to endorse peer support through social networking and chat sites (Wishart and Green 2010).

Summary

In summary, the contradictions embedded in the themes above are likely to persist as long as the components of the activity system remain constant. To ensure m-learning readiness, contradictions identified have to be addressed by reassessing and redefining components involved in contradictions. This will ensure a shift in the activity system towards the attainment of the object.

In theory, by adhering to all the recommendations, from recommendation one to recommendation six, it will ensure that tensions in the activity system can be overcome and will lead to m-learning readiness. However, in practical terms, decisions around resolving some complex tensions, for example, finding meaningful m-learning strategies that utilise low/non costing services are not so simplistic to resolve and, due to the HEI policies and bureaucracies, it may take several years before all resolutions can be implemented.

It is, therefore, recommended that resolutions be ranked according to ease of implementation and a phased approach to resolving tensions be applied before m-learning, in its true sense, can be utilized with great success. In the next section, the chapter summary is presented.

4.4 Chapter Summary

In this chapter, the results obtained from the closed and open-ended questions in the questionnaire were presented in the form of frequency distribution tables and graphs. The emerging factors were thematically analyzed from the questions of the survey using the activity theory. The findings of the focus group interviews were used to triangulate and strengthen results. In the next chapter, the summary, the main conclusions and implications of the study are presented.

5. SUMMARY, CONCLUSIONS AND IMPLICATIONS OF STUDY

Contents **Page**

5.1 Introduction

The previous chapter dealt with the presentation of results and a discussion thereof. This chapter focuses mainly on three issues. Firstly, the summary of the study is presented. Secondly, conclusions emanating from the findings related to the key research questions are made. Finally, implications of the study, the future of m-learning as well as areas for further/future research in the field are also suggested. The chapter concludes with a summary.

5.2 Summary of the Study

Chapter one provided the background and orientation to the study. In chapter one, reasons and justifications why this research topic is of interest were elucidated. “Today, a growing body of evidence suggest that ubiquitous mobile devices – and mobile phones in particular – are being used by students and teachers around the world to access information, streamline administration, and facilitate learning in new and innovative ways” (UNESCO 2013). HEI’s embarking on m-learning must consider the readiness of their students to use this technology before they implement it. The aim of this research was to establish the technology and operational readiness of students for m-learning at a South African HEI. In-depth research was conducted using the key research questions as a terms of reference.

The research questions were:

Technological readiness

a. *What m-learning applications are currently available?*
b. *What are the technology requirements of these m-learning applications?*
c. *To what extent does the student mobile handset profile fit the m-learning applications technology profile?*

Operational readiness

d. *What are students' awareness and attitude towards m-learning?*
e. *What m-learning support and training do students require?*

The significance of the study was to identify and address issues relating to the readiness of students for m-learning. It also addressed the issue of HEI's taking into account their students' level of readiness when preparing m-learning programmes.

Chapter two surveyed the literature as it relates to technology and operational requirements of currently available m-learning applications. Chapter two was introduced with the evolution of the definition of m- learning being unpacked. It was observed that the focus in the definition has evolved from the mobile device to the mobility thereof. Thereafter, issues relating to technology readiness were investigated.

The literature study on technology readiness began by reviewing the mobile technologies available. This was followed by a review of the extent of mobile device ownership as this was the first and foremost technology requirement in this study. The extent of device ownership from research studies abroad showed that mobile device ownership is increasing and the mobile phone is the most widely possessed mobile device (Idrus and Ismail 2010). In order for the device to be technology ready, it must run a base set of mobile applications required by m-learning approaches. The Clough et al. (2008:364) framework for categorizing mobile applications was introduced. Thereafter, a literature review, ordered under various 'types of m-learning applications', was undertaken. Based on the requirements of the framework of Clough et al. (2008:364) and the requirements of m-learning applications, an extended framework was proposed that took into consideration technologies used and data bundle requirements.

The cost of data bundles surveyed was presented. The data bundle cap varied from 250 mb to unlimited access. Prices varied depending on the cap and the type of the data bundle (prepaid or contract). A 500 mb data bundle (reasonable size) can be purchased at a cost of around R150, while smaller data bundles, such as a 250 mb data bundle, can be purchased at a cost of approximately R100. The cost of the mobile handset must also be factored into the total connectivity costs. Although researchers, such as Iqbal and Qureshi (2012: 148), suggest that prices have decreased, the question of whether these prices are affordable to students needs to be answered.

The review continued by highlighting various operational readiness factors such as students' awareness of and attitude towards m-learning. Various research studies conducted globally and locally, such as the study by Trifonova, Georgieva and Ronchetti (2006), the Stockwell (2008) study and the Ford and Batchelor (2007) study have shown that students, who are aware of m-learning and who display a positive attitude towards m-learning, will be successful at m-learning. Iqbal and Qureshi (2012: 158) have shown, in a study conducted in a developing country like Pakistan, that students' attitude towards the usefulness of m-learning and its ease of use can influence whether they will be successful at m-learning.

Other operational factors such as the importance of ongoing training and support were also highlighted in the literature. The chapter concluded with the theoretical and conceptual framework chosen for this study. Since m-learning occurs within a certain context, activity theory was the chosen theoretical model as a basis for understanding a students' level of readiness for m-learning. The theory and its concepts were discussed.

