A FRAMEWORK FOR PROVIDING MOBILE CENTRIC SERVICES TO STUDENTS AT HIGHER EDUCATION INSTITUTIONS: THE CASE OF OPEN DISTANCE LEARNING

By

BALDRECK CHIPANGURA

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SUPERVISOR: PROF J.A. VAN BILJON

CO-SUPERVISOR: DR A. BOTHA

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Declarations

I declare that, "*A Framework for Providing Mobile Centric Services to Students at Higher Education Institutions: The Case of Open Distance Learning in South Africa*" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Signature Date

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Abstract

In developing countries, the mobile phone market has matured in terms of subscription, penetration and mobile centric[1] services. In turn, people have integrated mobile phones into their daily lives. The interaction opportunities that have evolved in business and social life have given students at Higher Educational Institutions (HEIs) grounds to anticipate similar opportunities within their learning environments. In the context of developing countries, students primarily access information through mobile phones and there seems to be a disconnection between how HEI provide informational services and how students want to access the services. Therefore, HEIs are challenged with shifting from their traditional information distribution practices into integrating mobile centric services. Literature describes several models of providing mobile centric services in learning settings but there is a paucity of research that address the disconnection between students' mobile centric needs and expectations against the HEIs' provision of such services. Therefore, this study proposes a *Framework for providing mobile centric services to students at HEIs in Open Distance e-Learning (ODeL) context in South Africa*. The potential contribution of the framework is that it can facilitate strategic planning and implementation of mobile centric services whilst ensuring the needed synergies with students and academics.

The research is grounded in interpretive philosophy and was undertaken as a single case study. The case study employed mixed method design for data collection. The advantage of mixed method design is that it enables both qualitative and quantitative data to be collected from a variety of sources and triangulation of results to get a complete picture of the phenomenon under study.

The research was undertaken in four phases. Phase 1 of the study was a literature analysis carried out to identify the components for providing mobile centric services that facilitate students with information access and interaction. The objective was to provide a conceptual framework that would direct the search for evidence and organise the results. Phase 2 of the study employed the conceptual framework developed in Phase 1 to identify the units of analysis and to design the data collection instruments. Phase 3 of the study focused on collecting data within a single case study with embedded units of analysis. Data collection included Policy document analysis, Tool observation analysis, Student surveys and Lecturer interviews. The data collected from the case study was analysed with the view of enhancing the components of the conceptual framework developed in Phase 1. The enhancement of the components of the conceptual framework carried out in Phase 3 directed the development of the *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa* as presented in Phase 4. This adds new knowledge in addressing the literature gap between the mobile centric needs and expectations of students and the provision of mobile centric services at HEIs. The framework has practical value in that its components can guide HEIs in determining the mobile centric readiness of their institutions, the needs of the stakeholders, the context of use, the identification of mobile centric resources and the managing of constraints.

[1] Mobile centric refers to the preference of accessing and interacting with information services through a mobile device such as a mobile phone.

List of peer reviewed publications from this study

Journal papers

1. Chipangura B., Van Biljon J., & Botha A. (2012). Towards an ODL mobile centric model for inclusive sustainable interactions, *Progressio: South African journal for open and distance learning, 34(*3*),* 161-182.

2. Chipangura B., Van Biljon J., & Botha A. (2015). Evaluating mobile centric readiness of higher educational institutions: The case of institutional policies and information systems students. *The African Journal of Information and Communication (AJIC), (*15*),* 4-13.

Conference papers

1. Chipangura, B., van Biljon, J., & Botha, A. (2015). An evaluation of the mobile centric readiness of students in HEIs. In E. Coleman (Ed.), *Renewing ICT teaching and learning: Building on the past to create new energies.* Proceedings of the 44th SACLAR 2015 Conference (pp 92-99). Johannesburg, South Africa.

2. Chipangura, B., Botha, A., & Van Biljon, J. (2015). Support given to lecturers when providing mobile centric services in teaching and learning: A policy analysis perspective. In P. Cunningham & M. Cunningham (Eds), *IIMC International Information Management Corporation*. Proceedings of ISTAfrica 2015 Conference (pp 1-9). Lilongwe Malawi. DOI: 10.1109/ISTAFRICA.2015.7190537

3. Chipangura, B., van Biljon, J., & Botha, A. (2014). The provision of mobile centric services in Higher Educational Institutions: A case of lecturer readiness. In J. Steyn, J. & D. Van Greunen(Eds.), *ICTs for inclusive communities in developing societies.* Proceedings of the 8th International Development Informatics Association Conference (p 174-188). Port Elizabeth, South Africa. Retrieved from, http://www.developmentinformatics.org/conferences/2014/papers/16-Chipangura-VanBiljon-Botha.pdf

4. Chipangura, B., van Biljon, J., & Botha, A. (2013). Prioritizing students' mobile centric information access needs: A case of postgraduate students. *Proceedings of the 2013 International Conference on Adaptive Science and Technology (ICAST)* (p 1-7). DOI: 10.1109/ICASTech.2013.6707519

5. Chipangura, B. (2013). Categorizing the Provision of Mobile Centric Information Access and interaction for Higher Educational Institutions. *Proceedings of South African Institute for Computer Scientist and Information Technologies Conference, (p 101-1100).* East London, South Africa. DOI: 10.1145/2513456.2513460

6. Chipangura, B., van Biljon, J., & Botha, A. (2013). Evaluating mobile centric information access and interaction compatibility for learning websites. *Proceedings of The Pan African International Conference on Information Science, Computing and Telecommunication (PACT 2013)*(pp 2018-222). Lusaka, Zambia. DOI: 10.1109/SCAT.2013.7055084

7. Chipangura, B., van Biljon, J., & Botha, A. (2012). The digital difference between traditional information provision and students expectations in developing countries. In J. Steyn J & M Kirlidog (Eds.), *Alleviating Digital Poverty with ICT innovation in emerging economies. Will ICT Rights make a difference?* Proceedings of the 6th IDIA 2012 Conference (p 88-100). Beykent University, Istanbul, Turkey. Retrieved from http://www.developmentinformatics.org/conferences/2012/proceedings/IDIA2012-chipangura.pdf

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Abbreviations

2G	Second Generation Wireless Technology
3G	Third Generation Wireless Technology
4G	Fourth generation Wireless Technology
APEC	Asia-Pacific Economic Cooperation
BYOD	Bring your own device
EDGE	Enhanced Data Rates for GSM Evolution
EIU	Economist Intelligence Unit
ERG theory	Existence, Relatedness and Growth theory
FEMA	United States of America Federal Emergency Management Agency
Gb	Giga byte
Gbps	Giga bytes per second
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HEIs	Higher Educational Institutions
HSDPA	High-Speed Downlink Packet Access
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communication Technology
ICT4RED	Information Communication Technology for Rural Education Development
IS	Information Systems
ITU	International Telecommunication Union
IVR	Interactive Voice Response
J2ME	Java 2 Mobile Edition
LMS	Learning Management Systems
LTE	Long Term Evolution
Mbps	Mega Bytes Per Second
MCQ	Multiple Choice Questions
m-LMS	Mobile Learning Management System
MLW	Mobile Learning Week
MoLODUF	Mobile Learning Objects Deployment and Utilisation Framework
MOOCs	Massive Open Online Courses
ODeL	Open Distance electronic Learning
OER	Open Educational Resources
OS	Operating System
PC	Personal Computer
PDA	Personal Digital Assistant
QR code	Quick Response Code
SIP	Session Initiation Protocol
SMS	Short Message Service
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISA	University of South Africa
USA	United State of America
USAF	Universal Service and access Agency of South Africa
USAASA	Universal Service and Access Agency of South Africa
USAO	Universal Service and Access Obligations
USSD	Unstructured Supplementary Service Data
VoIP	Voice Over Internet Protocol

WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave

Chapter 1: Background and orientation of the study

1.1 Introduction

South Africa is a developing country that has witnessed a phenomenal growth in mobile cellular technology with an estimated penetration rate of over 145% in 2014 (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2014b). The high mobile cellular technology penetration has resulted in increased demand and use of mobile phone content and services in business (Kikulwe, Fischer & Qaim, 2014; van der Boor, Oliveira & Veloso, 2014) and social life (Danis et al., 2009; Lenhart, 2015). The mobile phone access and interaction opportunities that have evolved in business and social life have given students at Higher Educational Institutions (HEIs) grounds to anticipate similar opportunities in education. Such expectations by students arguably brought some challenges at HEIs. The challenges are exuberated by the assumption that mobile centric content should be provided in a personalised manner (Lenhart, 2015; MacGrane, 2013), where the reality is that mobile centric users have the same information requirements as desktop computer users (Donner, Gitau & Marsden, 2009; Poushter, Bell & Oates, 2015). In this study, mobile centric refers to the preference of accessing and interacting with information services through a mobile device such as a mobile phone.

Poushter et al., (2015) identified some of the challenges encountered by mobile centric users as incompatible mobile applications and content that does not display well on mobile devices. Donner and Gitau, (2009) argued that the challenges are due to the mismatch between content that is primarily authored for desktop access and consumers who want to access content through mobile phone devices. In HEIs, such a mismatch can raise tensions between the students' mobile centric needs and the HEIs' provision of such services. This study investigates this problem. Hence, this research focused on the components of a framework for providing mobile centric services to students at HEIs in the context of Open and Distance e-Learning (ODeL) in South Africa. The research was undertaken as a single case study with embedded units of analysis at the University of South Africa.

This introductory Chapter presents the research context (discussed in Section 1.2), problem statement (discussed in Section 1.3), research questions (discussed in Section 1.4), research objectives (discussed in Section 1.5), research methodology (discussed in Section 1.6), scope and context of the study (discussed in Section 1.7), benefits and significance of the study (discussed in Section 1.8), ethical considerations (discussed in Section 1.9) and thesis structure (discussed in Section 1.10).

1.2 Research context

The University of South Africa (UNISA) has a student population of over 400 000 and majority of the students are from the African continent (UNISA, 2015a). The diverse backgrounds of the student population introduce disparities in levels of exposure to accessible technological infrastructure. In response to this, the university provides students with technological infrastructure at its regional centres in South Africa (UNISA, 2013). The technological support initiatives lessen students' technological access problems but not for all the students. Even though the students can access the facilities, they can only do so during working hours, meaning that when they are at home, they cannot do so. This could be due to the nature of resource constrained environments in which students reside that are characterised by lack of Information and Communications Technology (ICT) resources, electricity and the fact that some families live below the poverty line (Fuchs & Horak, 2008).

Mobile phones provide prospects for overcoming some of the information access and communication limitations of students. Prior research found that mobile phones brought information access and communication to geographical areas where they never existed before (Donner & Gitau, 2009; Kreutzer, 2009). Research also established that mobile phones provide access to a number of internet based services that include music and video files, email, SMS, and banking just to mention a few (Brown, Campbell & Ling, 2011).

Given that the estimated global mobile phone subscription reached 7 billion (International Telecommunication Union [ITU], 2015) and that the African mobile broadband growth reached 20% (ITU, 2015), there is a high probability that most students would have access to a mobile phone with internet access as from 2015. The growth in the mobile technology sector has resulted in many students having access to a variety of information services and content through mobile phones. This has opened both challenges and opportunities for HEI's and raises questions on how HEIs should respond.

1.3 Problem statement

In a study on technology usage in South Africa, Donner and Gitau (2009) found students to be predominantly mobile centric while institutional policy makers and academics were predominantly desktop computer centric. Considering distance learning, it was found that traditional student support models depended on hardcopy study guides, modules and residential sessions (Muyinda, Lubega & Lynch, 2010). Muyinda et al., (2010) argued that the integration of ICTs into student support systems should benefit from opportunities offered by mobile phone access. This supports the view that mobile centric user needs are not being met by traditional ways of providing teaching

and learning services (MacGrane, 2013). In this regard, Traxler and Vosloo (2014) argued that mobile centric opportunities are no longer confined to m-learning but extend to reaching students in marginalised communities by expanding tuition and administrative services. At educational institutions, the provision of mobile centric services has been observed as taking place at a slow pace (Keegan, 2005). Keegan (2005:9) raised the following questions, "Why has mobile learning not yet emerged from its project status and not yet taken its place in mainstream provision? Why does it remain at the research project level and not emerge into a serious form of provision?" The questions remain relevant to date. In this respect, UNESCO has concerns over the slow growth at which educational institutions in developing countries are providing mobile centric services (Fritschi et al., 2012; Kraut, 2013; Vosloo, 2012; West & Valentini, 2013). UNESCO believes that mobile technology is a resource that could help in achieving its mandate of 'Education For All' (UNESCO, 2000). In line with that goal, UNESCO has put effort in understanding the challenges that are obstructing full implementation of mobile centric services at educational institutions through a series of Mobile Learning Week symposiums held in 2011, 2013, 2014 and 2015. The identified challenges included issues of policies, technical skills of teachers, provision of infrastructure, and failure to provide learning content formatted for mobile phone access (UNESCO, 2011; UNESCO, 2013a; UNESCO, 2014a).

As HEIs face these new challenges and opportunities, literature reports on several studies that have tried to find ways of providing mobile centric services to students. Literature analysis on existing frameworks for providing content and services for facilitating students' access and interaction through mobile cellular technology found a wide range of approaches focusing on the following themes as discussed in Chapter 2:

- M-learning system design frameworks (El-Gamil & Badawy, 2010; Martin et al., 2010; Mostakhdemin-Hosseini & Tuimala, 2005).
- M-learning adaptation frameworks (Motiwalla, 2007; Yang, 2007).
- M-learning activities classification framework (Gay, Rieger & Bennington, 2002; Park, 2011).
- M-learning evaluation frameworks (Muyinda, Lubega, Lynch & van der Weide, 2011).
- M-learning description frameworks (Dawson, Ling, Indrawan, Weeding & Fernando, 2008).
- Frameworks for designing M-learning activities (Flores & Morteo 2010; Koole, 2009; Muyinda et al., 2011).

The frameworks were found not to have a comprehensive focus on the provision of content and services that facilitate students with mobile centric access and interaction. The frameworks

discussed in the literature focus on m-learning as an extension of e-learning. These frameworks place more emphasis on the use of mobile devices as tools through which students can learn and less emphasis on mobile devices as tools through which students can access and interact with information. The basis of the frameworks is that students wish to learn on the move, that is, they wish to engage in a learning activity where ever they are and at any time, for example, travelling in a train. Notably, the reviewed frameworks do not consider mobile phones as tools that facilitate information access and interaction irrespective of whether the information is for learning or administration and whether the learner is mobile or not. Furthermore, the frameworks fall short of addressing the tension between the challenges and opportunities of providing mobile centric information access, the participation needs, and the expectations of students at HEIs. Therefore, there is a need to investigate the connection between the way content and services are provided by HEIs and how students can access the services through mobile phones.

1.4 Research questions

The following main research question and related sub research questions guided and helped frame the research. The main research question of this study is:

What are the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa?

The sub research questions to the main question are:

1. *What are the components for providing mobile centric services that facilitate students' information access and interaction at HEIs?*
2. *To what extent does practice in HEIs reflect the components for providing mobile centric services that facilitate students' information access and interaction?*

In order to answer sub research question 2, seven research questions developed from the context of the case study guided the investigation. The seven research questions are:

2.1 What is the status of the university policy on the provision of mobile centric services?

2.2 Which mobile cellular technology tools are provided by the university that facilitate students' information access and interaction?

2.3 Which services do students want to access and interact with through mobile cellular technology?

2.4 How ready are the students in accessing and interacting with mobile centric services at the university?

2.5 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?

2.6 Which mobile centric resources do lecturers provide to students that facilitate information access and interaction?

2.7 Which constraints affect the provision of mobile centric services at the university?

1.5 Research Aim

The aim of this study is to investigate the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa.

Objectives:

1. To identify the components for providing mobile centric services that facilitate students' information access and interaction at HEIs.

   This objective provides the study with a practical conceptual framework constructed from relevant literature. It will direct the search for evidence as well as organise results.

2. To reflect on HEIs' practice relative to the identified critical components for providing students with mobile centric services that facilitate access and interaction by collecting evidence from a single embedded case study.

   This objective directs the research methodology towards the development of a framework for HEIs' provision of information systems content and services in order to facilitate students' access and interaction through mobile cellular phone technology.

1.6 Research Methodology

This research is grounded in an interpretive research philosophy. The research was undertaken as a single embedded case study at UNISA. The case study employed mixed method design (Creswell & Plano, 2011) to collect quantitative and qualitative data from a variety of sources. Mixed method design ensures the completeness of data collection and increases the credibility of the study through triangulation. The research consisted of four phases as illustrated in Figure 1-1.

1.6.1 Phase 1

Phase 1 consisted of a literature analysis aimed at developing a conceptual framework for understanding the realities of providing mobile centric services to students at HEIs. The literature analysis covered domains of mobile information access and interaction that included but were not limited to m-learning, mobile centric readiness, mobile centric needs, context of use, and constraints. During the literature analysis, key concepts that relate to the provision of mobile centric services at HEIs were identified. The concepts were grouped into the main components of

the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6).