Chapter Three focused on the research design of the study. This chapter was presented under three sections, namely, the philosophical framework, the strategy of inquiry and the research methods. The chosen philosophy was activity theory. The case study approach was the selected strategy of inquiry and a mixed methods research design was employed. The quantitative research was in the form of a survey questionnaire. Questions were drafted on the basis of the extensive literature review. Permission was sought from the HEI and the research employed stratified random sampling as a sampling technique. A sample of 372 students was chosen from a student population of 23 227. A response rate of 89% was achieved for this study. The qualitative research in the form of the focus group interview was employed to strengthen the results. Issues relating to validity and reliability were also discussed.

Chapter four presented the results of the study in the form of tables, graphs, cross tabulations and other figures. The results were discussed by analyzing the results under themes using relevant research and the underlying conceptual framework.

In the next section, conclusions of the study are made.

5.3 Conclusions of Study

Technological advancements have brought many positive changes in the way one learns. The availability of more advanced mobile devices capable of using currently available m-learning applications have placed HEI's in a strong position to benefit from m-learning as a form of academic support (Zawacki-Richter, Brown and Delport 2009: 2).

Based on the aim and the key research questions, some clear conclusions are arrived at after analyzing the data. The study set out to answer the following questions as they relate to the technology and operational readiness of students for m-learning: Firstly, what are the technology requirements of currently available m-learning applications and to what extent do student mobile devices comply with these requirements? Secondly, from an operational readiness perspective, what are students attitude and awareness of m-learning and what training and support do they require for m-learning? The study was able to provide detailed data on the targeted population as well as highlight significant relationships between different factors, such as mobile phone ownership, mobile phone features and functionality, attitude towards, awareness of, training and support required for m-learning.

A summary of findings into technology readiness is presented below:

1. Mobile handset ownership in this study was 98.2% while mobile handset ownership with internet connectivity was 83.1%;
2. The majority of students can afford only a maximum of R100 pm for their total mobile connectivity;
3. More than half the respondents (57.5%) own or have access to other mobile devices; and
4. More than two thirds of the students indicated that they have the following features on their mobile phones: SMS (97.89%), photo and video camera (85.24%), Bluetooth technology (84.94 %), MMS (80.12%), Mp3 player (76.81%), email (75.90%), internet connectivity (71.08%), additional memory slots (71.39%), IM (66.57%), advanced graphic displays (65.66%) and java support (67.47%).

Based on the data gathered and presented, this study has to conclude that any m-learning endeavour is bound to fail if the answers to the questions in the paragraph above are unknown.

Although findings 1, 3 and 4 are positive, finding 2 creates a problem. The findings show that the technology requirements of currently available m-learning applications, the extent to which student mobile handset devices comply with these requirements, and the extent to which students are able to afford the data bundles required to effect advanced m-learning strategies, are, at best, unfavourable.

A summary of findings into operational readiness is presented below:

1. 43.37% of students are aware of m-learning;
2. 79.82% of students would like to use m-learning for academic support;
3. 70.18% of students need help desk support;
4. 78.61% of students need online support;
5. 69.28% of students need training on m-learning; and
6. 62.35% of students need training on mobile handset functionality.

Regarding operational readiness, the survey data indicated that students approached technology with a degree of expectation as over three quarters of the students expressed an interest in using mobile phones for academic support but a higher level of student awareness is required for m-learning. The majority of the students agreed that online support and help desk support was necessary. The study reported positive results with regard to training on mobile handset functionality and use of m-learning tools. Although findings 2 to 6 favour operational readiness for m-learning, finding 1 is problematic and needs to be addressed. It is therefore safe to say that, from an operational perspective, any immediate implementation of m-learning would prove unsuccessful as a greater awareness of m-learning is required. By increasing an awareness of m-learning, students' perceptions on the ease of use, support and training required for m-learning will also improve.

Different results can be expected if the same study is repeated with students from other HEI's as there can be a variety of factors such as socioeconomic status, exposure to technology, institutional policies and infrastructure that can have an influence on level of student m-learning readiness.

In the next section, the implications of this study are discussed.

5.4 Implications of the Study

The results of the research study showed that, in terms of technology and operational factors, immediate implementation of m-learning is unfavourable at the HEI under study. This does not imply that there is no space for novel m-learning approaches using the best and most cost-effective approaches, as suggested under the recommendations. Instead of a tendency to 'throw' technology at students in an attempt to gain a competitive advantage over competing HEI's, the researcher suggests that regular – if not annual - surveys targeting the technology and operational readiness of students are held before any decision on a m-learning strategy is implemented. Activity theory, as the chosen theoretical framework for this study, advocates that the system is in a constant state of transition and, therefore, consistent analysis over a period of time would result in the attainment of the object (m-learning readiness) at some point.

Another implication of this study is for the HEI, under study, to implement m-learning by structuring it around mobile technologies and applications that are highly represented and have no or low costs, such as SMS, photo camera, Bluetooth technology, media player and MMS. Implementation should initially be piloted in some faculties only as there are cost and logistic implications for a full-scale implementation and the HEI can use the pilot study to review the practicalities, benefits and challenges of their approach (Gregson and Jordaan 2009: 226).

Content and information can be made available to students in formats that are easily accessible on a mobile phone. To make instructional content more portable, instructors can convert their lectures into podcasts or vodcasts. These files can be transferred via Bluetooth to students. Information can be communicated to the learning community in an easy and convenient way. Instructors can also configure their voicemail systems to deliver important messages or class announcements when students call in. A phased approach with incremental gains into m-learning is more meaningful as opposed to an 'All or Nothing Approach'.

In the next section, the future of m-learning is discussed.

5.5 The future of m-learning

There are 5.3 billion mobile subscribers worldwide, which equates to 77% of the world's population (Oller 2012). At the same time, there is an increasing number of m-learning applications in the market place, for example, the itunes app store offers 46,340 apps and the android platform offers 12 129 apps in the education field (Oller 2012). These applications can be accessed on a wide variety of mobile devices. Owing to the high penetration of mobile educational applications, Sarrab, Elgamel and Aldabbas (2012: 33) see the future of m-learning as the next generation of e-learning.

The UNESCO (2013) report offers six predictions for the future of m-learning. Firstly, there will be technology that is more accessible, functional and affordable. Secondly, mobile devices will have the computational power to collect, synthesize and analyse ‘big data’. Thirdly, new data types, such as speed, sound or movement using sensor technology, will be created. Fourth, translation will take place seamlessly breaking language barriers in learning. Fifth, screen size limitations will disappear where projectors or glasses can be used to show much larger displays than what is physically available. Finally, energy sources and power capacity will improve as batteries become smaller, cheaper, longer lasting and faster to charge.

Kadle (2012) highlights four key trends for the future of m-learning. He concurs with the UNESCO (2013) report that predicts that the mobile devices will be able to handle ‘big data’. His second prediction is that, through the use of powerful mobile devices, learning that used to be considered conventional will now become ubiquitous. Thirdly, he contends that social networks will be used increasingly in m-learning. Finally, he predicts that the interconnectedness of the web will ensure that the mobile device will be used with greater ease as an ‘intelligent companion’ satisfying the demands of the user.

Marinagi, Skourlas and Belsis (2013) predict that classrooms of the future will be ubiquitous learning environments with m-learning playing a significant role. This classroom will provide students with facilities to support the mobile learner using mobile devices. On-line and real-time support, social networking, help desks, multimedia as collaborative tools will be some of the facilities that will be provided in the classroom of the future. Mobile augmented reality will also be used for learning in this classroom of the future where the user will be required to interact with virtual objects using his/her mobile device (Ifenthaler and Eseryel 2013: 429). Marinagi, Skourlas and Belsis (2013) concur that this is possible because they predict that mobile devices will have increased power and capabilities and will be available at a lower cost in the future.

In the next section suggestions for future research within this area of study are discussed.

5.6 Future Research

According to Wu et al. (2012: 186), there were 164 studies on m-learning from 2003 to 2010. Previous studies of m-learning fell into four categories, namely, (1) the effectiveness of m-learning (58%), (2) design of m-learning programmes and evaluating the effects on m-learning (32%), (3) investigating the affective domain during m-learning (5%) and (4) evaluating the influence of learner characteristics in the m-learning process (5%) (Wu et al. 2012: 186). Ample scope for m-learning research, therefore, exists in the latter two research areas. The demand for m-learning research is on the increase as mobile devices proliferate.

According to Bosomworth (2013), mobile devices are increasing their share of website traffic and current statistics show that mobile devices use roughly 20% of mobile traffic while desktops use 80% of website traffic. “Analysts believe that, based on the current rate of change and adoption, the mobile web will be bigger than desktop Internet use by 2015” (Newman 2012). This prediction suggests that there is ample scope for m-learning research in higher education, especially around m-learning readiness at the various SA HEI’s that want to implement m-learning (Wishart and Green 2010).

This research study includes all four research areas in m-learning as mentioned in the first paragraph. Future research on m-learning readiness should focus on a standardised scoring and rating methodology that will allow HEI’s locally and globally to rate themselves and see how they compare. This will give them a chance to identify where they rank among other HEI’s and highlight the actions to take in order to improve. This can only be achieved if there is greater collaboration between HEI’s in SA and globally in the arena of m-learning readiness. Further to this HEI’s locally can benchmark with global HEI’s with similar contextual factors to learn how they address their m-learning readiness problems.

To conclude, a summary of the chapter is presented in the next section.

5.7 Chapter Summary

The chapter began with a summary of the study. The conclusions of the research study based on the research questions were made. The implications of this study and the future of m-learning were discussed. The chapter concluded with suggestions for future research in this area of study.

6. REFERENCES

Abas, Z. W., Peng, C. L. and Mansor, N. 2009. A study on learner readiness for mobile learning at Open University Malaysia. Paper presented at the *IADIS International Conference Mobile Learning.* Barcelona, 26-28 February 2009.

Andaleeb, A. A., Idrus, R. M., Ismail, I. and Mokaram, A. K. 2010. Technology Readiness Index (TRI) among USM Distance Education Students According to Age. *International Journal of Social Sciences*, 5 (3): 189-192.

Attewell, J. 2005. From research and development to mobile learning: Tools for education and training providers and their learners. In: Learning and Skills Development Agency, 1-6

Attewell, J., Savill-Smith, C. and Douch, R. 2009. *The impact of mobile learning: examining what it means for teaching and learning*. London: Newnorth Print Ltd.

Babbie, E. 2001. *The Practice of Social Research*. Belmont: Wadsworth.

Babbie, E. 2008. *Introduction to social research*. International ed. Belmont: Wadsworth.

Barab, S. A., Barnett, M., Yamagata-Lynch, L., Squire, K. and Keating, T. 2002. Using Activity Theory to understand the systemic tensions characterizing a technolgy-rich introductory astronomy course. *Mind, Culture, and Activity*, 9 (2): 76-107.

Barker, A., Krull, G. and Mallinson, B. 2005. A proposed theoretical model for m-learning adoption in developing countries. In: Proceedings of *m-Learn.*

Basharina, O. K. 2007. An activity theory perpective on stident-reported contradictions in international telecollaboration. *Language Learning and Technology*, 11 (1): 36-58.