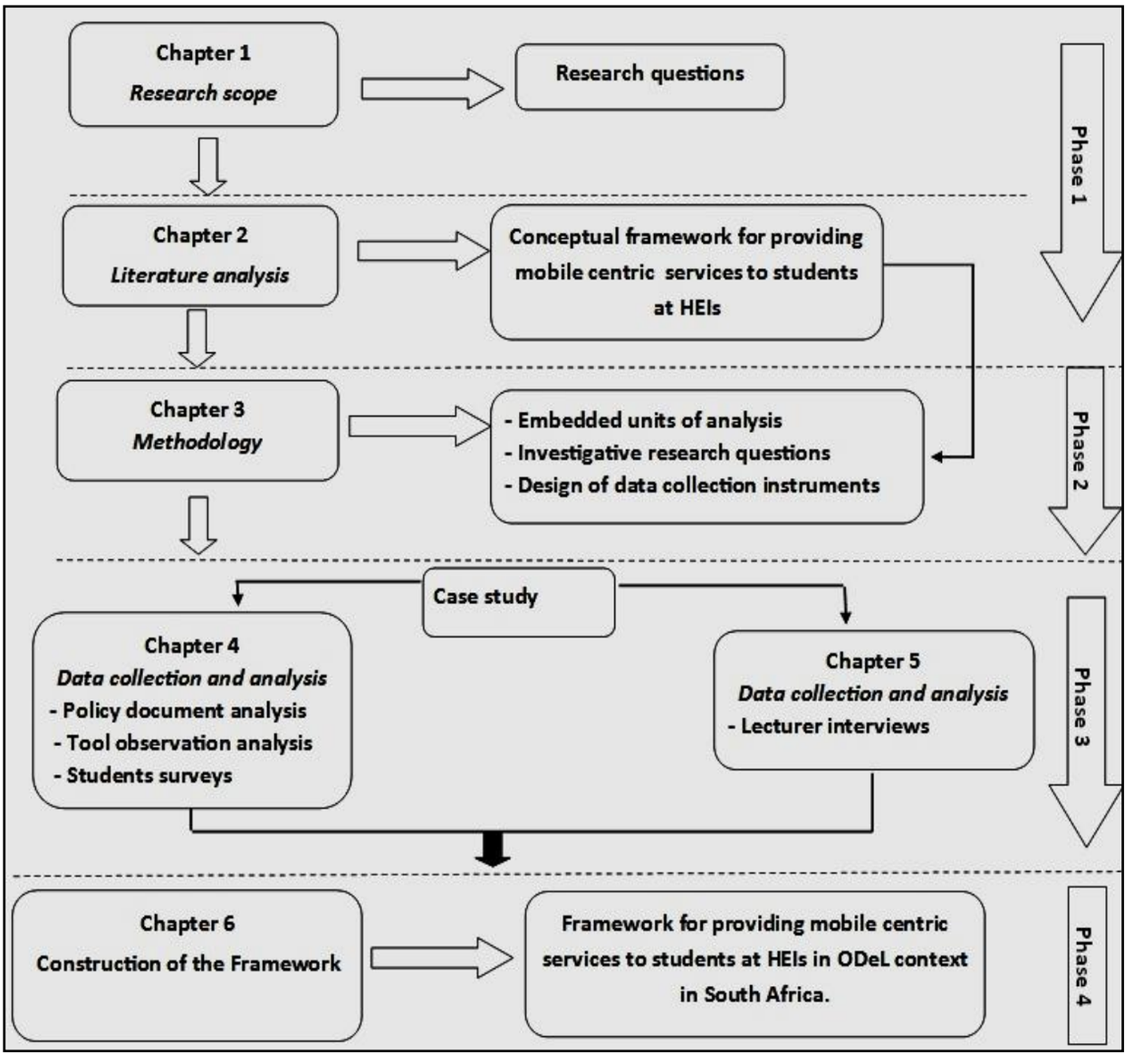


Figure 1-1: Research design

1.6.2 Phase 2

Phase 2 focused on selecting units of analysis, identifying data collection methods, developing and verifying data collection instruments (discussed in Chapter 3). The study employed mixed methods design to collect data through six instruments. The instruments were policy document analysis (discussed in Section 3.6.1), tool observation analysis (discussed in Section 3.6.2), three student surveys (discussed in Section 3.6.3) and lecturer interviews (Section 3.6.4). Table 1.1 maps the research questions and objectives with data collections methods.

Table 1-1: Mapping of research questions with data collection methods

Main research question	**Aim**	
What are the components of a framework for providing mobile centric services to students at HEIs in the ODeL context in South Africa?	To investigate the components of a framework for providing mobile centric services to students at HEIs in the context of ODeL in South Africa.	
Sub research question	**Objective**	**Data collection method**
1. What are the components for providing mobile centric services that facilitate student information access and interaction at HEIs?	To identify the components for providing mobile centric services that facilitate student information access and interaction at HEIs.	Literature analysis
2. To what extent does practice in HEI reflects the components for providing mobile centric services that facilitate students' information access and interaction?	To reflect on HEIs' practice relative to the identified critical components for providing students with mobile cellular phone services that facilitate access and interaction by collecting evidence from a single embedded case study.	See investigative research questions
Investigative research questions for sub research question 2		
2.1 What is the status of the university policy on the provision of mobile centric services?		Policy document analysis
2.2 Which mobile cellular technology tools are provided by the university that facilitate student information access and interaction?		Tool observation
2.3 Which services do students want to access and interact with through mobile cellular technology?		Student survey
2.4 How ready are the students in accessing and interacting with mobile centric services at the university?		Student survey
2.5 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?		Lecturer interviews
2.6 Which mobile centric resources do lecturers provide to students that facilitate information access and interaction?		Lecturer interviews
2.7 Which constraints affect the provision of mobile centric services at the university?		Lecturer interviews Student survey Policy document analysis

1.6.3 Phase 3

Phase 3 of the study involved data collection and analysis from a single case study. UNISA, an ODeL institution was selected as a unique case study of a HEI confronted with the challenge of providing mobile centric services to students. The case study employed mixed method design to collect and analyse both qualitative and quantitative data. The data collection methods were presented in Phase 2 and are further discussed in Section 3.6.

1.6.4 Phase 4

The findings from data analysis in Phase 3 were triangulated to draw conclusions and inform the conceptualisation of the Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa (discussed in Section 6.3). This phase concludes the investigation carried in this study.

1.7 Scope and context of the study

This research lies in the field of Information Systems and focuses on providing mobile centric information access and interaction within the context of an ODeL Higher Educational Institution (HEI) in South Africa. The research explores the ODeL University's provision of mobile centric services that facilitate students with information access and interaction on mobile cellular technologies. The exploration focuses on the components of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The research was undertaken as a single case study with embedded units of analysis at UNISA in South Africa. This research only focuses on the provision of mobile centric services that facilitate students' access and interaction through mobile cellular technologies. Mobile learning and the design of mobile learning activities are beyond the scope of this research.

1.8 Limitation

The following points summarises the limitations of this study and are further elaborated in Section 7.5 of Chapter 7. The limitations to the study were that:

- The case study was undertaken at one higher educational institution named UNISA, which presents limitations with generalising the study's findings. However, UNISA is the largest ODeL in Africa and the only in South Africa. It is a typical university confronted with the phenomenon investigated in this research.
- Respondents in the study were purposefully sampled. The targeted respondents were students and lecturers from the School of Computing. The technical aptitude and knowledge of mobile phone functionality could be different from other students and lecturers at the university. The sample was selected because the technological and other challenges experienced by Computer Science students or the lecturers would likely apply to all other students or lecturers at the university. On the other hand, other students and lecturers might experience challenges that might not be picked with this group of participants.
- The investigation was limited to mobile phone devices only even though students could own other devices such as a Personal Digital Assistant (PDA) or Tablet Personal Computer (PC). Nevertheless, the components of the framework are applicable to other mobile devices used in teaching and learning.

- Provision of mobile centric services in HEIs is time sensitive. New mobile phones with new technologies are produced within a short period of time and this presents challenges in capturing data that correctly reflects the needs of the students or lecturers. Data collection in this study was between 2011 and 2015, hence it is a snapshot of the current situation.
- There is paucity of research that addresses the disconnection between students' mobile centric needs and HEIs' provision of such needs, hence, the literature review in this study extended to some research undertaken at schools in South Africa.

1.9 Benefits and significance of the study

This study proposed a *Framework for Providing Mobile Centric Services to Students at HEIs in ODeL context in South Africa* (discussed in Section 6.3). The benefit of the framework is that it can guide strategic planning around the provision of mobile centric services by ensuring optimum investment on mobile resources and the needed synergies with the students, lecturers and the university. As such, the main components of the framework are valuable in guiding the provision of mobile centric services in terms of its five components, which are *Readiness, Needs, Resources, Context of use and Constraints*.

The *Readiness* component can guide an institution in determining its preparedness in providing mobile centric services. An institution is ready for mobile centric services if the students, lecturers and the institution itself are all ready as elaborated in Section 6.3.1.

The *Needs* component can guide the institution in identifying the mobile centric requirements of students and the lecturers. Knowing the needs of students and lecturers assists an institution to provide the required services. Section 6.3.2 elaborates on this component.

The *Resources* component is informed by the *needs* component and can guide an institution in designing and implementing mobile centric services. The resources are expected to meet specific needs of students and lecturers. Section 6.3.3 elaborates on this component.

The *Context of use* component guides an institution to identify the setting under which students would interact with mobile centric services. Identifying the interaction context is essential in guiding the design of mobile centric services, which are usable in varying contexts that students occupy, as elaborated in Section 6.3.4.

The *Constraints* component guides an institution in identifying limitations that could affect the provision of mobile centric services and suggest solutions to overcome them. Section 6.3.4 elaborates on this component.

Therefore, the mobile centric framework would be a valuable tool for informing HEIs' ICT strategies in general and when structuring policies for mobile phone information access. In addition, this study contributes to the body of knowledge in the field of mobile information access and interaction of students at HEIs in developing countries, as elaborated in Section 7.4.

1.10 Ethical considerations

Research ethics is concerned with the moral standards that guide a researcher in the life cycle of a study. This research was carried out in accordance with UNISA's policy on research ethics. UNISA's code of ethics requires that all research undertaken at the university get reviewed by the ethical committee before the research commences. The university's ethics committee approved this research. See Appendix 1 and Appendix 2 for ethical clearance certificates. Ethical principles that guided data collection in this study are:

- Informed consent
- Voluntary participation
- Confidentiality
- Anonymity

1.11 Chapter divisions

This thesis has seven chapters as depicted in Figure 1-2 below. This Chapter introduced the study and presented the scope of the investigation. Chapter 2 presents the literature review analysis and develops the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). Chapter 3 presents the research design and methodology. Chapters 4 and 5 present data analysis and results. Chapter 6 presents the discussion of the results (discussed in Section 6.3). The thesis is concluded in Chapter 7 through summary and reflections on the study.

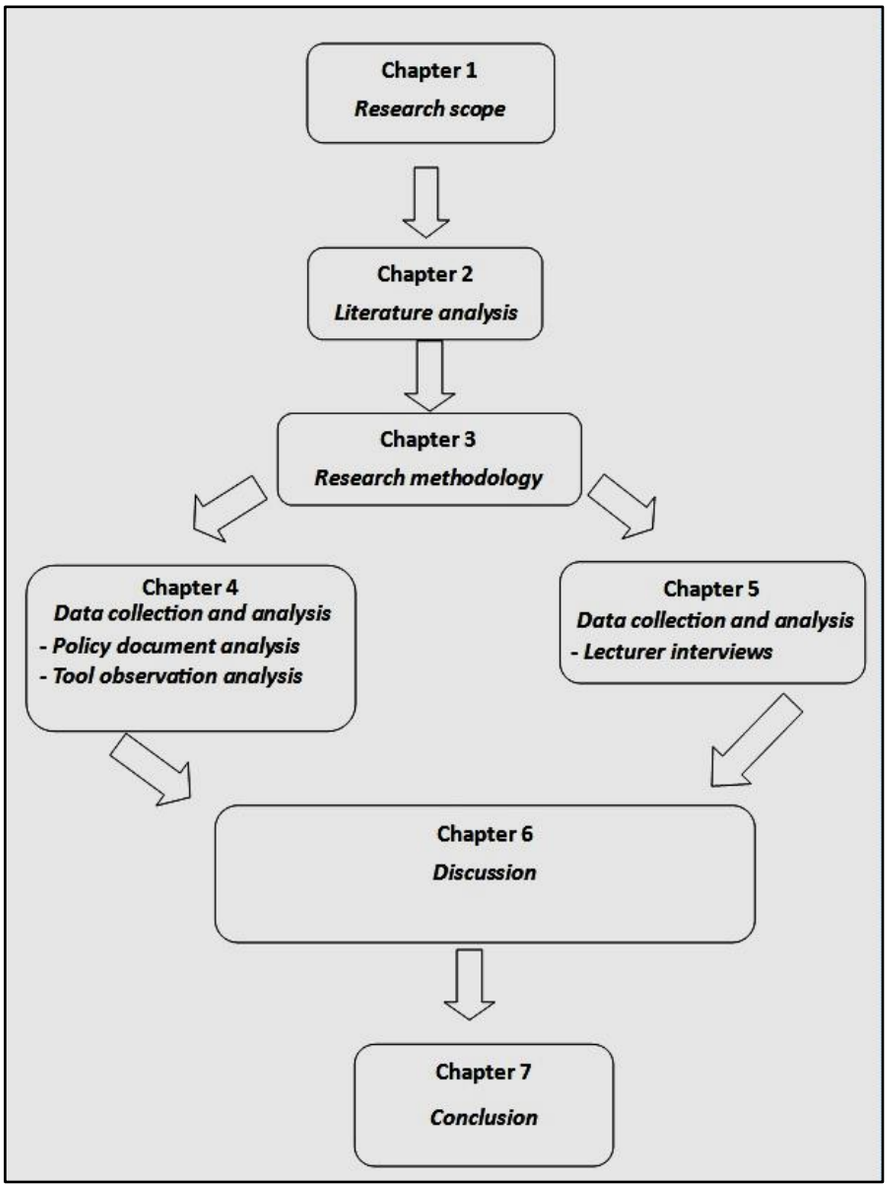


Figure 1-2: Thesis structure

Chapter 2: Mobile phone information access and interaction literature

2.1 Introduction

The aim of literature analysis is to answer sub research question 1, *"What are the components for providing mobile centric services that facilitate student information access and interaction at HEIs?"*

The literature analysis followed the Procedure for Conceptual Framework Analysis proposed by Jabareen (2009). The analysis focused on but not limited to aspects of m-learning, e-readiness, mobile technology penetration in South Africa and globally, mobile phone information access and interaction in learning, student mobile phone needs, mobile phone context of use, mobile phone constraints. The studies and their findings were grouped according to their central foci. The groups or clusters were given preliminary names. The categories were analysed for possible relations with other categories to establish a hierarchy. The following stages of the conceptual framework analysis procedure were followed:

i. Mapping the selected data sources
ii. Extensive reading and categorizing of the selected data
iii. Identifying and naming concepts
iv. Deconstructing and categorizing the concepts
v. Integrating concepts
vi. Synthesis, resynthesis, and making it all make sense
vii. Validating the conceptual framework

The data sources for literature analysis comprised of published academic journal papers, conference proceedings, research reports, Department of education policies (South Africa), Department of Communication policies (South Africa), and online magazines. Research articles were retrieved through the Google search engine since it provides links to indexed electronic databases and any other electronic resources. Some of the searched electronic databases included ACM digital library, IEEE Explore, Web of Science, Elsevier and Springer.

The literature analysis was carried in the following order. Section 2.2 discusses mobile technology readiness, Section 2.3 discusses mobile phone context of use, Section 2.4 discusses mobile phone information needs, Section 2.5 discusses mobile phone information access and interaction, Section 2.6 discusses mobile phone information access and interaction frameworks in education, and Section 2.7 discusses mobile phone information access and interaction constraints. The outcome of

the literature analysis is a *Conceptual framework for providing mobile centric services to students at HEI*s (depicted in Figure 2-6). Figure 2.1 provides an overview of the topics covered in this chapter.