Basole, R. and Rouse, W. B. 2007. Mobile Enterprise Readiness and Transformation. In: *Encyclopedia of Mobile Computing and Commerce.* Hershey, PA: Idea Group Inc. IGI.

Beger, G. and Sinha, A. 2012. *South African mobile generation: Study on South African young people on mobiles.* New York: UNICEF New York, Division of Communication, Social and Civic Media Section.

Blin, F. and Munro, M. 2008. Why hasn't technology disrupted academics' teaching practices? Understanding resistance to change through the lens of activity theory. *Science Direct*, 50: 475-490.

Bosomworth, D. 2013. *Mobile Marketing Statistics 2013*. Available: http://www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/ (Accessed 5 September 2013).

Brett, C. 2009. Educational Perspectives on digital communications technologies. *Journal of E-Learning*, 6 (3): 281-291.

Brown, T. H. 2004. The role of m-learning in the future of e-learning in Africa? . Paper presented at the *Distance Education and Technology:Issues and Practice.* Hong Kong, February 2004.

Caudill, J. 2007. The growth of m-learning and the growth of mobile computing: Parallel developments. *International Review of Research in Open and Distance Learning*, 8 (2).

Cavus, N. 2011. Investigating mobile devices and LMS integration in education: Student perspectives. *Science Direct*, 3 (1): 1469-1474.

Cebeci, Z. and Tekdal, M. 2006. Using Podcasts as Audio Learning Objects. *Interdisciplinary Journal of Knowledge and Learning Objects*, 2 (1): 47-57.

Cheng, K. and Tsai, C. 2011. An investigation of Taiwan University students' perceptions of online academic help seeking, and their web-based learning self-efficacy. *Science Direct Internet and Higher Education*, 14: 150-157.

Cheung, B., McGreal, R. and Tin, T. 2010. Implementation of Mobile Learning Using Smart Phones at an Open University: From Stylesheets to Proxies.

Cheung, S. K. S., Yuen, K. S. and Tsang, E. Y. M. 2011. A study on the readiness of mobile learning in open education. In: IEEE, 133-136

Chigona, W., Kamkwenda, G. and Manjoo, S. 2008. Uses and gratifications of mobile internet among South African students. *South African Journal of Information Management*, 10 (3): 10-20.

Chinnery, G. M. 2006. Emerging Technologies Going to the MALL: Mobile Assisted Language Learning and Technology. *Language Learning and Technology*, 10 (1): 9-16.

Clough, G., Jones, A. C., McAndrew, P. and Scanlon, E. 2008. Informal learning with PDAs and smartphones. *Journal of Computer Assisted Learning*, 24 (5): 359-371.

Collins, M. and Berge, Z. L. 2000. *Technological minimalism in distance education.* Available: http://technologysource.org/article/technological_minimalism_in_distance_education (Accessed 26 July 2012).

Corbeil, J. R. and Valdes-Corbeil, M. E. 2007. Are you ready for mobile learning? *Educause Quarterly*, 30 (2): 51.

Corlett, D., Sharples, M., Bull, S. and Chan, T. 2005. Evaluation of a mobile learning organiser for university students. *Journal of Computer Assisted Learning*, 21 (1): 162-170.

Creswell, J. W. 2009. *Research design: qualitative, quantitative , and mixed methods approaches*. Thousand Oaks: Sage Publications Inc.

Day, C., Sammons, P. and Gu, Q. 2008. Combining Qualitative and Quantitative Methodologies in Research on Teachers' Lives, Work, and Effectiveness: From Integration to Synergy. *Educational Researcher*, 37 (6): 330-342.

Denscombe, M. 2012. *The Good Research Guide*. 4th ed. New York: McGraw Hill Open University Press.

Dunn, R. L. 2013. *Bivariate - Spearman Correlation Coefficient*. Available: https://experts.missouristate.edu/display/csvhelpdesk/Bivariate+-+Spearman+Correlation+Coefficient (Accessed 21 March 2013).

Economides, A. A. 2008. Requirements of mobile learning applications. International Journal of Innovation and Learning, 5 (5), 457-479.

Engeström, Y. 1987. *Learning by expanding: An Activity-Theoretical Approach to Developmental Research*. Helsinki: Orienta-Konsultit Oy.

Esselaar, S. and Stork, C. 2005. Mobile cellular telephone: fixed-line substitution in Sub-Saharan Africa. *South African journal of information and communication*, 6: 64-73.

Fitton, D. 2007. *Java Development on Mobile Phones*. Available: http://www.caside.lancs.ac.uk/j2me_phone.php (Accessed 20 August 2013).

Fitton, D. 2012. *Java Development on Mobile Phones*. Available: http://www.caside.lancs.ac.uk/j2me_phone.php (Accessed 14 Sept 2012).

Fitzgerald, E. 2013. *Learning on field trips with mobile technology*. Available: http://www.academia.edu/2402087/Learning_on_field_trips_with_mobile_technology (Accessed 20 August 2013).

Ford, M. and Batchelor, J. 2007. From zero to hero–is the mobile phone a viable learning tool for Africa? Paper presented at the *3rd International Conference on Social and Organizational Informatics and Cybernetics* Orlando, Florida, USA, 12-15 July 2007.

Forment, M. A., Guerrero, M. J. C. and Poch, J. P. 2009. Towards mobile learning applications integration with learning management systems. *Multiplatform e-learning systems and technologies: mobile devices for ubiquitous ICT-based education*: 182.

Friedman, H. H. and Amoo, T. 1999. Rating the rating scales. *Journal of Marketing Management*, 9 (3): 114-123.

Georgiev, T., Georgieva, E. and Smrikarov, A. 2004. M-Learning- A New Stage of E-Learning. Paper presented at the *International Conference on Computer Systems and Technologies.* Rousse, Bulgaria, 17-18 June 2004.

Giemza, A., Kunte, O. and Hoppe, H. U. 2010. A Mobile Application for Collecting Numerical and Multimedia Data during Experiments and Field Trips in Inquiry Learning. Paper presented at the *18th International Conference on Computers in Education.* Putrajaya, Malaysia, 29 Nov 2010 - 03 Dec 2010.

Godwin-Jones, R. 2005. Emerging Technologies: Messaging, Gaming, Peer-to-peer sharing: Language Learning Strategies & Tools for the Millennial Generation. *Language Learning and Technology*, 9 (1): 17-22.

Gregson, J. and Jordaan, D. 2009. Exploring the challenges and opportunities of m-learning within an international distance education programme. *Mobile Learning*: 215.

Gupta, P. 2010. *Short Message Service: What, How and Where?* Available: http://www.wirelessdevnet.com/channels/sms/features/sms.html (Accessed 10 August 2013).

Guy, R. 2009. *The Evolution of Mobile Teaching and Learning*. Santa Rosa, California: Informing Science Press.

Hellkom. 2013. *Data Bundle Prices*. Available: http://www.hellkom.co.za/data-bundles/ (Accessed 12 March 2013).

Hung, Y.-H. and Chou, S.-C. 2005. On constructing a knowledge management pyramid model. In: Proceedings of *Information Reuse and Integration, Conf, 2005. IRI-2005 IEEE International Conference on.* IEEE, 1-6

IDRE. 2013. *Introduction to SAS. UCLA: Statistical Consulting Group.* Available: http://www.ats.ucla.edu/stat/sas/notes2/ (Accessed 16 March 2013).

Idrus, R. M. and Ismail, I. 2010. Role of institutions of higher learning towards a knowledge-based community utilising mobile devices. *Procedia Social and Behavioral Sciences*, 2 (1): 2766-2770.

Ifenthaler, D. and Eseryel, D. 2013. Facilitating complex learning by mobile augmented reality learning environments. In: *Reshaping Learning.* Springer, 415-438.

Iqbal, S. and Qureshi, I. A. 2012. M-learning adoption: A perspective from a developing country. *The International Review of Research in Open and Distance Learning*, 13 (3): 147-164.

Johnson, D. and Daughterty, J. 2008. Quality and Characteristics of Recent Research in Technology Education. *Journal of Technology Education*, 20 (1): 16-31.

Kadle, A. 2012. *The future of mobile learning*. Available: http://www.upsidelearning.com/blog/index.php/2012/10/04/the-future-of-mobile-learning/ (Accessed 5 September 2013).

Kasumuni, L. 2011. *Delivering video by mobile phone to classrooms in Tanzania*. Available: http://www.elearning-africa.com/eLA_Newsportal/delivering-video-by-mobile-phone-to-classrooms-in-tanzania/ (Accessed 20 July 2013).

Koszalka, A. T. and Ntloedibe-Kuswani, G. S. 2010. Literature on the safe and disruptive learning potential of mobile tecnologies. *Distance Education*, 31 (2): 139-157.

Kreutzer, T. 2009. *Generation mobile: online and digital media usage on mobile phones among low-income urban youth in South Africa.* Cape Town: University of Cape Town.

Kuittinen, T. 2012. *WhatsApp now delivers 10 billion messages each day*. Available: http://bgr.com/2012/08/23/whatsapp-stats-10-billion-messages/ (Accessed 3 May 2013).

Kukulska-Hulme, A. 2007. Mobile Usability in Educational Contexts: What have we learnt? *International Review of Research in Open and Distance Learning*, 8 (2): 1-16.

Kuutti, K. 1995. Activity Theory as a potential framework for human-computer interaction research. *B. Nardi (ed)*, 1 (1): 17-44.

Leedy, P. D. 1993. *Practical Research: Planning and Design*. New York: Macmillan Publishing Company.

Leung, C. H. and Chan, Y. Y. 2003. Mobile Learning: A New Paradigm in Electronic Learning. Paper presented at the *Proceedings of the 3rd IEEE International Conference on Advanced Learning Technologies.* Kagawa, 11-11 July 2003.

Li, Q. 2008. Mobile Enhanced Learning: Application Model and Practice. Paper presented at the *International Conference on Computer Science and Software Engineering.* Wuhan, China, December 12-14.

Lim, C. P. and Hang, D. 2003. An activity theory approach to research of ICT integration in Singapore schools. *Computers and Education*, 41 (1): 49-63.

Lin , C., Lee, M., Wong, L. and Shao, Y. 2010. A Feasibility Study of Applying MMS for Mobile Learning of Cardiopulmonary Resuscitation (CPR). Paper presented at the *Proceedings of the 18th International Conference on Computers in Education.* Putrajaya, Malaysia, 29 Nov 2010 to 3 Dec 2010.

Liu, X. 2009. Applied research on the mobile learning in foreign language learning. In: Proceedings of *Second International Conference on Education Technology and Training.* New York, IEEE Press, 309-312

Lominé, L. L. and Buckhingham, C. 2009. M-learning: texting (SMS) as a teaching & learning tool in higher arts education. Paper presented at the *ELIA Teachers' Academy 2009.* Sofia, 1-4 July 2009.