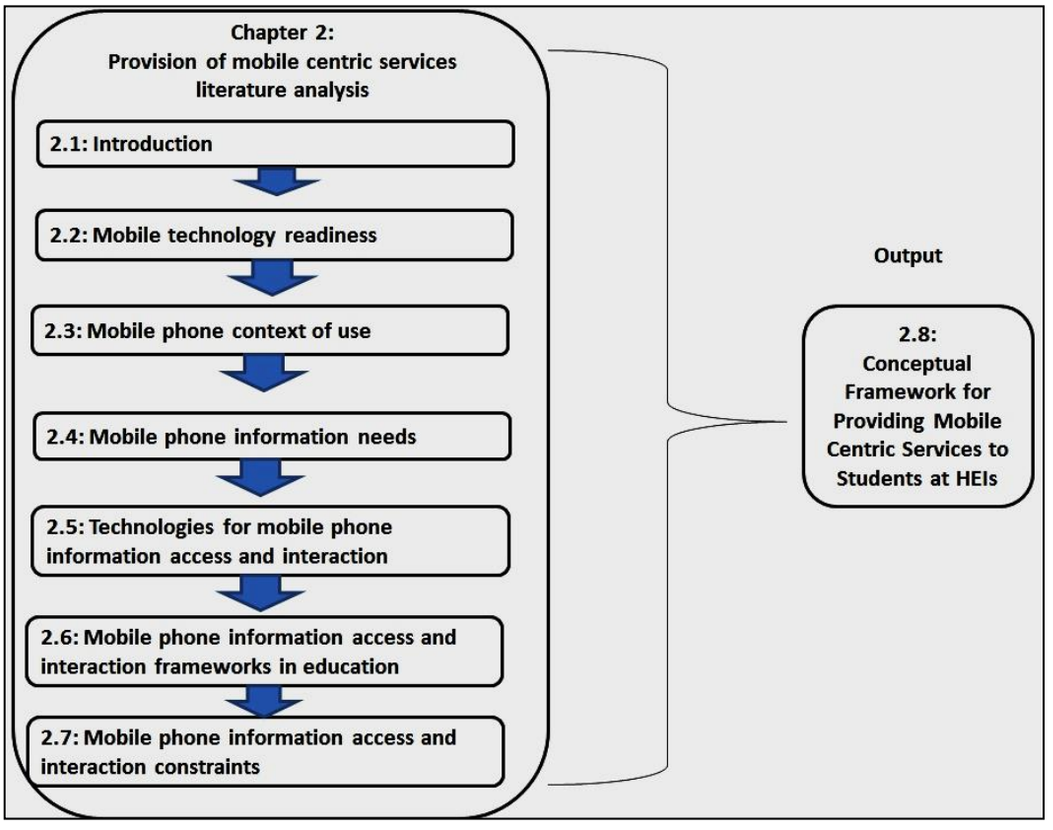


Figure 2-1: Overview of Chapter 2

2.2 Mobile technology readiness

The readiness of a country, institution or a person in using ICT related technologies such as mobile cellular phones is known as e-readiness (Sachs, 2000). The term e-readiness has numerous definitions and some are now discussed. E-readiness is "the degree to which a community is prepared to participate in the Networked World. It is gauged by assessing a community's relative advancement in areas that are most critical for ICT adoption and the most important applications of ICTs" Sachs (2000, p.5). E-readiness has also been defined as, "the ability to pursue value creation opportunities facilitated by the use of the Internet" Maugis et al., (2005, p.316). The Economist Intelligence Unit [EIU] (EIU,2003) defined e-readiness as the extent to which a market is conducive to Internet based opportunities, taking into consideration the quality of IT infrastructure, government initiatives and the degree to which the internet is creating commercial efficiencies. The definitions of e-readiness revolve around the preparedness of people in using ICTs to pursue value creation opportunities in their daily lives. As such, HEIs in developing countries need to be ready to exploit opportunities presented by mobile phones as information access and interaction tools in teaching and learning. Literature analysis continues as follows: Section 2.2.1 discusses e-readiness

models, Section 2.2.2 gives an overview of mobile phone readiness, Section 2.2.3 discusses South Africa mobile phone readiness and Section 2.2.4 discusses mobile phone readiness at South African higher educational institutions.

2.2.1 E-readiness models

This section discusses two categories of e-readiness models, which are models for evaluating the readiness of a country (Asia-Pacific Economic Cooperation [APEC], 2000; EIU, 2003) and models for evaluating the readiness of an institution (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Machado, 2007).

Although this study focuses on the provision of mobile centric services at HEIs, the models for evaluating e-readiness for a country are essential in understanding how South Africa as a developing country is providing an environment that supports the provision of mobile centric services at HEIs. The provision of mobile centric services at HEIs depends on the infrastructure provided by the country. Literature analysis continues as follows: Section 2.2.1.1 discusses models for evaluating e-readiness of a country, and Section 2.2.1.2 discusses models for evaluating e-readiness for an institution.

2.2.1.1 Models of evaluating e-readiness of a country

This section discusses three models that inform e-readiness evaluation. The models are The EIU e-Readiness Model (EIU, 2003), The APEC e-Readiness Model (APEC, 2000) and The Convergence Measure for e-Readiness Assessment Model (Hanafizadeh, Hanafizadeh, & Khodabakhshi, 2009). The three models provide benchmarks for evaluating e-readiness in adopting and using ICTs for social and economic benefits of a country. The three e-readiness models were developed during different periods but seem to have some common dimensions for measuring e-readiness. All the models based their evaluation of e-readiness on telecommunications infrastructure development. The common dimensions for benchmarking infrastructure development were ICT technology penetration, affordability, quality of broadband, accessibility and the enabling environment. The models gave different names to the enabling environment dimension but suggested similar parameters for evaluating the e-readiness. The EIU (2003) e-Readiness model divided the environmental readiness dimension into business environment, social and cultural environment, and legal environment. The APEC (2000) e-Readiness model combined the legal and business environment and just named it environmental factors. On the other hand, the Hanafizadeh et al., (2009) model named the environmental dimension as the enabling factors, which is similar to the EIU e-Readiness model's (2003) business environment dimension. From a different perspective, the Hanafizadeh et al., (2009) model suggested that the e-readiness of a country could be evaluated

based on its e-business, e-governance, and e-education. Therefore, the three models suggested factors for benchmarking the e-readiness of a country as technological infrastructure developments, country policies, business and political environment, and technological culture of the people.

2.2.1.2 Models for evaluating the e-readiness of an institution

The consensus among the models for evaluating institutional e-readiness is that when introducing e-learning at an institution, all the stakeholders involved in the project have to be assessed for e-readiness (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007). The stakeholders include administrative managers, academics, and students. Common dimensions among all the proposed models for evaluating the e-readiness of an institution are technological infrastructure, finance, human resources and course content (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007).

Technological infrastructure readiness assessment focuses on evaluating if existing infrastructure sustains the new intervention. If the existing infrastructure cannot provide or sustain the services of a new intervention, the institution is expected to provide the required infrastructure (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007).

Course content readiness focuses on assessing if the institution already has content that is compatible for mobile phone access in terms of format, personalisation and usability (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007).

Financial readiness focuses on assessing if the institution has a sustainable budget to fund the implementation of e-leaning. The budget is expected to cover the cost for infrastructure, training, policy development, just to mention a few (Borotis & Poulymenakou, 2004; Darab & Montazer, 2011; Haney, 2002; Machado, 2007).

Human resources readiness focuses on evaluating the incumbents in terms of motivation, attitude, resistance and skills required in providing e-learning. With respect to human resources readiness, Machado (2007) recommended that prior to the implementation of e-learning services, it is important to understand the vision of managers, their abilities in implementing policies and strategies that inform e-learning. The policies and strategies empower other stakeholders in terms of motivation and training.

Borotis and Poulymenakou's (2004) model had a unique dimension not included in the other models, which is the business dimension. The business readiness of an institution is measured by

assessing its goals, needs, motivators, resources and constraints with respect to e-learning. Needs assessment helps in identifying the gaps that need to be closed by providing e-learning. Business readiness assessment encompasses policy and strategy assessment.

Two of the models, the Borotis and Poulymenakou (2004) model and the Darab and Montazer (2011) model posited that the e-readiness evaluation could be based on the culture of an institution. Institutional culture could be evaluated in terms of its response to technology adoption, staff training, budget, provision of resources and management support.

In summary, Sections 2.2.1.1 and 2.2.1.2 identified important factors that affect e-readiness as infrastructure, policies, human resources and content. The identified factors would be applied in analysing the mobile phone e-readiness of South Africa as a country where this research was undertaken in Section 2.2.3. Before reviewing the mobile phone readiness of South Africa, Section 2.2.2 gives a general overview of mobile phone e-readiness from a global perspective.

2.2.2 Overview of mobile phone readiness

There is compelling evidence to show that HEIs and students live in environments that are ready for mobile centric information access and interaction. The evidence is based on statistical reports produced by ICT research organisations over the past five years that show a progression on mobile technology adoption in developing countries (Ericsson, 2015; ITU, 2014c; Kearney, 2013). The reports put mobile cellular technology as the fastest growing technology in the world that many people can afford and own (ITU, 2014c; Kearney, 2013). Consequently, mobile phones have provided a platform for information access and interaction to people who were previously side lined by ownership and access to appropriate ICT technologies (Brown et al., 2011; ITU, 2014a; Kearney, 2013). As evidence, the estimated global mobile cellular phone subscription has surpassed 7 billion (ITU, 2015). As a percentage of the global population, ITU (2015) estimated the subscription rate at 96%, shared between developing countries (90%) and developed countries (122%). As from the year 2015, ITU (2015) projected a slow growth in global mobile phone penetration as developing countries reaches saturation point. Kearney (2013) and Ericsson (2015) made short term projections. Kearney (2013) projected that by the year 2017 the global mobile phone subscription will reach 9.7 billion. In that respect, Ericsson (2015) projected that by year 2020 the figures will grow to 9.2 billion. The predictions were based on the projected demand for smartphones, tablet PCs and mobile broadband.

The global mobile phone penetration growth rate is not homogeneous. The Asia Pacific regions have the highest mobile phone penetration rates with a global share value of just below 50% (ITU,

2014b). The Asia Pacific region countries that have mobile phone penetration rates above world average included Korea, China, Japan, Australia, Singapore and Malaysia. The Asia Pacific region is projected to grow by 7% per year between the years 2012 and 2017 (Kearney, 2013). This is against the African region, which lags below the world average with a predicted growth of 6% per year between the years 2012 and 2017 (Kearney, 2013). Globally, the estimates are that as from the year 2015, 93% of the population would live under mobile cellular network coverage (ITU, 2015). The factors that contribute to high mobile phone penetration are falling prices of broadband and mobile phone devices, and infrastructure investments in developing countries (Ericsson, 2015; ITU, 2014c; Kearney, 2013). Ericsson (2015) observed that the high mobile phone penetration could be due to multiple device ownership, with some people having mobile devices dedicated for business, family and friends.

In line with the significant growth in global mobile phone penetration, there has been a consistent growth in global mobile broadband penetration, estimated at 47% in the year 2015 (ITU, 2015). Ericsson (2015) projected the global mobile broadband subscription to reach 7.7 billion by the year 2020. The estimates for mobile broadband growth rate for developing and developed countries in the year 2014 are at 26% and 11.5% respectively (ITU, 2014c). Even though developing countries are reported to have a higher mobile broadband growth rate than developed countries, the penetration rate of developed countries is reported to be higher (84%) than that of developing countries (21%) (ITU, 2014c). The mobile broadband penetration estimates in Europe and America are at 78% against Africa with 19% (ITU, 2014c).

The growth in mobile broadband has resulted in the rise of global internet access. This is due to the deployment of 2G, 3G and 4G Long Term Evolution (LTE) data networks with an estimated global coverage of 90%, 30% and >5% respectively (ITU, 2014c). In developed countries, the growth rate of 2G reached the tangent around the year 2003 and 3G overtook it in the year 2010 (ITU, 2014c). Similarly, developing countries are now realising a decline in 2G growth rate and a rise in 3G and 4G growth rates. The rise in 3G and 4G data networks explains the rise in internet usage globally, especially in developing countries. Globally, China, Japan and the United States of America are leading mobile phone internet access penetration (Ericsson, 2015). ComScore (2015) reported that in the United States of America (USA), Canada and United Kingdom (UK), the number of people who access internet through mobile phones have surpassed those who access internet through desktop computers. The rise in mobile internet access has been attributed to the rise in smartphone penetration, which is over 90% amongst the 18-34 year old age groups (comScore, 2015).
The rise in internet access in developing countries, in particular in Africa is against a slow growth in fixed broadband, which is historically constrained by infrastructure limitations (Ericsson, 2015).

In the year 2015, the estimates for fixed broadband penetration in Africa were at 0.5%, mobile broadband penetration at 17.4% and internet penetration at 20.7% (ITU, 2015). Evidently, the growth in internet access is due to the growth in mobile broadband penetration. Due to limited alternative internet access in African countries, most people are mobile centric internet users (Groupe Speciale Mobile Association [GSMA], 2015a).

In summary, Section 2.2.2 gave an overview of the mobile phone readiness looking at global penetration and trends. Hence, this provides evidence to support that HEIs strives in environments that are ready for mobile information access and interaction. The following section narrows down the review to mobile phone readiness of South Africa as a country where this study was undertaken.

2.2.3 The South African mobile phone readiness

As revealed by the e-readiness models discussed in Section 2.2.1, measures for evaluating mobile phone e-readiness of a country are technological infrastructure developments, country policies, business and political environment, and technological culture of the people. This section adopts the measures to discuss the mobile phone e-readiness of South Africa as a country. The discussion continues under the following sub headings: Section 2.2.3.1 discusses mobile phone penetration, Section 2.2.3.2 discusses mobile broadband coverage, Section 2.2.3.3 discusses broadband policy, Section 2.2.3.4 discusses mobile phone device and Section 2.2.3.5 discusses cost of broadband.

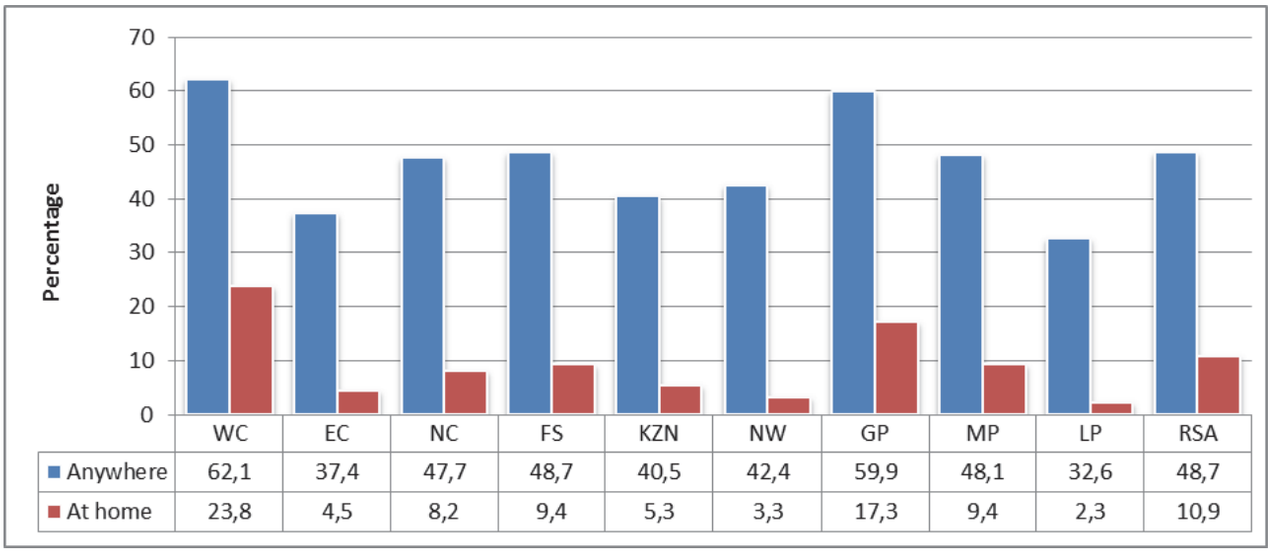
2.2.3.1 Mobile phone penetration

South Africa is amongst the leading countries in mobile cellular growth in Africa. As of the year 2015, 89% of its adult population owned a mobile phone up from 33% in the year 2002 (ITU, 2015; Poushter et al., 2015). The metric mobile phone subscription for South Africa surpassed 120% in the year 2012 (ITU, 2012) and reached 145% in the year 2014 (UNESCO, 2014b). Despite the 145% mobile phone subscriptions, Statistics South Africa reported that 4.1% of the households had none of their members with access to a landline telephone or a cell phone (Statistics South Africa, 2015). Provinces identified as having the least telecommunications penetration in South Africa were Northern Cape (NC) and Eastern Cape (EC). The gap in the provision of telecommunications infrastructure could be due to the lack of investment in backbone infrastructure and last mile or local loop infrastructure (Department of Communication, 2013). To address the issue of universal access in the country, the government is putting resources through the Universal Services and Access Fund (USAF) agency and Universal Services and Access Obligations (USAO) agency that will enable it to provide the required infrastructure to least developed areas (Department of Communication, 2013).

Statistics South Africa (2015) divided access to telecommunication infrastructure into landline access, mobile phone access and combination of both. Their findings revealed that 83.1% of South African households were mobile phone only users. The provinces with the highest mobile phone only users were Limpopo (LP) (93.3%), Mpumalanga (MP) (92.1%), North West (NW) (88.6%) and Free State (FS) (87.6%). With respect to fixed landline telephone access, only 0.2% of households have access, most of which are concentrated in Gauteng (GP) and Western Cape (WC).

The South African government recognises that internet connectivity is essential in building a knowledge society through The South African National Broadband Policy of 2013 (Department of Communication, 2013). Despite the acknowledgement, the broadband penetration of the country is regarded as poor compared with other middle level countries such as Turkey, Brazil, Russia and China (Gillwald, Moyo & Stork, 2012). According to The Broadband Commission 2014 report, the fixed broadband penetration of South Africa was 3.1% (UNESCO, 2014b). Comparing South Africa with other countries globally, it was ranked number 106 out of 190 countries. Other statistical measures in The Broadband Commission 2014 report included households with internet access (39.4%), internet user penetration (48.9%), and social network penetration (48.9%).

South Africans access fixed internet through various sources as depicted in Figure 2-2 (Statistics South Africa, 2015). The groups of internet access sources are *internet access from anywhere* and *internet access at home*. *Internet access from anywhere* referred to accessing internet from places such as workplace, place of study or internet café. Based on Figure 2-2, the margins between *internet access from anywhere* and *internet access at home* are large across all South Africa's nine provinces. This was interpreted to mean that people mostly access internet from their work places, study places or internet cafes. According to the report, internet access from home was highest among households in Western Cape (WC) (23, 8%) and Gauteng (GP) (17, 3%), and lowest in Limpopo (LP) (2, 3%) and North West (NW) (3, 3%).



	WC	EC	NC	FS	KZN	NW	GP	MP	LP	RSA
Anywhere	62,1	37,4	47,7	48,7	40,5	42,4	59,9	48,1	32,6	48,7
At home	23,8	4,5	8,2	9,4	5,3	3,3	17,3	9,4	2,3	10,9

Figure 2-2: Internet access in South Africa's provinces (Statistics South Africa, 2015)

2.2.3.2 Mobile phone broadband coverage

In South Africa, several companies provide broadband, two are fixed line operators and six are mobile cellular network operators. The two fixed line operators are Telkom mobile[2] and Neotel[3]. The six mobile cellular network operators are Vodacom[4], MTN[5], Cell C[6], Telkom mobile[7], Neotel [8]and Virgin mobile[9]. There are also broadband wireless providers such as Wireless Business Solutions (Pty) who owns iBurst[10], Sentech[11] and several other wireless network operators.

The mobile cellular network operators that include Vodacom, MTN, Cell C, Telkom mobile, Neotel and Virgin mobile offer broadband services through the following technologies: General Packet Radio Service (GPRS), Enhanced Data for GSM Evolution (EDGE), Second Generation (2G), Third Generation (3G) and High Speed Downlink Packet Access (HSDPA), Fourth Generation (4G) and Long Term Evolution (LTE). Whilst most of the technologies have over 99% population coverage, 4G and LTE were introduced recently and are only accessible in the metropolitan cities of the country (Mybroadband, 2015).

[2] http://www.telkom.co.za

[3] http://www.neotel.co.za

[4] http://www.vodacom.co.za

[5] http://www.mtn.co.za

[6] http://www.cellc.co.za

[7] http://www.telkom.co.za

[8] http://www.neotel.co.za

[9] http://www.virginmobile.co.za

[10] http://www.iburst.co.za

[11] http://www.sentech.co.za/content/wireless-broadband

Apart from the commercial telecommunication mobile broadband providers, several other organisations provide wireless broadband to their communities in South Africa. The organisations include universities, metropolitan cities and rural community wireless networks. Universities that provide wireless broadband to their communities include University of South Africa[12], University of Pretoria[13] and University of Cape Town[14], just to mention a few. Metropolitan cities that provide free wireless broadband services include Pretoria[15], Johannesburg[16] and Cape Town[17], just to mention a few. Rural wireless connectivity has been deployed as experimental test beds by research organisations that have interest in the last mile connectivity. An example of a research organisation is Meraka Institute, which deployed a wireless mesh network in Mpumalanga (Matthee, 2012) and Eastern Cape (Herselman & Botha, 2014). The universities of Fort Hare and Rhodes provided WiMAX and Wireless networks in Eastern Cape (Mudziwepasi, Nomnga, Ntsizi, Scott & Sibanda, 2014).

2.2.3.3 Broadband policy

The South African government commits to provide broadband infrastructure to its citizens, social organisations and businesses through the South African National Broadband Policy of 2013 (Department of Communication, 2013). The South African National Broadband Policy is dubbed 'South Africa Connect'. The aim of the South Africa Connect is to provide national broadband that meets the needs of its consumers. The policy references other national policies that include the National Development Plan of 2013. The policy is supported by government acts that include The Independent Communication Authority of South Africa Act of 2000, amended in 2014, The Electronic Communication Act of 2005, amended in 2014, The Telecommunication Act of 2000, and the Promotion of Access to Information Act of 2000. In line with these policies, the government established institutions that operate under regulatory frameworks to champion the promotion of universal access and universal services. The institutions include the Independent Communication Authority of South Africa (ICASA), the Universal Service and Access Agency of South Africa (USAASA), and the strategic Integrated Project (SIP) 15: Expanding Access to Communication Technology.

[12] http://www.unisa.ac.za/Default.asp?Cmd=ViewContent&ContentID=7521

[13] http://www.up.ac.za/up-wireless-network

14 http://www.icts.uct.ac.za/modules.php?name=News&file=article&sid=3196

15 http://www.ptawug.co.za/

16 http://www.jawug.org.za/

17 http://www.ctwug.za.net/content.php

The South African Connect is a target based policy. The government has medium to long-term targets that it has to achieve, presented in Table 2-1 for the targets.

Table 2-1: National Broadband policy targets

Target	Penetration measure	Baseline (2013)	By 2016	By 2020	By 2030
Broadband access in Mbps user experience	% of population	33.7% Internet access	50% at 5Mbps	90% at 5Mbps; 50% at 100Mbps	100% at 10Mbps; 80% at 100Mbps
Schools	% of schools	25% connected	50% at 10Mbps	100% at 10Mbps; 80% at 100Mbps	100% at 1Gbps
Health facilities	% of health services	13% connected	50% at 10Mbps	100% at 10Mbps; 80% at 100Mbps	100% at 1Gbps
Government facilities	% of government offices	–	50% at 5Mbps	100% at 10Mbps	100% at 100Mbps

Source: Research ICT Africa, 2012 ICT access and use survey

An important observation from Table 2-1 is that the government targets to provide 50% of schools with 10Mbps by the year 2016 and 100% of schools with 1 Gbps by the year 2030. This would be an important advancement in creating a knowledge society in South Africa.

2.2.3.4 Mobile phone devices

South Africa is experiencing an increase in smartphone ownership against a decrease in feature phone ownership. The exact smartphone penetration figures are not certain but some research organisations have provided estimates over different periods. GSMA estimated the smartphone penetration rate at 23% (GSMA, 2014), Huawei estimated that it is around 31% (Rawlins, 2015), and Pew Research Centre estimated that it is around 34% (Poushter et al., 2015). The smartphone penetration rate in South Africa is above that of the rest of the Sub Saharan African countries, which have an inclusive average penetration of 13% (GSMA, 2014). However, the estimated smartphone penetration in South Africa is lower than that of the developed countries, estimated at 60%, which ranges from 51% in Europe to 71% in North America (GSMA, 2015c).

A factor attributed to the growth of smartphone penetration in South Africa is mobile phone broadband network coverage. As discussed in the previous section, South Africa has four mobile cellular phone network operators, Vodacom, MTN, Cell C and Telkom Mobile, which have inclusive network coverage of over 90% of the country. Smartphone penetration in South Africa and globally has been credited to the decrease in the price of smartphones (Ericsson, 2015; GSMA,

2015c; Internet Society, 2015). Internet Society (2015) reported on a 12.8% decrease on the global average selling price of smartphones, which is from US$387 in the year 2012 down to US$ 337 in the year 2013. In Africa, the reduction in smartphone costs is credited to mobile manufacturing companies competing for market domination (Ericsson, 2015). The competition resulted in the manufacturing of low cost smartphones. Major competitors included Samsung, Nokia, Motorola, Huawei, and Mozilla, who have provided smartphones that cost from US$25 to US$100 (Internet Society, 2015).

In South Africa, smartphones provide an opportunity for closing the information access and interaction gap due to the historical unequal distribution of ICT resources in the country (Kearney, 2013). Hence, there is a new class of mobile centric users, who rely on mobile phones as tools for business and social life information access and interaction.

2.2.3.5 Broadband cost

The South Africa National Broadband Policy of 2013 commits the government to provide reliable, accessible and affordable broadband to the citizens (Department of Communication, 2013). The policy envisioned that by the year 2020, the cost of broadband services would be 2.5% or less of the average monthly income of citizens. Despite this vision, researchICTafrica reported that South Africa has expensive broadband according to the Broadband Price Index compiled in August 2014 (Calandro, Gillwald & Rademan, 2014). The Broadband Price Index compared broadband prices for 12 African countries with competitive mobile broadband penetration. The comparison was calculated based on the price of a 1 Giga Byte (GB) prepaid data bundle from every mobile cellular network operator in a country. Calandro et al., (2014) revealed that the average cost of a 1GB prepaid data bundle from Cell C, MTN SA, and Vodacom SA was sold at an average price of US$14.10. Telkom mobile was the most expensive operator in the country, sold a 1GB of prepaid data bundle at US$ 17.00, whilst Virgin Mobile was the least expensive and sold a 1GB of prepaid data bundle at US$ 9.20. Comparing South Africa with other African countries, Namibia was the most expensive country with an average price for a 1GB of prepaid data bundle at US$ 25.90, followed by Botswana (US$ 21.80) and Ethiopia (US$ 20.6). The least expensive countries were Cameroon (US$ 2.10), Kenya (US$ 4.60) and Senegal (US$ 5.20) (Calandro et al., 2014).

The researchICTafrica 2014 report only considered prepaid data bundles, yet the South African mobile cellular network operators also provide post-paid broadband contracts. The South African broadband market is dynamic due to competition amongst the network operators. Table 2.4 provides the broadband cost for the four main mobile operators in the country according to data extracted from MyBroadband (Vermeulen, 2015). The table shows that the smallest package of

broadband is 25MB and Cell C offers the cheapest price at R6.00. All the other mobile cellular network operators offer competitive prices around that figure. The price of 1GB of broadband is cheapest at Telkom Mobile (R99.00) and most expensive at MTN (R160.00). Even though the MTN 1GB data bundle was the most expensive, it was giving away a 1GB of data free on promotion. Data presented in Table 2-2 shows that Telkom Mobile offers the cheapest contract broadband data bundles.

Table 2-2: Contract broadband prices of South Africa in 2015

Data Bundle	Telkom mobile	Vodacom	MTN	Cell C
25MB	R7.25	R12 (30MB)	R12 (20MB)	R6
50MB	R14.50	–	R25	R10
100MB	R29	R29	R35	R19
250MB	R39	R59	R85 (300MB)	R55 (300MB)
500MB	R69	R99	R105	R85
1GB	R99	R149	R160*	R149
2GB	R139	R249	[R160 *] R260 *	R245
3GB	R199	R299	R330 *	R299
5GB	R299	R399	R430 *	R399
10GB	R499	R599	[R430 *] R650	R549
20GB	R899	R999	R1,250	R1,099
50GB	R1,799	–	–	–

Source: (Vermeulen, 2015)*MTN promotion doubles the caps of its 1GB, 2GB, and 3GB.

To summarise Section 2.2.3, there is compelling evidence to support the view that South Africa is a country that is mobile phone ready, which implies that HEIs in the country can provide mobile centric services to the students. The country has mobile phone penetration of 145% (UNESCO, 2014b), mobile phone only users accounts for 83.1% of the population (Statistics South Africa, 2015), mobile broadband coverage accounts for 99% of the population (Mybroadband, 2015), smartphone penetration is rising, and the country has a favourable National Broadband Policy that regulates the provision of broadband in the country. Therefore, HEIs in South Africa have the opportunity to implement mobile information access and interaction services for its students. The following section explores mobile phone readiness at South African educational institutions.

2.2.4 Mobile phone readiness at South African educational institutions

E-readiness models discussed in Section 2.2.1.2, suggested that e-readiness evaluation of an institution should focus on the readiness of policies, infrastructure, finance, and human resources. This section adopts the measures to discuss the mobile phone readiness of South African educational institutions. The discussion continues as follows: Section 2.2.4.1 discusses policy readiness, Section 2.2.4.2 discusses infrastructure readiness, Section 2.2.4.3 discusses financial readiness, Section 2.2.4.4 discusses lecturer readiness and Section 2.2.4.5 discusses student readiness.

2.2.4.1 Policy readiness

The South African ICT policies on teaching and learning are considered outdated and fail to provide necessary guidance on the use of mobile technology in teaching and learning (Vosloo, 2012). As a result, the policies prohibit full utilisation of mobile devices as learning tools. Czerniewicz and Ngugi (2007) analysed South African ICT educational policies and they found that the national policies were broad and had no strategies for supporting the use of ICTs in teaching and learning. At the institutional level, the study found that the development of e-learning policies were at different levels. The study concluded that the differences in the development of policies at HEIs are rooted in the national e-learning policies, which are fragmented (Czerniewicz & Ngugi, 2007). The findings are important in this study because existing ICT educational policies inform mobile technology policies. In line with this argument, a study by Vosloo (2012) concluded that most ICT policies in education only focused on the provision of hardware, software and networking, whose link to pedagogy, curriculum or assessment was not clear. Hence, UNESCO sees this as a vacuum in the educational ICT policies (UNESCO, 2011) and has pioneered a project for developing mobile policy guidelines that can be adopted by educational institutions.

UNESCO has converged a series of symposiums dubbed the UNESCO Mobile Learning Week (MLW) in 2011 (UNESCO, 2011), 2013 (UNESCO, 2013a), and 2014 (UNESCO, 2014a), which had at least one objective on determining the role of policy in supporting mobile learning. The symposiums provided a platform for discussing strategies for employing mobile phones as tools for teaching and learning. UNESCO's point of departure was to respond to high mobile technology adoption rates and the opportunities it presents in facilitating learning (UNESCO, 2011). Vosloo (2012) argued that successful integration of mobile technology in teaching and learning would depend on the support given through policies. In that respect, Traxler and Vosloo (2014) contended that opportunities for providing teaching and learning through mobile technology would be useless if they are not supported by policy.

The deliberations of the MLW 2011 symposium resulted in the publication of a policy guideline to help educational institutions and governments in developing mobile learning policies (Kraut, 2013). The MLW 2013 symposiums focused on how mobile technologies could support teachers in their professional development. The MLW 2014 symposium focused on bringing educational policy makers together to share experiences on how educators could leverage mobile technologies to improve educational outcomes (UNESCO, 2014a). Hence, the lesson learnt from the MLW symposiums is that successful provision of mobile centric services in teaching and learning depends on institutional support provided to the educators through policies.

In response to the vacuum in the ICT educational policies, UNESCO published guidelines for designing polices that regulate the use of mobile technology in education (Kraut, 2013). Table 2-3 presents a summary of UNESCO's policy recommendations.

Table 3-3: Summary of UNESCO 2013 mobile learning policy guidelines (Kraut, 2013)

Policy Recommendation	Contents
Create or update polices related to mobile learning	Update existing ICT policies to incorporate the use of mobile technology in teaching and learning.
Train teachers to advance learning through mobile technologies	It is recommended that educators receive training on how to incorporate learning into their curricula.
Provide support and training to teachers through mobile technologies	In educator development courses, educators should be provided with curricula, course plans, and activities through mobile technologies.
Optimise educational content for use on mobile devices	Ensure that online content repositories are accessible through mobile devices. Provide educators with tools that facilitate creation of mobile content.
Ensure gender equity for mobile students	Promote mobile technology as a tool that is not gender based.
Expand and improve connectivity options while ensuring equity	Ensure that the community has equal access to mobile networks. Subsidise mobile data or broadband.
Develop strategies to provide devices for students/lecturers who cannot afford them	Provide a strategy that ensures that all the staff or students have access to mobile devices.
Use mobile technology to improve communication and education	Encourage communication through mobile technologies in teaching and learning.
Promote safe, responsible and healthy use of mobile technologies	Promote ethical use of mobile devices in communication and interaction. Safeguard against the flow of inappropriate content. Warn of potential health risks.
Raise awareness of mobile learning	Highlight the benefits of using mobile technology in teaching and learning. Encourage dialogue among key stakeholders.

With reference to Table 2-3, the UNESCO guidelines for m-learning policies recommended government and educational institutions to review and upgrade their ICT educational policies to benefit from the use of mobile technology in teaching and learning. The guidelines recommended policies to encourage and support lecturers with training to provide mobile centric services. With

respect to the provision of online content, the guidelines recommended that all content and websites be accessible through mobile devices. The recommendations emphasise equitable access in terms of communication, interaction, accessing mobile resources, connectivity, economic status, and gender. Lastly, the guidelines encourage the use of mobile technology among stakeholders and promote safe, responsible and healthy use of the devices.

2.2.4.2 Infrastructure readiness

This section provides literature analysis of South Africa's M-Learning projects and analyse their mobile phone infrastructure readiness. The analysed projects revealed that some projects were ready to provide software and hardware infrastructure while others were ready to provide software infrastructure only. The discussion continues as follows: Section 2.2.4.2.1 discusses software infrastructure readiness and Section 2.2.4.2.2 discusses hardware infrastructure readiness.

2.2.4.2.1 Software Infrastructure readiness

Literature analysis established that South African M-Learning projects applied different approaches to provide students with software infrastructure. The approaches included providing services through social media platforms, for example, studies reported by Butgereit (2007), Makoe (2010), Puckree, Maharaj & Mshunquane (2015), Rambe & Bere (2013) and Willemse (2015). Other studies provided services through mobile apps, for example, studies reported by Jantjies & Joy (2015), Ng'ambi (2006), and Ntinda, Thinyane & Sieborger (2014).

Social media platforms were used to provide mobile phone services in two ways. There were projects that used the basic functionality of social media platforms to provide communication and interaction with students. For example studies by Makoe (2010), Puckree et al.(2015), Rambe & Bere (2013) and Willemse (2015). The other projects built and integrated mobile phone applications with social media platforms, for example Dr Maths on Mxit (Butgereit, 2007).

On the other hand, there were projects that utilised SMS as a platform for providing basic one-way communication with students, for example studies by Gregson & Jordaan (2009b), Puckree et al.(2015) and van Rooyen (2008). Some projects extended the SMS platform to provide specialised services, for example, Ng'ambi (2006) deployed an SMS based application at the University of Cape Town for students to ask questions anonymously.