Long, S., Kooper, R., Abowd, G. D. and Atkeson, C. G. 1996. Rapid prototyping of mobile context-aware applications: The cyberguide case study. In: Proceedings of *2nd ACM International Conference on Mobile Computing and Networking.* New York, ACM, 97-107

Loretto, P. 2012. *The Definition of Multimedia*. Available: http://internships.about.com/od/internshipsquestions/g/whatismultimedia.htm (Accessed 16 Sept 2012).

Loudon, M. 2009. *Moble Data Collection and Reporting Projects*. Available: http://mobileactive.org/howtos/mobile-phones-data-collection (Accessed 26 June 2012).

Low, L. 2013. *An Online Reflective Journal on Mobile Learning Practice*. Available: http://mlearning.edublogs.org/category/applications/photo/ (Accessed 02 May 2013).

Lundin, J. and Magnusson, M. 2003. Collaborative learning in mobile work. *Journal of Computer Assisted Learning*, 19 (1): 273-283.

Mahlangu, D. M. D. 1987. *Educational Research Methodology*. Durban: De Jager-HAUM Publishers

Maree, K. 2007. *First Steps in Research*. Pretoria: Van Schaik Publishers.

Marinagi, C., Skourlas, C. and Belsis, P. 2013. Employing Ubiquitous Computing Devices and Technologies in the Higher Education Classroom of the Future. *Procedia-Social and Behavioral Sciences*, 73: 487-494.

Martin, S., Botički, I., Jacobs, G., Castro, M. and Peire, J. 2010. M2Learn framework: How to facilitate the development of mobile collaborative context-aware applications. Paper presented at the *40th ASEE/IEEE Frontiers in Education Conference.* Washington DC, 27 - 30 Oct 2010.

McGarr, O. 2009. A review of podcasting in higher education:Its influence on the traditional lecture. *Australasian Journal of Educational Technology*, 25 (3): 309-321.

Meighan, T. J., Doolan, D. C. and Tabirca, S. 2007. *Bluetooth Applications for the m-learning classroom of the future*. Available: http://www.ilta.net/edtech2007/presentations07/session1/7_Mehigan_UCC_Bluetooth_MLearning_Applications.pdf (Accessed 25 July 2012).

Melville, S. and Goddard, W. 1996. *Research Methodology*. Cape Town: Juta and Co.

Messagelabs. 2008. *Instant Messaging: Benefits and Threats for Business* Available: http://www.ecrimewales.com/upload/pdf/EIM_Whitepaper_Instant_Messaging_Benefits_and_Threats_for_Businesses.pdf (Accessed 10 August 2013).

Motiwalla, L. F. 2007. Mobile Learning: A framework and evaluation *Computers and Education*, 49 (1): 581-596.

Moutan, J. 1996. *Understanding Social Research*. Pretoria: Van Schaik Publishers.

Muller, R. 2010. New Cell C data bundles: Pricing compared. Available: http://mybroadband.co.za/news/cellular/16685-new-cell-c-data-bundles-pricing-compared.html (Accessed 11 March 2013).

Multisilta, J., Perttula, A., Suominen, M. and Koivisto, A. 2010. Mobile Social Video Sharing Tool for Learning Applications. Paper presented at the *The 6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education.* Kaohsiung, 12 Apr 2010 - 16 Apr 2010.

Murphy, E. and Rodriguez-Manzanares, M. A. 2008. Using activity theory and its principle of contradictions to guide research in educational technology. *Australasian Journal of Educational Technology*, 24 (4): 442-457.

Naicker, N. K. and Van der Merwe, T. M. 2012. Mobile Learning in Higher Education: a Study of the Technology Readiness of Students at a South African Higher Education Institution. Paper presented at the *14th Annual Conference on World Wide Web Applications.* Durban, 7-10 November 2012.

Naismith, L., Lonsdale, P., Vavoula, G. and Sharples, M. 2006. *Literature Review in Mobile Technologies and Learning.*

Nations, D. 2013. *A List of Mobile Web Browsers* Available: http://webtrends.about.com/od/mobileweb20/tp/list_of_mobile_web_browsers.htm (Accessed 1 June 2013).

Newman, E. 2012. *Corporate Mobile Readiness Report.* iMomentous.

Nokia. 2013. *Products*. Available: http://www.nokia.com/za-en/products/products/?action=catalogsearch&featuresnfc=on#nk-main_menu_component (Accessed 4 May 2013).

O'Malley, C., Vavoula, G., Glew, J. P., Taylor, J., Sharples, M. and Lefrere, P. 2003. *Mobilearn WP4 Guidelines for Learning/Teaching/Tutoring in a MobileEnvironment.*

Oller, R. 2012. *The Future of Mobile Learning*. Available: http://www.educause.edu/ecar (Accessed 5 September 2013).

Ozdamli, F. 2012. Pedagogical framework of m-learning. *Procedia-Social and Behavioral Sciences*, 31: 927-931.

Parasuraman, A. and Colby, C. L. 2001. *Techno-ready marketing: how and why your customers adopt technology*. New York: Free Press.

Pocatilu, P. and Pocovnicu, A. 2009. Multimedia Applications and Technologies for m-Learning. *Economy Informatics*, 9 (1): 63-69.

Prensky, M. 2004. What can you learn from a cell phone?–Almost anything. Paper presented at the *4th Conference on Mobile Learning.* Cape Town, 25-28 Oct 2004.

Punch, K. F. 2005. *Introduction to social research: Quantitative and Qualitative approaches*. 2nd ed. London: Sage Publications Ltd.

Rabiee, F. 2004. Focus-group interview and data analysis. *Proceedings of the Nutrition Society*, 63: 655-660.

Raento, M., Oulasvirta, A., Petit, R. and Toivonen, H. 2005. ContextPhone: A prototyping platform for context-aware mobile applications. *Pervasive Computing, IEEE*, 4 (2): 51-59.

Rice, W. R. 1989. Analyzing tables of statistical tests. *Evolution*, 43 (1): 223-225.

Rouse, M. 2007. *Multimedia Messaging Service (MMS)*. Available: http://searchmobilecomputing.techtarget.com/definition/Multimedia-Messaging-Service (Accessed 10 August 2013).

Sarker, S. and Wells, J. D. 2003. Understanding Mobile Handheld Device Use and Adoption. *Communications of the ACM*, 46 (12): 35-40.

Sarrab, M., Elgamel, L. and Aldabbas, H. 2012. Mobile learning (m-learning) and educational environments. *International Journal of Distributed and Parallel Systems*, 3 (4): 31-38.

Sekaran, U. 1992. *Research methods for business: A skill-building approach*. 3rd ed. New York: John Wiley.

Sharples, M., Sanchez, A. I., Milrad, M. and Vavoula, G. 2007. *Mobile Learning: Smalll devices, Big Issues*. Available: http://www.bbc.co.uk/schools/gcsebitesize/mobile/ (Accessed 1 July 2010).

Sharples, M., Taylor, J. and Vavoula, G. 2007. A Theory of Learning for the Mobile Age. *The Sage Handbook of E-learning Research*, 1 (1): 221-247.

Spoonauer, M. 2013. *iPhone 5 vs Galaxy S4 Camera Shootout: You Be the Judge*. Available: http://blog.laptopmag.com/iphone-5-vs-galaxy-s4-camera-shootout-you-be-the-judge (Accessed 12 May 2013).

Srivastava, L. 2005. Mobile phones and the evolution of social behaviour. *Behaviour & Information Technology*, 24 (2): 111-129.

Stockwell, G. 2008. Investigating learner preparedness for and usage patterns of mobile learning. *ReCALL*, 20 (03): 253-270.

Struwig, F. W. and Stead, G. B. 2001. *Planning, designing and reporting research*. Maskew Miller Longman (Pty) Ltd.

Strydom, J. F., Mentz, M. and Kuh, G. D. 2010. Enhancing success in higher education by measuring student engagement in South Africa. *Acta Academica*, 1 (1): 1-12.

Thornton, P. and Houser, C. 2005. Using mobile phones in English education in Japan. *Journal of Computer Assisted Learning*, 21: 217-228.

Trifonova, A., Georgieva, E. and Ronchetti, M. 2006. Determining Students' Readiness for Mobile Learning. In: Proceedings of *5th WSEAS International Conference on E-ACTIVITIES.* Venice, Itlay, 20-22 November.

Trifonova, A. and Ronchetti, M. 2003. *A general architecture for m-learning.* University of Trento: Department of Information and Communication Technology.

Uden, L. 2007. Activity theory for designing mobile learning. *International Journal of Mobile Learning and Organisation*, 1 (1): 81-102.

Ulbricht, M. 2010. *How To Capture High Quality Video on Your Mobile Phone*. Available: http://www.pbs.org/idealab/2010/11/how-to-capture-high-quality-video-on-your-mobile-phone319 (Accessed 20 August 2013).

UNESCO. 2013. *The future of mobile learming.* The United Nations Educational, Scientific and Cultural Organization

Uther, M., Zipitria, I., Uther, J. and Singh, P. 2005. Mobile Adaptive CALL (MAC): A case-study in developing a mobile learning application for speech/audio language training. In: IEEE, 5 pp.

Vodacom. 2013. *SMS/MMS bundled prices*. Available: http://www.vodacom.co.za/personal/services/messaging/smsbundles#smsbundles/ (Accessed 26 July 2012).

Wagner, C., Kawulich, B. and Garner, M. 2012. *Doing Social Research: A global context*. New York: MaGraw-Hill Higher Education.

Wagner, E. D. 2005. Enabling Mobile Learning. *Educause Review*: 41-52.

WapSoft.Net. 2010. *Java Applications*. Available: http://softbox.wapka.mobi/index.xhtml (Accessed 20 August 2013).

Wei, F. H. and Chen, G. D. 2006. Collaborative mentor support in a learning context using a ubiquitous discussion forum to facilitate knowledge sharing for lifelong learning. *British Journal of Educational Technology*, 37 (6): 917-935.

Welman, J. C. and Kruger, S. J. 2001. *Research Methodology for the Business and Administrative Sciences*. 2nd ed. Cape Town: Oxford University Press Southern Africa.

Wishart, J. 2011. Identifying the potential of mobile phone cameras in science teaching and learning: A case study undertaken in Sri Lanka. *International Journal of blended learning*, 3 (2): 16-30.

Wishart, J. and Green, S. 2010. *Identifying Emerging Issues in Mobile Learning in Higher and Further Education: A report to JISC.*

Wu, W.-H., Jim Wu, Y.-C., Chen, C.-Y., Kao, H.-Y., Lin, C.-H. and Huang, S.-H. 2012. Review of trends from mobile learning studies: A meta-analysis. *Computers & Education*, 59 (2): 817-827.

Yin, R. K. 1999. Enhancing the quality of case studies in health services research. *Health Services Research*, 34 (5 Pt 2): 1209.