2.2.4.2.2 Hardware Infrastructure readiness

Literature analysis established that the provision of infrastructure depended on the funding structure of the M-Learning project. All funded projects provided hardware deemed necessary for

the project. Studies that provided hardware include studies by Ford & Botha (2009), Herselman & Botha (2014) and School Net South Africa (2015). The hardware infrastructure comprised client side hardware and administrative server side hardware. The client side hardware were mobile phone handsets provided to students, for example in the MobiLED project (Ford & Botha, 2009), the Microsoft Math Project (School Net South Africa, 2015), the University of Pretoria's M-learning Project (Bon, De Schryver, Twinomurinzi & Jordaan, 2012) and the ICT4RED Project (Herselman & Botha, 2014). Among all the projects that provided infrastructure, the ICT4RED Project provided a complete set of hardware infrastructure to 26 Schools in the Eastern Cape Province of South Africa. The infrastructure provided to the 26 schools included tablet computers, satellite internet connection resources, Wi-Fi resources, computer servers, charging stations for tablet computers, electricity, biogas energy sources and upgraded security for the computer rooms. In line with providing South African schools with mobile technology and connectivity, the government launched 'The Big Switch On initiative' (South Africa.info Reporter, 2015). The objective of the initiative is to pilot a paperless classroom by equipping Gauteng schools with tablet computers. The tablet computers would be pre-loaded with study material. Most funded projects provided the hardware infrastructure as a way of correcting the previously imbalanced distribution of ICT resources in the country.

Unfunded projects implemented the Bring Your Own Device (BYOD) model to rely on the devices of end users. For example, studies reported by Ntinda et al. (2014), Oxford (2013) and Rambe & Bere (2013) and Willemse (2015). Among the projects that implemented BYOD, of interest, are the tablet computers initiatives at the Sunward Park High School in the Gauteng Province of South Africa (Oxford, 2013) and another initiative at a private school (Eicker-Nel & Matthee, 2014) where the Parents-Teachers Association initiated the projects. The Sunward Park High School project (Oxford 2013) targeted 1230 pupils in grades 8 to 10. The project required the pupils to buy and bring either a 7-inch or a 10-inch tablet computer to class. The estimated cost of the 7-inch tablet computer was R1 000 and a 10-inch was R2 000. Out of the 1230 students, it was reported that only four families requested for financial assistance from the school management. Similarly, the private school project (Eicker-Nel & Matthee, 2014) targeted grade 10 pupils and required the parents to buy the tablet PCs for the pupils. Hence, the unfunded projects employed BYOD as a way of cutting the cost of providing mobile centric services.

To summarise Section 2.2.4.2, literature analysis found that either HEIs can adopt the BYOD to rely on the mobile phone infrastructure of users or they can provide the users with the mobile devices. Apart from end users infrastructure, HEIs are required to provide hardware that includes

computer servers and wireless networks such as Wi-Fi. Wireless networks are essential in providing cheap internet access to mobile phone users.

2.2.4.3 Financial readiness

This section discusses the financial readiness of mobile phone projects reported at South African educational institutions. Analysis of the projects found that the funding structure of the projects could be grouped into none funded projects, externally funded projects and institutionally funded projects. The discussion continues as follows: Section 2.2.4.3.1 discusses none funded projects, Section 2.2.4.3.2 discusses externally funded projects and Section 2.2.4.3.3 discusses institutionally funded projects.

2.2.4.3.1 None funded projects

Literature analysis established that there were mobile phone projects that did not reveal their financial sponsors. For example, studies reported by Day & Kumar(2010), Ntinda et al.(2014), Rambe & Bere (2013), van Rooyen (2008) and Willemse (2015). The reason could be that the projects were exploratory research projects, championed by individual researchers. The projects used the BYOD model to provide services. That is, the students bought their own devices, paid for the broadband costs and the projects relied on social media software. Even though the projects did not disclose sources of their funds, some universities provide wireless networks on which smartphones can access internet and SMS services for communicating with students.

2.2.4.3.2 Externally funded projects

The literature analysis established that some projects received external funding and these included MobiLED Project (Ford & Botha, 2009), The Case study of four South African Schools Project (Jantjies & Joy, 2015), Dunia Moja Project (Stanford University, 2015), Microsoft Math Project (School Net South Africa, 2015), ICT4RED Project (Herselman & Botha, 2014) and The Big Switch On Project (South Africa.info Reporter, 2015). The projects are regarded as externally funded because the beneficiaries of the projects did not financially contribute to the implementation of the projects.

Three of the externally funded projects, MobiLED, Microsoft Math and Dunia Moja were international collaborations. The objectives of the projects were to deliver learning solutions that have tangible benefits to receiving communities. Donor organisations together with the South African collaborators funded the projects. For example, the MobiLED project is a brainchild of the Meraka Institute of the Council for Scientific and Industrial Research (CSIR) in partnership with two local universities and three international organisations. The MobiLED project piloted three

mobile phone applications for teaching and learning in South Africa and they were the Mobile Audio Wikipedia project (Ford & Botha, 2009), the Math on Mxit Project (Butgereit, 2007) and the IGLOO project (Ogunleye, Botha, Ford, Tolmay & Krause, 2009). The MobiLED Project received funding from the Nokia Corporation and participating institutions. The funding sponsored the design of the mobile application, mobile phone handsets and other logistical operations. Another externally funded project is the ICT4RED initiative that provided 26 schools with tablet computers in the Eastern Cape (Herselman & Botha, 2014). The project is part of the Technology for Rural Development programme an initiative of the Department of Science and Technology in collaboration with the Department of Basic Education, Eastern Cape Department of Education and the Department of Rural Development and Land Reform. The funding sponsored the purchase of tablet computers, satellite connection, installation of Wi-Fi, computer servers, tablet PC charging stations, human resources training and securing the computer rooms.

Similarly, the Microsoft Math (School Net South Africa, 2015), an initiative of the South African President's office received financial and logistical support from the Microsoft Corporation and Nokia International in partnership with local mobile cellular companies. The other internationally funded project is the Dunia Moja Project (Stanford University, 2015), which is a collaboration of three universities in Africa and one in the United States of America. The project investigated global environmental issues and their impact on the African continent and in the United States. The project sponsors were Stanford University's Institute for International Studies, the Woods Institute for the Environment, the Whitehead Foundation and the Communication for All Programs at Ericsson.

There were two other projects that received government related funding, The Case study of four South African schools project (Jantjies & Joy, 2015) and The Big Switch On Project (South Africa.info Reporter, 2015). The Department of Education's North West Province funded The Case study of four South African schools project. The Big Switch On Project is a government funded initiative with a budget of R17 billion aimed at equipping Gauteng Province schools with tablet computers loaded with lessons and reading material (South Africa.info Reporter, 2015).

The externally funded projects were big projects initiated to address the digital divide in developing countries. The donor organisations provided financial support for equipment, technology, logistical support and training.

2.2.4.3.3 Institutionally funded projects

This study found two projects that seem to have received funding from the institutions where they were implemented. The projects are the M-Learning project at the University of Pretoria (Brown, 2003; Gregson & Jordaan, 2009; Matthee & Liebenberg, 2007) and the Dynamic Frequently Asked Questions at the University of Cape Town (Ng'ambi 2006). These two projects provide university supported services and could have university financial backing.

To summarise Section 2.2.4.3, literature analysis found that some mobile phone initiatives did not reveal how they were funded. Such mobile phone initiatives relied on the mobile devices of the students and free software such as social media and SMS services. Other mobile phone initiatives received external funding. The externally funded initiatives provided both software and hardware infrastructure to the recipient institutions. There were also mobile phone initiatives that were sponsored by some universities. These were strategic projects to provide students with mobile centric access to administrative resources, as well as teaching and learning resources.

2.2.4.4 Lecturer readiness

Factors that affect lecturer readiness in providing mobile centric services at HEIs were training, discussed in Section 2.2.4.4.1, motivation, discussed in Section 2.2.4.4.2, and workload, discussed in Section 2.2.4.4.3.

2.2.4.4.1 Training

The UNESCO working paper series (Dykes & Knight, 2012; Goundar, 2011; Isaacs, Vosloo & West, 2012) identified the lack of technical expertise in providing mobile centric services as a bottleneck to lecturer readiness. It also identified lecturer readiness as a global problem affecting Africa and Middle East regions (Isaacs et al., 2012), North America region (Fritschi et al., 2012) and Europe region (Dykes & Knight, 2012). Hence, the working paper series advocated for lecturer training in providing mobile centric services in teaching and learning. In this regard, Traxler and Vosloo (2014) argued that among many issues that need attention in M-learning, lecturer training takes centre stage. In a project to introduce tablet computers based e-textbooks at a private school in South Africa, Eicker-Nel and Matthee (2014) provided teachers and pupils with training as a way of increasing the acceptance of e-textbooks by both the teachers and pupils. Eicker-Nel and Matthee (2014) observed that older teachers at the school appreciated the training because they considered themselves less tech savvy. Goundar (2011) pointed out that if the issue of lecturer training is not addressed, the impact of mobile phones in education would be constrained by lecturer resistance and would not be achieved.

2.2.4.4.2 Workload

The workload of lecturers could affect their readiness in providing mobile centric services in HEIs (Sridharan 2013). Sridharan (2013) argued that lecturers might resist providing M-learning services if they see it as an extra workload that is time consuming. Analysis of small-scale pilot M-learning projects found that in most cases, the researchers were the only human resources supporting the projects. For example, studies reported by Makoe (2010), Ng'ambi (2006), Rambe & Bere (2013) and van Rooyen (2008). Rambe and Bere (2013) reported that they had to sacrifice long hours interacting with students otherwise, the project was going to fail.

2.2.4.4.3 Motivation

Motivation is a factor that could affect the readiness of lecturers in providing mobile centric services (Gloria & Abimbade 2013; Ekamayake & Wishart 2011; Ozdamli & Uzunboylu 2014; Cheon et al., 2012). Educators could be motivated in providing mobile centric services if they enjoy the process, see the value and could associate the activity with their teaching goals (Chiu & Wang, 2008). HEIs could motivate lecturers in providing mobile centric services through technological awareness workshops (Boyera, 2007; Ramburn & Van Belle, 2011).

2.2.4.5 Students readiness

The Eclectic Model for Assessing E-learning Readiness in the Iranian Universities (Darab & Montazer, 2011) and the Readiness Combination Model for Acceptance of E-learning (Borotis & Poulymenakou, 2004) identified culture as a dimension for evaluating e-readiness (discussed in Section 2.2.1.2). The cultural aspect is important in this study because it is essential to understand the mobile centric culture of students. The factors that influence the mobile centric culture of students include student age, gender, economic status and cyber characteristics (Zickuhr & Smith, 2012). The cyber characteristics of students include multitasking (Haddington & Rauniomaa, 2011; Vazquez-Alvarez & Brewster, 2011), and networking (Wilson & McCarthy, 2010a). The discussion continues as follows: Section 2.2.4.5.1 discusses gender, Section 2.2.4.5.2 discusses age, Section 2.2.4.5.3 discusses economic status, Section 2.2.4.5.4 discusses multitasking and Section 2.2.4.5.5 discusses device portability.

2.2.4.5.1 Gender

Early studies on ICT technological ownership and usage found gender differences in the ownership and use of ICT technologies (Rice & Katz, 2003; Wasserman & Richmond-Abbott, 2005). The findings remain true to date and are supported by research that found that the information society is not gender balanced (GSMA, 2015a; Gurumurthy & Chami, 2014; UNESCO, 2013b). The Broadband Commission Working Group on Education’s 2013 report identified that gaps in access

and use of ICTs are caused by differences in advanced ICT skills between men and women (UNESCO, 2013b). The differences in advanced ICT skills have effects on how men and women access and interact on the internet (GSMA, 2015a; Intel, 2013; ITU, 2013). Men were found to have strength on internet activities such as reading online news, sports and games, while women were found to have strength on social networking and communication activities (Forgays, Hyman & Schreiber, 2014; ITU, 2013; Wiese, Lauer, Pantazis & Samuels, 2014). The gender difference has effects on the confidence of interacting with a technology (Brown & Czerniewicz, 2010).

Regional variations have an effect on technological ownership and use (Intel, 2013). Intel (2013) observed developed countries to have a smaller gender gap on internet usage (2%) as compared to developing countries (16%). Factors that influence gender gaps were identified as educational level and economic status of women in society (Deen-Swarray, Gillwald & Morrell, 2013). Deen-Swarray et al., (2013) found that if mobile phone ownership is benchmarked on educational or economic status of individuals, women are as likely to own a mobile phone as men irrespective of their country origin.

Despite the increased uptake and use of mobile phones by both men and women in developing countries, the gap in ICT technology usage and ownership is said to be increasing (GSMA, 2015a). GSMA (2015a) reported that over 1.7 billion women in low and middle-income countries do not own a mobile phone. That is, women are 14% more likely not to own a mobile phone than men and the figures could increase to 38% if a woman lives in a South Asian country.

In South Africa, the South African Digital Media and Marketing Association found a gender gap in mobile information access and interaction between females and males between the ages of 16 to 60 years with ratios of 31% and 69% respectively (Muller, 2011). This contradicts Porter (2012) who found the national ratio of mobile ownership between female and male students in high school to be 23.7% and 17.3% respectively. The contradiction between the two studies shows that technology usage and ownership among students could be different from the general population of a country. An earlier study by Brown and Czerniewicz (2010) found that at a South African university both male and female students had equal access to ICT resources at the university and home. In this respect, several studies in literature have reported 100% ownership of mobile phones at many universities in South Africa (Bester, 2014; De Villiers, 2010; Mayisela, 2013; Nagel & Verster, 2012). Despite the imbalanced global mobile phone access and use in developing countries (GSMA 2015), HEIs could provide students with mobile information access and interaction services without any fear of discriminating any student on gender basis.

2.2.4.5.2 Age

Age is a factor that affects the use of mobile phones in business, social life and education (Niehaves & Plattfaut, 2014; Smith, 2014). Current research indicates that young people have confidence when using mobile phone based services such as internet access, social networking and entertainment, just to mention a few (Almutairy, Davies & Dimitriadi, 2014; Bakay, Delialioğlu & Savaş, 2015; Hussin, Manap, Amir & Krish, 2012). On the other hand, older people were found to resist mobile phone adoption (Meyer, 2011). Resistance by older people was reported to be due to their inability to quickly learn on new technologies, in particular those over 50 years (Ertmer & Ottenbreit-Leftwich, 2010; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; van Deursen & Van Dijk, 2014; Yu, 2012). In this respect, van Deursen and van Dijk (2014) postulated that the differences in age were temporal since any new good technology would become part of daily life in the end. Ertmer and Ottenbreit-Leftwich (2010) observed important factors that determine the use of technology to be knowledge and self-efficacy. Hence, if older people are knowledgeable, they can easily learn how to use the features of a mobile phone. However, some research found no significant difference on the adoption of mobile phone handsets on people who are between the ages of 18 years to 68 years (O'Bannon, Lubke, Beard & Britt, 2011; Smith, 2014). In the USA, Smith (2014) reported that older adults above 65 years had substantial ICT technology resources and used their mobile phones to go online. The effects of age variations were recognised on activities such as texting and entertainment, but not on voice calls (Forgays et al., 2014). Furthermore, Smith (2014) observed that once adults join the digital world they easily adapt and it becomes part of their life. In this regard, Margaryan, Littlejohn and Vojt (2011) found no evidence to support that young people have different abilities in learning with technology than adults. Hence, the provision of mobile centric services at HEIs would not discriminate other students based on age.

2.2.4.5.3 Economic status

Distance education provides accessible learning opportunities to many people in South Africa (Department of Higher Education and Technology, 2014). The Department of Higher Education and Technology (2014) recognises that the ubiquity and penetration of mobile phones in the country have the added advantage of improving the quality and realities of student learning. Students have diverse economic backgrounds and disparities in technological infrastructure access and ownership, in particular the type of mobile phone (Beger, Sinha & Pawelczyk, 2012). Students from wealthier families have been observed to afford expensive smartphones and tablet computers, whilst students from disadvantaged families afford cheap smartphones and feature phones (Bornman, 2015; North, Johnston & Ophoff, 2014). South Africa is a country with a substantial number of disadvantaged inhabitants who live in historically side-lined communities in terms of

infrastructure development (National Planning Commission, 2012).The economic status of students from such communities predetermines the type of mobile phone handsets that they can afford and the activities that they can do on the internet. Supporting student learning through mobile phones is challenged by the students' financial readiness in terms of financing the devices and broadband. Taking into consideration that the South African education system is indiscriminate and emphasises equal access to opportunities (National Planning Commission, 2012), it is essential to determine the financial readiness of students before implementing a learning technology.

2.2.4.5.4 Multitasking

Mobile phone users multitask (Tapscott, 2009), hence, they can engage in concurrent processing of two or more tasks through context switching (Ellis, Daniels & Jauregui, 2010). The motives for multitasking include acquiring information, social interactions, enjoyment through music or video, efficiency and a habit developed over a period of time (Hwang, Kim & Jeong, 2014; Wood et al., 2012). Wood et al., (2012) observed that although multitasking is not a new phenomenon, of interest is the number of electronic activities that users can engage with simultaneously. Multitasking requires a person to switch between tasks (Judd, 2013). Judd (2013) explained that an increase in multitasking is indicated by an increased rate of task switching. Hence, multitasking research focused on its disruptive nature in student learning (Ellis et al., 2010; Judd, 2014; Junco & Cotten, 2012; Rosen, Carrier & Cheever, 2013). The results of these studies agreed that multitasking significantly reduces student performance, hence it was considered to be a distraction during student learning.