Zahradnik, F. 2012. *Global Positioning System (GPS)*. Available: http://gps.about.com/od/glossary/g/GPS.htm (Accessed 13 September 2012).

Zawacki-Richter, O., Brown, T. and Delport, R. 2009. Mobile Learning: From single project status into the mainstream? *European Journal of Open, Distance and E-Learning*, 1 (1).

Zhang, Y., Ansari, N. and Tsunoda, H. 2010. Wireless telemedicine services over integrated IEEE 802.11/WLAN and IEEE 802.16/WiMAX networks. *Wireless Communications, IEEE*, 17 (1): 30-36.

7. LIST OF APENDICES

Appendix A

QUESTIONAIRE FOR STUDENTS ON MOBILE LEARNING READINESS

Thank you for volunteering to complete this questionnaire. The purpose of this questionnaire is to explore the technological and operational readiness of students for mobile learning. It is important that you answer questions as honestly as possible. Your answers will be treated confidentially.

Date of researcher's initial contact with participant	

Section A: Demographic Information

Place a tick in the appropriate block ☑

1. In which Faculty are you registered?

Accounting and Informatics		**1**
Engineering and the Built Environment		**2**
Management Sciences		**3**
Arts and Design		**4**
Applied Sciences		**5**
Health Sciences		**6**

2. What type of qualification are you currently registered for?

National Certificate		**1**
National Diploma		**2**

B. Tech.		**3**
Postgraduate Studies		**4**
Other		**5**

3. Indicate your mode of study?

Full-time		**1**
Part-time		**2**

4. What is your age group? (In completed years)

15-20		**1**
21-25		**2**
26-30		**3**
31-35		**4**
Other		**5**

5. What is your gender?

Male		**1**
Female		**2**

6. What race group do you belong to?

African		**1**
Indian		**2**
White		**3**
Coloured		**4**
Other		**5**

Section B: Accessibility and Affordability

Please indicate your opinion by ticking ☑ the appropriate column.

	1	2	3
Statement	**Disagree**	**Not Sure**	**Agree**
1. I own a mobile phone			
2. I own a mobile phone with internet connectivity.			

3. I can afford a <u>mobile phone with Internet connectivity</u> that costs on average:

Please indicate your opinion by ticking ☑ the appropriate row.

Less than R100 per month		**1**
R101-R300 per month		**2**
R301-R500 per month		**3**
R 500-1000 per month		**4**
Over R1000 per month		**5**

4. What other mobile devices do you own?

Please indicate by ticking ☑ the appropriate row.

i-pad		**1**
i-pod		**2**
i-phone		**3**
mp3 player		**4**
Personal Digital Assistant (PDA)		**5**
Other		**6**

Section C: Student Handset Profile

The following features/facilities are available <u>on my mobile phone</u>:

Please indicate by ticking ☑ the appropriate column.

	1	2	3
Statement	**Disagree**	**Not Sure**	**Agree**
1. e-mail			
2. mobile web			
3. SMS			
4. MMS			
5. instant messaging			
6. media player			
7. photo camera			
8. video recording			
9. video conferencing			
10. voice recording			
11. conference calling			
12. e-book reader			
13. Bluetooth technology			
14. graphic display that support pictures and animation			
15. additional memory			
16. GPS facilities			
17. Mp3 player			
18. Java Support			
19. Word processor			
20. Spreadsheet			
21. Presentation program			

Section D: Awareness and Attitude

Please indicate your opinion by ticking ☑ the appropriate column.

	1	2	3	4	5
Statement	**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
1. I have used e-learning before					
2. I am aware of mobile learning					
3. I have used mobile learning before					
4. I would like to use mobile learning for academic support					
5. I think that usage of mobile learning will increase the quality of instruction					

Section E: Support and Training

Please indicate your opinion by ticking ☑ the appropriate column.

I require the following institutional support for mobile learning:

	1	2	3	4	5
Statement	**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
1. Help desk support					
2. Online support					

I require the following training for mobile learning:

	1	2	3	4	5
Statement	**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
3. Use of mobile learning tools					
4. Mobile handset functionality					

Section F: Open Ended Questions

1. Do you think that mobile learning can enhance your learning experience?

   ____

   ____

2. List the most important service that you think a mobile learning system must provide?

   ____

   ____

3. What in your opinion is the major weakness of mobile devices that might hinder mobile learning?

   ____

   ____

4. In your opinion do you think that mobile devices and mobile applications in future will be used more extensively for academic support? Give a reason.

   ____

   ____

Thank you for your time and co-operation in completing this survey.

Appendix B

PERMISSION TO CONDUCT RESEARCH

DURBAN UNIVERSITY of TECHNOLOGY

Research Management and Development
Durban University of Technology
Tromso Annexe, Steve Biko Campus
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946
E-mail: moyos@dut.ac.za

6th October 2011

Mr. N. K. Naicker
c/o Department of Information Technology
Durban University of Technology

Dear Mr. Naicker

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence dated 3rd October 2011 in respect of the above refers. I am pleased to inform you that the Institutional Research Committee (IRC) will grant permission to you to conduct your research at the Durban University of Technology. However, kindly note that the committee requires you to provide proof of ethical clearance prior to you commencing with your research at the DUT.

We would be grateful if a summary of your key research findings can be submitted to the IRC on completion of your studies.

Kindest regards.
Yours sincerely

PROF. S. MOYO
DIRECTOR: RESEARCH MANAGEMENT AND DEVELOPMENT (ACTING)