2.2.4.5.5 Device portability

Mobile phone users appreciate device portability (Albrecht & Pirani, 2009; Donner & Gitau, 2009) and they always carry their devices. Furthermore, mobile phone users are creative and opportunistic people, who make use of technology for instant capturing of interesting events in formal or informal events (Tapscott, 2009). In formal events, Batchelor and Botha (2009) reported on high school students that used their mobile phones to record videos during practical classes. In informal events, mobile phones play a crucial role in capturing videos and pictures of interesting events, a situation common in citizen journalism (Banda, 2010).

To summarise Section 2.2.4.5, the technological culture of students affects their readiness in using mobile phones as information access and interaction tools. The factors that affect the technological culture of students are gender, age, economic status, multitasking and appreciation of device portability. Gender and age of students were found not to have an effect on the provision of mobile centric services to students. Literature analysis found that even though age and gender affects ICT

skills and confidence of using ICT technologies, they have no effect if people have equal academic knowledge. Economic status of students has an effect on the devices that they buy and their ability to pay for mobile phone broadband. Hence, HEIs should consider the economic status of students when providing mobile centric services to students.

2.2.5 Summary of mobile technology readiness

To summarise Section 2.2, literature analysis found several factors that affect the mobile centric readiness of HEIs in providing mobile centric services to students. The factors include policy readiness, infrastructure readiness, financial readiness, lecturer readiness and student readiness.

In terms of policy readiness as discussed in Section 2.2.4.1, South Africa regulates the provision of mobile phone broadband through The National Broadband Policy of 2013. One of the aims of The National Broadband Policy of 2013 is to provide universal access to ICT resources to citizens. With respect to policies for regulating the provision of mobile centric services at HEIs, Vosloo (2012) found that the South African ICT policies in teaching and learning were outdated and failed to provide guidance on the use of mobile phones in teaching and learning. In that respect, UNESCO (Kraut 2013) provided a policy guideline that could help educational institutions and governments in developing mobile learning policies. The guidelines recommended that all content and websites be accessible through mobile devices. The recommendations emphasise equitable access in terms of communication, interaction, accessing mobile resources, connectivity, economic status, and gender.

In terms of infrastructure readiness as discussed in Sections 2.2.2, 2.2.3 and 2.2.4.2, South Africa as a country has high mobile phone penetration, which is necessitated by the deployment of telecommunication network infrastructure that covers all the regions in the country. Many people in the country have access to a mobile phone handset and close to 83.1% of the population are mobile phone only users (Statistics South Africa, 2015). With respect to infrastructure readiness at educational institutions, literature analysis found that HEIs could either adopt the BYOD or provide students with mobile phone devices. Apart from end users infrastructure, HEIs need to provide hardware that includes computer servers and wireless networks such as Wi-Fi. Wireless networks are essential in providing cheap internet access to mobile phone users.

In terms of financial readiness as discussed in Section 2.2.4.3, literature analysis established that mobile phone projects were funded in three ways, which are non-funded projects, externally funded projects and institutionally funded projects. The none-funded projects are projects that do not disclose their funding structure, most of which are research initiatives by individual people.

Externally funded projects were donor funded and provided the infrastructure deemed necessary to the project. There were also mobile phone initiatives that were sponsored by some universities. These were strategic projects to provide students with mobile centric access to administrative resources, as well as teaching and learning resources.

In terms of lecturer readiness as discussed in Section 2.2.4.4, literature analysis established that technical skills, workload and motivation affected the lecturers. This means that lecturer readiness could be an important component in providing mobile centric services that facilitate student information access and interaction at HEIs and hence requires further investigation

In terms of student readiness as discussed in Section 2.2.4.5, literature analysis established that technological cultural factors affect student readiness. The factors that affect the technological culture are gender, age, economic status, multitasking and appreciation of device portability. This means that student readiness could be an important component in providing mobile centric services that facilitate information access and interaction at HEIs and hence requires further investigation.

2.3 Mobile phone context of use

The assumption for mobile information access and interaction at HEIs is that mobile phones are portable and students can carry and use them anywhere at any time for their learning (Traxler & Leach, 2006). Hence, students interact with their mobile phones in dynamic and changing environments during the course of their day (Dourish, 2004). The environments in which mobile phones are used are different from those of desktop computers (Sears et al., 2003). Sears et al., (2003) replaced the term environment with context and clarified that the term environment is limited to the physical space in which the technology is used while context expands focus to include social situations that may influence interaction in the physical space. Similarly, Kjeldskov and Graham (2003) found that studies on mobile phone context of use focused on artificial environmental sensing at the expense of real use of mobile phone devices. Dourish (2004) distinguished between mobile phone interaction in a physical environment and augmented environment interactions. Physical environment interactions focus on static use of mobile phones in situations such as offices, and classrooms. Augmented environment interactions focus on social processes that affect mobile phone interaction (Dourish, 2004).

The discussion in the following section focuses on contexts in which students in HEIs may find themselves when interacting with mobile phones at different times of the day. Discussion in this section continues as follows: Section 2.3.1 defines the term context, Section 2.3.2 presents context

models, Section 2.3.3 discusses the physical environment context, Section 2.3.4 discusses user context and Section 2.3.5 discusses the social context.

2.3.1 Definition of context

The definition of the term context is discussed within the limits of the work of the following three authors Schilit and Theimer (1994), Schilit, Adams and Want (2008) and Dey (2001).

Schilit and Theimer (1994) introduced the term context-aware computing. They characterised the term context aware computing as "Such information that allows stationary clients to track moving objects. In general, location information enables software to adapt according to its location of use, the collection of nearby people and objects, as well as changes to those objects over time" (Schilit &Theimer, 1994, p.23).

Schilit et al., (2008) identified three aspects of context as where you are, who you are with, and what resources are accessible to you? They said that context encompasses more than the user's location because other things of interest are also mobile and changing such as lighting, noise level, network connectivity, communication costs, communication bandwidth and social situation.
Dey (2001) defined context as any information that characterises the situation of an entity. An entity is a person, place, or object that is relevant to the interaction between a user and an application, including the user and application themselves.

Deducting from the above definitions (Dey, 2001; Schilit et al., 2008; Schilit & Theimer, 1994), the context in which students can use mobile phones as information access tools can be described in terms of location of use, and the physical and social conditions at the place of interaction. The following section looks into the context models.

2.3.2 Context models

This section discusses three models that explain the concept of context in the field of mobile information access and interaction. The three models discussed in this section are Context Feature Space (Schmidt, Beigl & Gellersen, 1999), the 3D Context Space (Sears et al., 2003), and the Mobility and Context Matrix (Botha, Van Greunen & Herselman, 2010).

2.3.2.1 Context Feature Space model

Schmidt et al., (1999) proposed the Context Feature Space model. The model describes a context as an environment a device or user is in, as having a unique name, as having a set of features and for each feature a set of values is determined by the context. The model is presented in Figure 2-3.

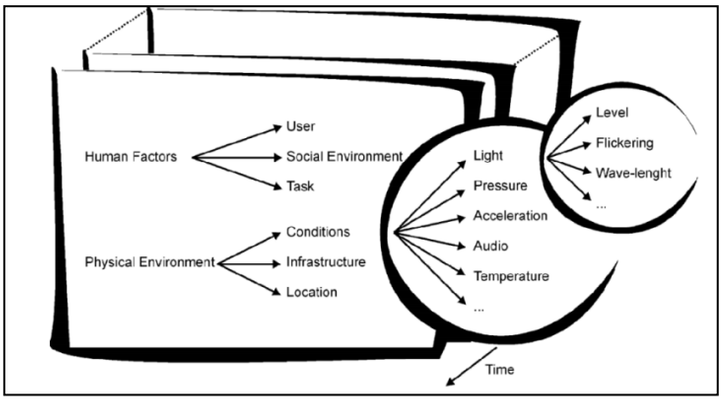


Figure 2-3: Context Feature Space model (Schmidt et al., 1999)

The model denotes a context space as consisting of the Human Factors context space and the Physical Environment context space. That is, when interacting with mobile devices, users are affected by their cognition, social environment and tasks undertaken. The physical environment also affects the users. The environmental factors that affect the users when interacting with mobile phones are the physical conditions, infrastructure, and location. The physical conditions space includes factors such as light level, noise level, temperature, and pressure. The Context Feature Space is important in this study because it informs the factors that would affect the provision of mobile centric services at HEIs.

2.3.2.2 3D Context space model

Sears et al., (2003) combined the features of Schmidt et al's., (1999) model and the elements of the definition of context as provided by Dey (2001) to build the 3D Context Space model, depicted in Figure 2-4. The 3D Context Space model categorised the contextual information into three categories: Human, Environment, and Applications. The Human and Environment space dimensions are similar to those of the Context Feature Space model (Schmidt et al., 1999). The difference between the 3D Context Space model with the aforementioned one is the Application space dimension. The Application space dimension is concerned with the factors that affect the device functionality such as the back light control, font size adjustment, and input/output channels.

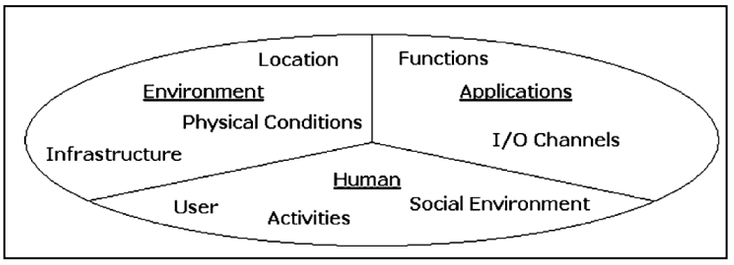


Figure 2-4: Context Space model (Sears at al., 2003)

2.3.2.3 Mobility and Context Matrix

Botha et al., (2010) proposed the Mobility and Context Matrix. The model shows how users can engage with mobile technology in different contexts against different mobility possibilities, depicted in Figure 2-5.

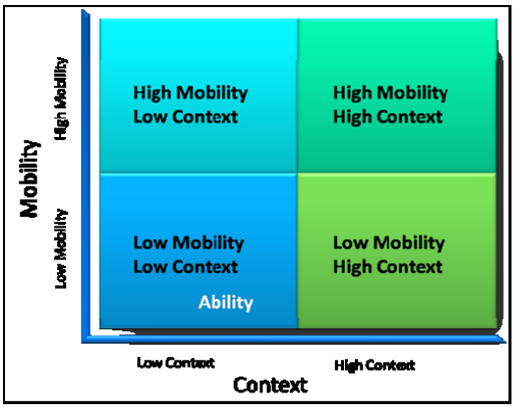


Figure 2-5: Mobility and Context matrix (Botha et al., 2010)

The matrix has four quadrants of interactions, namely Low Context Low Mobility, Low Context High Mobility, High Context Low Mobility, and High Context High Mobility interactions. In the Low Context Low Mobility quadrant a group of students receives general broadcasted information. In this quadrant, mobile phones give users the ability to connect to remote and undirected information. The second quadrant, Low Context High Mobility quadrant is characterised by the portability of mobile phones and facilitates mobility of users. In this quadrant, the physical context does not feed into the mobile phone interaction. An example of an interaction in this quadrant is studying in a train. In the third quadrant, the High Context Low Mobility quadrant, the user has a virtual context or history of interaction. In this quadrant, mobile phone interaction requires instant feedback and a user waits for a response from the system. In the fourth quadrant, the High Context High Mobility quadrant, context, whether physically or virtually feeds into the interaction that is on the move. The Mobility and Context Matrix is important in this study because it helps in structuring the provision of mobile phone services to students at HEIs.

To summarise Section 2.3.2, the Context Feature Space model (Schmidt et al., 1999) and the 3D Context Space model (Sears et al., 2003) showed that factors such as human factors, physical

environment factors, and the physical device factors affect mobile phone information access and interaction. The factors influence how students in HEIs interact with mobile phones. The following sections discuss the factors under the following headings: physical environment context, the user context, and the social context.

2.3.3 Physical environment context

The physical contexts in which students interact with mobile devices have an effect on their performance but not in a uniform way (Barnard, Yi, Jacko & Sears, 2007; Brewster, 2002). Physical context is associated with the physical constraints in the usage environment (Kiljander, 2004). Students can interact with mobile phones in places where the environment is constrained for example in places where network coverage is intermittent, bad weather, noisy places, or bad lighting conditions. All these factors affect how the students would interact with a mobile cellular phone (De Groot & van Welie, 2002). The physical mobile phone handset has constraints that affect how students interact in contexts that include limited memory, processing power, small keyboard, and small display screen (Schmidt et al., 1999).

2.3.4 User context

The user context of students relates to their general goals, engaged tasks, spontaneous activity, emotional state, and bio-physiological conditions when interacting with mobile phones (Schmidt et al., 1999). To achieve a goal, students need to concentrate on a task and manage other factors such as emotions and multi-tasking (Preece, Rogers & Sharp, 2002). When providing students with mobile phone information access and interaction, the designers of the services need to consider the effects of user context.

2.3.5 Social context

The social environment relates to the co-location of other people, social interaction, and group dynamics (Schmidt et al., 1999). When students interact with a mobile phone, they sometimes share their attention between the device and other people (Kiljander, 2004). Other people introduce unplanned acts, which the students need to deal with when interacting with mobile phones (Tamminen, Oulasvirta, Toiskallio & Kankainen, 2004). The unplanned acts may derail students from concentrating and completing a task. The use of a mobile phone in a public place would require students to divide their attention between the device and the social environment. In such a situation, Tamminen et al., (2004) observed that it would be difficult for students to multi task especially when walking due to disturbances such as colliding with other people.

2.3.6 Summary of mobile phone context of use

To summarise Section 2.3, the above presented discussion found various factors that affect students when interacting with mobile phones in a dynamic environment. The factors include physical factors, user factors, and social factors. As presented by Botha et al., (2010), users can engage with mobile technology in different contexts against different mobility possibilities. If HEIs are to provide mobile information access and interaction to its students they should provide students with interaction activities that are suited for specific contexts.

2.4 Mobile phone information needs

Physical, social and technical challenges that are encountered when accessing and interacting with mobile phone services in a context results in user needs that are different from those of desktop computer users. Students would use mobile phones to access and interact with services if they have some specific needs that they want to satisfy. Hence, this section seeks to understand the information access needs of students. Discussion continues as follows: Section 2.4.1 discusses theory of needs, Section 2.4.2 discusses information access needs, Section 2.4.3 discusses information access needs models, Section 2.4.4 discusses mobile phone interaction needs, Section 2.4.5 discusses mobile phone communication needs, 2.4.6 discusses mobile phone access to resources needs and Section 2.4.7 discusses presents a summary of mobile phone access to information needs.

2.4.1 Theory of needs

Theories that address the needs of human beings have origins in the field of motivational psychology. This study reviewed theories that address the issue of human needs and they are the Maslow Hierarchy of Human Needs theory (Maslow, 1943), and the Existence, Relatedness and Growth theory (ERG) (Alderfer, 1969).

Maslow (1943), a physiologist by profession proposed the Hierarchy of Human Needs theory. The theory is a motivational theory concerned with the needs that people want to satisfy in order to be motivated. The assumption of the theory is that people's needs come in an incremental order, from high order needs to lower order needs. The theory assumes that human needs have an order of precedence. The order in which human needs could be satisfied is depicted as a triangle with five layers of needs. The layers of the triangle are physiological needs, security needs, social needs, affiliation needs, esteem needs and self-actualisation needs.

The following studies tested the credibility of the Hierarchy of Human Needs theory, Alderfer (1969), Bandura (1969) and Hofstede (1980). The theory has been criticised for not taking into

consideration factors that affect the needs of people, for example culture, economic status, and educational level (Bandura 1969). The theory has also been criticised for depicting human needs as gratified in a vertical fashion from higher order needs to lower order needs (Alderfer 1969). The criticism of the Hierarchy of Human Needs theory led to the development of other theories that address human needs. The theories include the ERG theory (Alderfer1969), the Human Motivation theory (McClelland 1987) and the Herzberg's Motivation and Hygiene Factors theory (Miner 2005). Among all the theories that were developed as a result of criticising the Maslow's hierarchy of needs, of interest to this study is the ERG motivation theory (Alderfer 1969).

Alderfer (1969) proposed the ERG theory in an effort to overcome some of the weaknesses of the Hierarchy of Human Needs theory (Maslow, 1943). The ERG theory adopted two assumptions of the Hierarchy of Human Needs theory, which are the hierarchy of needs hypothesis and the satisfaction of progression hypothesis. The third assumption of the ERG theory is the frustration regression hypothesis, which states that if people's higher order needs are frustrated and cannot be gratified, people would seek gratification from lower order needs. The shift from unsatisfied needs does not have to follow some hierarchical order. The categories of the ERG theory are Existence of needs, Relatedness needs, and Growth needs.

Even though Maslow's (1943) theory received some criticism, it has remained relevant since its inception and has been adopted by numerous researchers in studying human needs (Cao et al., 2013; Freitas & Leonard, 2011; Kang & Jung, 2014; Sun & Wang, 2011). The theory has been applied in the following studies:

- Freitas and Leonard (2011) understanding the relationships between the physiological needs of students and their pass rates.
- Sun and Wang (2011) adopted the Maslow's theory an analytic tool for designing an e-learning platform.
- Kang and Jung (2014) adopted the Maslow's theory as the basis for identifying the needs of Smartphone users in America and Korea.

2.4.2 Information access needs

The term information access need is defined as the perceived requirement for information that leads someone to use an information retrieval system in the first place (Shneiderman, Byrd & Croft, 1997). Broder (2002) argued that the intent for information retrieval is not only informational but may be navigational or transactional. Rose and Levinson (2004) contended that there are cases where the goal for information access is not to get information but to get access to resources. However, there are some social and technical challenges that need to be managed to

allow optimal use of mobile centric services. Socially, mobile phone interactions happen in contexts that are prone to many disturbances. Technically, learning content has to be optimised for mobile phone access and interaction (Muyinda et al., 2010). Other challenges that may be encountered emanate from the context of interaction since different contexts have different information access and interaction needs. Therefore, there is a need to identify the mobile information access and interaction needs of mobile primary users at HEIs.

The discussion on taxonomies and frameworks for information access needs continues as follows: Section 2.4.2.1 discusses the Taxonomy of Web Search (Broder, 2002), Section 2.4.2.2 discusses the Search Hierarchy Framework (Rose & Levinson, 2004), Section 2.4.2.3 discusses the Taxonomy of Web Activities (Sellen & Murphy, 2002), and Section 2.4.2.4 discusses the Classification of Web Information Tasks Framework (Kellar et al., 2006).

2.4.2.1 Taxonomy of Web Search

The Taxonomy of Web Search (Broder, 2002) explains the reasons for searching the web. The reasons for searching the web could be explained in terms of the needs of a person. The needs of a person fall into three categories, which are Navigational, Informational and Transactional. The categories were explained as follows: Navigational needs concern the immediate intent to reach some particular source of information, for example, a website. The Informational needs concern the intent to acquire some information assumed present on some source of information. The Transactional needs concern the intent to perform some web mediated activity. The Taxonomy of Web Search is important in this study because it provides the foundation for all the other models that were developed to explain information access needs.

2.4.2.2 Search Hierarchy Framework

The Search Hierarchy Framework (Rose & Levinson, 2004) provides an understanding of the information access needs of users when searching the web. The framework extended the Taxonomy of Web Search (Broder, 2002). The Search Hierarchy Framework has three categories, which are, Navigational, Informational, and Resources. The framework differs from the Taxonomy of Web Search in that it replaced the Transactional category with the Resource category and described the Informational category in a different way. The Informational category defines the goal of a user as obtaining some information on a request. The user can search for answers to a question, ask for advice, locate some information, or have a list of resources to choose from. The Resources category defines the goal of a user when obtaining something other than information.
2.4.2.3Taxonomy of Web Activities

The Taxonomy of Web Activities (Sellen & Murphy, 2002) is based on the information needs of stationary desktop computer users. The taxonomy has six categories, which are, Finding, Information gathering, Browsing, Transacting, Communicating and Housekeeping. Some of the categories have similar names to the Taxonomy of Web Search (Broder, 2002). The Finding category defines users as performing goal-oriented tasks such as searching for some specific information, for example directions. The Information gathering category defines users as purposively carrying a search on a specific topic. The Browsing category defines users as visiting some web sites for no apparent reason. The Transacting category defines users as using the web to execute a transaction for example, making a bank transfer. The Communication category defines users as using the web to participate on social media networks. The Housekeeping category defines users as carrying a maintenance routine for the accuracy and functionality of the web.

The Taxonomy of Web Activities was constructed based on the information needs of desktop web users. They concluded that some of the activities of the taxonomy were suitable for mobile cellular phone browsing such as information gathering and browsing but others were not.

2.4.2.4 Classification of Web Information Tasks framework

The Classification of Web Information Tasks framework (Kellar et al., 2006) extends the Taxonomy of Web Activities (Sellen & Murphy, 2002). The framework consists of three categories of needs and they are Information Seeking, Information Exchange and Information Maintenance. The Information-Seeking category describes users as using the web for fact finding, information gathering and browsing. The Information Exchange category describes users as engaging in transactional activities and communicating with one another. The Information Maintenance category describes users as visiting a website for purposes of doing routine updates, adding new information on the web page, loading new pictures and removing old information.

To summarise Section 2.4.2, the general information needs of a person can be classified into navigational, informational, transactional, resources, communicating and information maintenance. The following section focus on mobile phone information needs.

2.4.3 Mobile phone information needs

This section discusses the needs of mobile phone users. The discussion focuses on taxonomies and frameworks for mobile phone information needs. This section continues in the following order: Section 2.4.3.1 discusses the Framework for Understanding Mobile Internet Motivations and Behaviors (Taylor et al., 2008) and Section 2.4.3.2 discusses the Activities on the Mobile Web' Taxonomy (Cui, & Roto, 2008).

2.4.3.1 Framework for Understanding Mobile Internet Motivations and Behaviours

The Framework for Understanding Mobile Internet Motivations and Behaviours (Taylor et al., 2008) extends the Classification of the Web Information Tasks framework (Kellar et al., 2006) and the Mobile Phone Characterisation Hierarchy framework (Kim, Kim, Lee, Chae & Choi, 2002). The framework has three categories, which are Motivational, Behavioural, and Classification of Physical Settings.

The Motivational category explains the motivations for using a mobile phone to access internet as either due to utilitarian or hedonic motives. Utilitarian motives focus on the need to use a mobile phone for convenience due to restrictions at work or lack of alternative access. Hedonic motives are as a result of curiosity, social connection, and social avoidance.

The Behavioural category explains the motivation for accessing mobile phone internet as due to information seeking or activity support. The Behavioural category was inherited from the Classification of Web information tasks (Kellar et al., 2006).

The Classification of Physical Settings category was described by ten parameters that explain different contexts in which people use mobile phones. The contexts were: On transit, Walking, Work, Service facility, Store, Recreation site, Home, Someone's house, Driving a car and Car passenger.

2.4.3.2 The User Activities on the Mobile Web taxonomy

The User Activities on the Mobile Web taxonomy (Cui & Roto, 2008) provides a way for understanding the needs of mobile phone web users. The taxonomy inherited three categories from The Classification of Web Information Tasks framework (Kellar et al., 2007) and added one new category, the Personal Space Extension, and a description column, the Content Object Handling category. The Personal Space Extension category describes activities that are undertaken by the users when they use mobile phones to load content on the web for personal access. The Content Object Handling column describes activities that happen in each of the categories. Table 2-4 presents the taxonomy.

Table 2-4: User Activities on the Mobile Web taxonomy (Cui & Roto, 2008)

	Content Object Handling
1. Information Seeking	Capturing content objects from the Web for personal use
2. Communication 3. Transaction	Sharing public or personal content objects with others
4. Personal Space Extension	Maintaining content objects online for personal access

To summarise Section 2.4.3, literature analysis established that categories for mobile phone information needs are similar to the general information needs as discussed in Section 2.4.2. Hence, the categories for mobile phone information needs are Information Seeking, Transaction, Resources, Communication, and Personal Space Extension. The categories Information seeking, Transaction and Personal Space extension require a user to interact with a mobile phone to carry some online transaction. The three categories are combined and renamed to Interaction. The other two categories Resources and Communication remain unchanged. Therefore, the categories that come out of this literature analysis are Interaction needs, Communication needs and Resources needs. The three categories are used to guide literature analysis for the mobile centric needs of students in the following sections. Section 2.4.4 discusses mobile phone interaction needs, Section 2.4.5 discusses mobile phone communication needs and Section 2.4.6 discusses mobile phone access to resources needs.

2.4.4 Mobile phone interaction needs

Mobile phones provide a medium that can facilitate interaction among students especially in distance learning (Brown, 2005). The interaction activities that students can do includes practical learning (Day & Kumar, 2010), group work (Park, 2011; Silander, Sutinen & Tarhio, 2004), peer tutoring (Butgereit, 2007; Butgereit & Botha, 2010) and assessments (Stone et al., 2002, Danis et al., 2010; Lim et al., 2011). The discussion continues as follows: Section 2.4.4.1 discusses practical demonstrations, Section 2.4.4.2 discusses group work, Section 2.4.4.3 discusses getting help, Section 2.4.4.4 discusses peer tutoring and 2.4.4.5 discusses assessment.

2.4.4.1 Practical demonstrations

One way of providing distance-learning students with practical learning is through computer simulation or home laboratory, especially in applied courses such as biology or chemistry (Chec, 2001). Computer simulation requires expensive and specialised software installed on students' computers, which some students may not afford. Alternatively, podcasts and vodcasts could be designed to provide students with practical demonstrations (Chan, 2014; Hickey & Donnelly, 2011; Marçal, Viana, Andrade & Rodrigues, 2014). Chan (2014) reported on the use of vodcasts in teaching practical aspects of learning German as a foreign language at a Singapore university. The vodcasts taught students how to pronounce words, grammatical structure, and narrations. Hickey and Donnely (2011) created vodcasts that provided students with demonstrations of bricklaying techniques for use during workshops. Students were allowed to ask questions from lecturers whenever they needed explanations during the workshops. Marçal et al., (2014) created a mobile phone application called Geomovel, which aided geology students at a Brazilian university with doing fieldwork. The Geomovel application facilitated students to collect data by taking pictures,

videos, perform measurements, taking geographical coordinates and taking notes. The application uploaded the data to Google cloud. Similar other practical uses of mobile phones have been reported in literature (Ekanayake & Wishart, 2014; Nilsson, Sørensen & Sørensen, 2014; Zhang & Choi, 2015).

2.4.4.2 Group work

One of the drawbacks of distance learning is that students find it difficult to do group learning in real time (Cowan, 1995). Cowan (1995) argued that the difficulties result from student isolation, which makes it difficult to have group discussion and share learning material. The introduction of E-learning gave hope in solving the problems of isolation but students could not afford to buy the computers and pay for bandwidth (Block, 2010; Guri-Rosenblit, 2009). Mobile phones can facilitate students in organising group work sessions because they provide services that enable real time interactions, sharing of resources, and communication (Park, 2011). This is facilitated by recent mobile phone handsets such as smartphones that have multimedia capabilities with features such as a camera, microphone, speakers, video players and web browsers. The web browsers facilitate mobile phone internet access and provide an opportunity for utilising social networking sites as learning tools (Mayisela, 2013).

Social networking sites facilitate group learning at higher educational institutions in a formal way or in an informal way. Case studies where students utilised social network platforms for arranging group work, and collaborating have been reported in South Africa (Bester, 2014; De Villiers, 2010; Mayisela, 2013; Nagel & Verster, 2012). Nagel and Verster (2012) reported that eight five second year Architecture students at the University of Pretoria informally formed a Facebook group aimed at facilitating communication, sharing of resources and coordinating class activities. Formally, De Villiers (2010), Mayisela (2013) and Bester (2014) created Facebook group pages for their students as a way of encouraging student communication and collaboration. De Villiers (2010) carried the study at UNISA and a group of twenty-four honours students participated on the Facebook group. Mayisela (2013) carried the study at Walter Sisulu University and a group of twenty-eight students participated in the group. Bester (2014) carried the study at North West University (Potchefstroom) and twenty-two students participated on the Facebook page. All the case studies reported that they were successful in encouraging students to work in groups. In the context of ODeL, De Villiers (2010) emphasised that the social networking group was instrumental in enforcing constructivist-learning practices among students. Mayisela (2013) indicated that social networking platforms provided an open platform that has a quick turnaround for receiving responses for questions asked (Mayisela, 2013). Nagel and Verster (2012) found that the major driver for group interaction was the sharing of resources.

2.4.4.3 Getting help

In distance learning environment, many students learn in isolation and find it difficult to ask questions or clarifications from fellow students or the lecturers. Mobile phones provide an opportunity for getting help from peers or lecturers (Hodgkinson-Williams & Ng'ambi, 2009). Hodgkinson-Williams and Ng'ambi (2009) demonstrated this with the implementation of the Dynamic Frequently Asked Question at the University of Cape Town. Similar initiatives were reported at an Australian University (Horstmanshof, 2004) and a German university (Markett et al., 2006). In line with the use of social networking platforms for convening group work and collaboration (discussed in Section 2.4.5.2), students can also use social networking platforms for getting help from fellow students (De Villiers, 2010; Mayisela, 2013; Nagel & Verster, 2012).

2.4.4.4 Peer tutoring

First year students face social and academic challenges, which may result in dropouts (Heirdsfield et al., 2008). In trying to avoid such challenges, some universities implemented the peer-tutoring systems (Evans & Moore, 2013; Madiope & Ranko-Ramaili, 2013). Peer tutoring is a service where one student or a tutor teaches other students, where the tutor and the student are at different academic levels (Tymms et al., 2011). A practical example of a peer tutoring system is the Dr Maths on Mxit project (Butgereit, 2007). Dr Maths on Mxit is a mobile phone application that utilises Mxit instant messenger as a communication channel for interactions between high school students and a tutor. The students ask tutors some mathematical questions and get help in solving the problems in real time. HEIs can learn from this practical example and implement similar platforms for peer tutoring.

2.4.4.5 Assessment

At HEIs, there are two assessment modes, formative assessment and summative assessment (Morgan, O'Reilly 1999). In the context of distance learning, mobile phones could provide alternative formative assessment because they present a medium of interaction between the students and the lecturers (Leung & Chan, 2003; Traxler, 2009). Traxler (2009) argued that mobile phone interactions could enable students to participate in real life problem solving and their peers could evaluate them. Formative mobile phone evaluation activities can enable students to receive feedback from lecturers, as well as do self-assessments, peer evaluations and comment on online group discussions (Falchikov, 2013).

In summative assessments, mobile phones can provide an interface for doing multiple choice assignments (Danis et al., 2010; Lim et al., 2011) and short text based assignments (Balasundaram

& Ramadoss, 2007; Stone, Briggs & Smith, 2002). Evaluation of mobile phone assignments should provide students with immediate feedback in the form of correct answers and comments.

To summarise Section 2.4.4, literature analysis established that mobile phones could satisfy interaction needs of students that include practical demonstrations, group work, getting help, peer tutoring and assessments.

2.4.5 Mobile phone communication needs

Literature analysis in this study established that mobile phones can facilitate the following communication activities at HEIs: tuition communication (van Rooyen 2008; Abas et al., 2009) and disaster management communication (Young 2007; Rivera 2007). The discussion in this section is as follows: Section 2.4.5.1 discusses tuition communication and Section 2.4.5.2 discusses disaster management communication.

2.4.5.1 Tuition communication

A mobile phone provides students with an array of communication technologies. Popular communication technologies include Twitter, Facebook, phone or VoIP, two way audio or video interaction, instant messaging, text messaging, and email. Some studies found students to be comfortable and frequently use most of the communication technologies in their daily lives (Charron & Raschke, 2014; Dahlstrom, Walker & Dziuban, 2013). Even though students are familiar with the communication technologies, some research found that technologies that students prefer to use for learning are different from technologies that they prefer to use for social life (Dahlstrom et al., 2013; Kay & Lauricella, 2015; Lauricella & Kay, 2013). Dahlstrom et al., (2013) observed that students separate and maintain their social and academic boundaries when using technologies. Within the academic sphere, communication technologies that students use to communicate with other students are different from technologies that they use to communicate with their lecturers (Lauricella & Kay, 2013).

Consistently, research has found that students prefer to communicate with their lecturers through email (Dahlstrom et al., 2013; Kay & Lauricella, 2015; Kim, 2008; Lauricella & Kay, 2013). Email communication provides students with opportunities for presenting structured questions or answers, as well as to document a conversation (Dahlstrom et al., 2013). Some studies found that students prefer to use text messaging to communicate with both their lecturers and other students (Abas, Lim & Woo, 2009). Abas et al., (2009) claimed that text messages are good to communicate time sensitive, relevant, unambiguous, and trustworthy information to students instantly. Text messages that can be sent to students include due date reminders, encouragement messages, class

cancellation and publishing of results (Naismith, 2007). Comparing text messaging with instant messaging, some studies found that students reserved instant messaging for student-to-student communication (Dahlstrom et al., 2013; Jeong, 2007; Kay & Lauricella, 2015). The disadvantage of instant messaging is that in order to initiate communication, both parties should be logged on the messenger, hence students have to wait for a lecturer to logon (Lauricella & Kay, 2013). Other communication technologies that students would limit to social communication than academic communication include social networking sites such as Twitter and Facebook (Dahlstrom et al., 2013). Even though Skype has the advantage of file sharing, instant messaging and real time video/voice interaction between student and lecturer, its use in educational communication is not popular but picking up (Lauricella & Kay, 2013).

In academic libraries, SMS provides communication in the form of alerts on upcoming library appointments with librarians, due date reminders on borrowed books, availability of requested material and availability of new resources in the library (Seeholzer & Salem Jr, 2011). The move towards using SMS text messages in libraries witnessed the introduction of new initiatives at universities in the USA (Buczynski, 2008). Buczynski (2008) gave examples of popular initiatives as texting a library to receive a return call, and ask a librarian. Therefore, mobile phones could provide tuition and library communication services at HEIs.

2.4.5.2 Disaster management communication

Higher Educational Institutions are communities that are not spared from disaster when it strikes. During the year 2015, several natural disasters affected human habitats the world over with the most devastating being the Nepal earthquake, flooding in Japan, volcanic eruptions in Mexico and Ebola in West Africa (ScienceDaily, 2015). Apart from natural disasters, people are also prone to humanitarian disasters such as wars, crime, and accidents. Like any other community, HEIs need to be prepared in managing these disasters when they strike. The aftermath of the Philippines and Sri Lanka disasters have seen a rise in the use of mobile phones as tools for mitigating disaster. Mobile phones are now used to provide early warning alerts and as a primary communication channel during relief operations (GSMA, 2012; GSMA, 2015b).

Mobile phone based early warning apps have been developed to provide people with warnings on imminent disasters (West & Valentini, 2013). The development of early warning mobile apps are reported to have been initiated by mobile telecom companies in the Philippines (GSMA, 2012), the USA local governments (USA Federal Emergency Management Agency, 2015), and non-governmental organisations (American Red Cross, 2015). GSMA (2015b) reported that when Sri Lanka got stuck by the tsunami in 2005, about 35 000 lives could have been saved if a simple

message was broadcasted warning people to evacuate coastal areas. The use of mobile surveillance and warning systems is now common and has been used in providing hurricane warning in the USA (Steen, 2014). With respect to HEIs, mobile phones have been employed in giving warning alerts at St John University (Rivera, 2007) and University of Louisiana (Young et al., 2010). St. John's University sent text messages to all students and the staff members alerting them of a gunman that was on campus (Rivera, 2007). The St John University community responded to the message positively, which resulted in the arrest of the gunman. Similarly, the University of Louisiana sent text massages alerting the university community of the shooting of two graduate students on campus (Young et al., 2010). The advantage of sending text messages in times of emergency is that it notifies everyone on campus, including those working outside their offices. The aftermath of the Virginia Tech Shooting in 2007 has seen some American universities coming up with mobile disaster management apps, for example the Pathlight app from the University of Chicago (The University of Chicago, 2015).

During disaster relief operations, mobile phones facilitate critical communication between the victims of the disaster and the aid agencies (GSMA, 2015b). West and Valentine (2013) indicated that when disaster strikes, disaster victims could provide up-to-date information to aid agencies through mobile applications such as SMS, Twitter, Facebook or calling. Disasters where mobile phones have been used to give updates of rescue operations include the typhoon that hit the Philippines in 2012 (GSMA, 2015b), the Queensland flooding in Australia 2011 (Liddy, 2013), and Ebola in the USA in 2015 (McKay, 2015). Since mobile communication requires money, GSMA (2012) reported on a disaster management plan in the Philippines called Smarts Emergency Response Plan, which provides the following services during times of disaster adversities: free emergency calling, free SMS, regular updates on social networks, SMS channels for donations and emergency alerts (GSMA, 2012). In the case of Ebola in the USA, citizens alerting each other of a person who had tested positive for the virus used social media such as Twitter and Facebook (McKay, 2015). Even though some of the disaster cases discussed here do not directly address HEIs, they are applicable because when disaster strikes, it affects everyone.

To summarise Section 2.4.5, literature analysis established that mobile phones can satisfy communication needs of students that include tuition communication and disaster management communication. Several mobile phone resources that include social media, SMS, VoIP apps and instant messaging services can be used for tuition communication or disaster management communication. In tuition communication, there are certain resources that students prefer to use for student inter communication than to communicate with lecturers.

2.4.6. Mobile phone access to resources needs

Mobile phones can give students the advantage of accessing online resources at anytime from anywhere (McKinney & Page, 2009; Richardson & Lenarcic, 2009). The online learning resources that mobile phones can access through Mobile Learning Management Systems (m-LMS) include tuition resources and administrative resources (Bon et al., 2012; Ssekakubo, Suleman & Marsden, 2014). The advantage of m-LMS is that they provide students who primarily access learning resources through mobile phones with optimised access to content and resources (Mtebe, 2015).

In South Africa, the use of m-LMS has been reported at the University of Cape Town (Ssekakubo et al., 2014) and the University of Pretoria (Bon et al., 2012). Ssekakubo et al., (2014) reported that the University of Cape Town redesigned and streamlined the university m-LMS in order to improve its accessibility through mobile phone devices. Prior to the redesign of the m-LMS at the University of Cape Town, it was described as similar to the main LMS in functionality, not appealing and not used by students. The streamlined m-LMS provides students with access to services such as assignments, chats, blogs, content, notifications, and gradebook. While the University of Cape Town m-LMS is open source based, the University of Pretoria reported on the deployment of proprietary m-LMS supported by Blackboard Mobile (Bon et al., 2012).

McKinnney and Page (2009) identified podcasts as an important resource that students could access through mobile phones. They indicated that podcasts could provide students with recorded lectures, book chapter summaries or power point slides with audio commentary. The advantages of podcasting are that it gives students a chance to revisit the lectures (Lonn & Teasley, 2009), and provide students who miss class with a chance to access the class (Evans, 2008).

Mobile phone access to tuition resources extend to accessing library resources (Akeriwa, Penzhorn & Holmner, 2015; Li, 2013; Mohamed, 2013). Libraries are providing mobile phone interfaces to electronic catalogues, databases, e-books, e-journals and electronic resources in audio visual format (Li, 2013). In South Africa, Mohamed (2013) reported that the University of Cape Town and the University of Pretoria provide mobile phone access to library resources. Mohamed (2013) reported that the University of Cape was initiating mobile phone access to library resources through the Quick Response (QR) codes. The QR codes are also used at the University of Amsterdam Library (Ashford, 2010), the Ryerson University Library and the Museum of Inuit Art in Canada (Schultz, 2013). In China, Li (2013) surveyed 36 national universities and found that only 36% provided mobile phone access to library services. The mobile phone library services at the Chinese universities were based on SMS communication services and WAP services. The WAP services included access to user information, catalogues, book collections and e-journal services (Li, 2013).

Therefore, HEIs can provide students with mobile phone access to tuition resources through m-LMS and library resources through mobile web sites, mobile apps or QR codes.

2.4.7 Summary of mobile phone information needs

To summarise Section 2.4, literature analysis established that the mobile phone information needs of students falls into mobile phone interaction needs, mobile phone communication needs and access to resources needs. In distance learning, mobile phones can satisfy the interaction needs of students that include practical demonstrations, group work, peer tutoring and assessments. The communication needs of students that can be satisfied through mobile phones include tuition communication and disaster management communication. Tuition communication includes inter students communication and student to lecturer communication. Mobile phone communication can be achieved through SMS, instant messaging, VoIP/voice services and email. Mobile phones can satisfy students' access to resources needs. Students can access tuition resources through m-LMS. In turn, m-LMS can provide students with access to course administrative resources such as assignment submission, assessment marks and timetables. Students can also access tuition resources such as reading material, power point slides and podcasts. Therefore, services provided through mobile phones can satisfy the interaction needs, communication needs and access to resources needs of students.

2.5 Mobile phone technologies

This section discusses technologies that run on mobile phones whilst providing channels for information access and interaction. An information access channel is a medium where information seekers find and consume information (Boyd, 2004). Channels through which students can access and interact with information using mobile phones include Simple Messaging Service (SMS), Unstructured Supplementary Services Data (USSD), Instant messaging, web, social networks, email and podcasts/vodcasts. The channels have influence on how students access and interact with information resources because they present data in different formats. As presented in Section 2.4, students have a variety of information needs, which they satisfy through information seeking activities. Since different channels present data differently, students choose an interaction channel that satisfies their information needs. Therefore, it is important to have an understanding of different channels through which students can access and interact with information. Discussion in this section continues in the following order: Section 2.5.1 discusses SMS, Section 2.5.2 discusses USSD, Section 2.5.3 discusses Mobile web, Section 2.5.4 discusses E-books, Section 2.5.5 discusses Podcasting, Section 2.5.6 discusses E-mail, Section 2.5.7 discusses Mobile apps, and Section 2.5.8 discusses QR codes and 2.5.9 discusses Mobile cloud computing.

2.5.1 Simple Message Service (SMS)

Simple Messaging Service (SMS) is a mobile cellular technology service that is part of the GSM phase 2 specifications (Peersman, Cvetkovic, Griffiths & Spear, 2000) and operates on a signalling channel originally used for monitoring of the GSM network (Gokhale, 1998). SMS can be broadcasted or sent as point-to-point communication. Broadcasts are received by active nodes in the cell and do not require confirmation from the recipient. Point-to-point messages are from one mobile phone to the other or from a computer to a mobile phone or from a mobile phone to a PBX telephone (Neuman, 2003). An SMS message has a maximum length of 160 characters and is delivered within a few seconds if the recipient is within GSM coverage anywhere in the world (Peersman et al., 2000). In teaching and learning, several case studies have been reported where students have been supported through SMS (Hayati, Jalilifar & Mashhadi, 2013; Klein, da Silva Freitas, Jose Carlos, Barbosa & Luis, 2015; Lai, Yang, Yen & Chou, 2014; van Rooyen, 2008).

2.5.2 Unstructured Supplementary Services Data (USSD)

Unstructured Supplementary Services Data (USSD) is an interactive data service based on GSM signal technology (Wang, Gu, Zhao & Wang, 2008). It is a service that provides high-speed interaction between customers and services. Examples of USSD services include checking mobile phone credit balances, and buying credit. Recently, a number of USSD services have surfaced providing services such as mobile banking, train reservations, telephone directories and a USSD Facebook (Fripp, 2012). In education, Ogunleye et al., (2009) reported on the provision of a USSD based learning system for supporting nursing education in South Africa.

2.5.3 Mobile Web

Some mobile phones are multimedia devices with many functionalities and capability to connect to the internet through 3G network and Wi-Fi network. Multimedia capable mobile phones have default web access to web 2.0 and above services (Ullrich et al., 2008). Web 2.0 is a term that describes a set of services that run on the web and enable human creativity, participation, communication, collaboration and sharing of knowledge (O'Reilly, 2005). Web 2.0 services are important in education because they support student centred learning (Anderson, 2005) by utilising services such as blogs, wikis, multimedia sharing services, content syndication, podcasting and content tagging services.

2.5.4 E-books

An E-book is a digital representation of a printed book (Lee, 2012). E-books are read either on dedicated hardware devices called E-book readers or general software book readers that run on devices that include mobile phone handsets and tablet computers (van der Velde & Ernst, 2009).

Popular E-book dedicated readers include Amazon Kindle 3 and DX, Barnes Noble Nook, Sony Reader Daily, and Apple iPad, just to mention a few. Popular general software book readers include products like Microsoft Reader, Adobe Acrobat eBook reader and Mobi pocket (IPC Media, 2013).

2.5.5 Podcasting

Podcasting is one of the web 2.0 services accessible through a mobile phone. Podcasts are recorded media files in the form of audio (MP3 or Wave files) or video and sometimes a mixture of the two, uploaded on the web with the help of Rapid Simple Syndication feeds (Walch & Lafferty, 2006). People can listen to podcasts in real time or download and store them on the device for later use. At HEIs, podcasts could provide students with an interface for accessing information in the form of recorded lectures or instructor interviews (Abdous et al., 2012).

2.5.6 Social media technologies

Dabbagh and Reo (2011) defined social media as a channel for communication, collaboration, and creative expression. Several social media platforms are accessible on the Internet and many students at HEIs are familiar with some of them (Dabbagh & Reo, 2011). Some of the popular social media technologies include Facebook, WhatsApp, Twitter, Badoo, Bedo, LinkedIn, Orkut and Myspace. Popular social media platforms in Africa include Facebook, Twitter, Mxit, WhatApps, 2Go, and BBM, all of which run on mobile devices. In the context of teaching and learning, social media platforms provide networked tools that encourage individuals to learn while returning individual control over time, space, presence, activity, identity, and relationship (Anderson, 2005). Anderson (2005) emphasised that social media in education supports community building, tutoring and personal learning assistance, collaborative learning, and complex group functions. Several case studies have been reported were social media has been used in teaching and learning (Bansal & Dhananjay Joshi, 2014; Cuesta, Eklund, Rydin & Witt, 2015; De Villiers, 2010; Mayisela, 2013; Nagel & Verster, 2012).

2.5.7 Mobile applications

A mobile application is a software program designed to run on smartphones or related mobile devices such as tablet computers (Viswanathan, 2015). Mobile applications are popularly known as mobile apps. Mobile apps are either native apps or hybrid apps (IBM, 2015). Native mobile phone apps are applications that were programmed to run on a specific mobile phone operating system. Hybrid mobile phone apps are applications that were programmed to run on a range of mobile phone operating systems. Examples of mobile phone operating systems that run on smartphones or related devices include Android OS, Blackberry OS, iPhone OS, Palm OS, Symbian OS and

Windows Mobile OS. It is important for a user to know the operating system of the mobile device that they use since native mobile phone apps are designed for a specific operating system. App Stores market and sell mobile phone apps. An App Store officially sells mobile phone apps that only run on a specific mobile phone operating system. Examples of App Stores for some mobile operating systems are iOS Apple App Store (iPhone OS), Google Play Store (Android OS) and Blackberry App World (Blackberry OS).

Literature reports on several studies where mobile phone apps are used in teaching and learning, especially in mathematics. Mobile phone apps that aid students in learning mathematics include the Math4Mobile project (Math4Mobile, 2015), Dr Maths on Mxit (Butgereit & Botha, 2010), and the m-Learning System Enhancing Mathematical Concepts (Ntinda et al., 2014). The Educators technology websites listed 12 Android mobile apps that aid students in learning geometry, algebra, games and provide a mathematical dictionary (Educational Technology and Mobile Learning, 2015).

2.5.8 Quick Response (QR) code

Denso ADC (2011) defined QR code as, “a two-dimensional (2-D) matrix code that belongs to a larger set of machine-readable codes, all of which are often referred to as barcodes, regardless of whether they are made up of bars, squares or other-shaped elements”. The technical advantages of the QR code over other bar code technologies are that they are smaller in size, can store different types of data, have distortion compensation technology, high speed reading and can be read by a smartphone camera or by the QR reader. Apart from the technical advantages, the QR code is open access and no one pays to use it (Denso ADC, 2011).

The QR code can store different types of data that include numeric, alphanumeric, binary and Kanji/Kana data types. This allows the QR code to store data such as personal information, product labelling, website addresses, text messages, pictures, email or emails (Donnelly, 2010). Data stored in the QR code is mostly targeted for smartphone decoding (Edwards, 2012).

The use of QR codes in teaching and learning has been limited to embedding links to reference study material, outdoor learning activities (Lai, Chang, Wen-Shiane, Fan & Wu, 2013; Rikala & Kankaanranta, 2012; Vieira, Coutinho, Graça & Graça, 2014), classroom activities (Bonifacio, 2012) and library catalogues (Mohamed, 2013; Schultz, 2013).

2.5.9 Mobile cloud computing

The convergence of mobile computing technology, wireless networks and clouding computing technology brought about mobile cloud computing. According to Sanaei, Abolfazli, Gani & Buyya (2014, p.371),

> "mobile cloud computing leverages unified elastic resources of varied clouds and network technologies toward unrestricted functionality, storage, and mobility to serve a multitude of mobile devices anywhere, anytime through the channel of Ethernet or Internet regardless of heterogeneous environments and platforms based on the pay-as-you-use principle."

Mobile cloud computing is a technology that augments the resource constraints of mobile phones, especially smartphones with regards to their limited processing power, battery life span and storage capacity (Sanaei et al., 2014). Mobile cloud computing enhances the performance of mobile devices by offloading the processing of applications and storage of large files from the mobile device to the cloud (Kumar, Liu, Lu & Bhargava, 2013; Sundeen & Sundeen, 2013). Mobile apps facilitate data access and retrieval from the cloud to the mobile phone device. Mobile cloud computing improves the interoperability of mobile apps since they are accessed through web browsers. The issue of mobile phone apps incompatibility across different operating systems would be bypassed since all smartphones have standard web browsers (Sanaei et al., 2014). Additionally, mobile cloud computing is a dream come true for accessing resources at anytime from anywhere (Almrot, Andersson, Rönkkö & Fogelström, 2013; Fernando, Loke & Rahayu, 2013), and providing reliable data backup and disaster recovery (Chen, Yao & Wang, 2013; Sharma & Singh, 2012).

The benefits of mobile cloud computing extends to HEIs and both students and lecturers can realise the benefits. Cloud computing applications can either be non-academic apps or dedicated academic apps.

Non-academic applications include file sharing services such as DropBox or SkyDrive, collaboration services such as Google talk and Facebook, which can be used by both students and lecturers (Dennerlein et al., 2015; Lin, Wang & Yu, 2014). Lecturers can upload reading resources and videos on file sharing services and students can access the files at their own time. Students can also use file sharing services for submitting portfolios of evidence (Lim, Lee & Suh, 2014).

Academic mobile cloud computing applications are in the form of m-LMS, for example Moodle (Wang, Chen & Khan, 2014). m-LMS on the cloud provides students with learning resources that can be accessed from anywhere, especially students in resource constrained environments such as rural areas (Wang et al., 2014). HEIs can provide students with licensed academic applications

under the pay per use model, which is cost saving (Branon, Wolfenstein & Raasch, 2012). HEIs can also upload learning application software on the cloud for easy access, for example, mathematics apps for learning geometry (Stein, Ware, Laboy & Schaffer, 2013). Providing software applications through the cloud saves HEIs from purchasing computer hardware for installing the applications (Lin et al., 2014).

To summarise Section 2.5, the technologies through which students can access and interact with information are SMS, USSD, Mobile Web, E-Books, Podcasting and Social Media. The technologies provide channels through which students can access and interact with information through their mobile phones.

2.6 Mobile phone information access and interaction frameworks in education

Literature analysis on existing frameworks for providing mobile phone content and services in teaching and learning found a wide range of approaches and Table 2-5 groups the frameworks according to categories. The identified categories are discussed in the following order: Section 2.6.1 discusses M-learning adaptation frameworks, Section 2.6.2 discusses M-learning classification frameworks, Section 2.6.3 discusses M-learning evaluation frameworks and Section 2.6.4 discusses Frameworks for designing M-learning activities.

Table 2-5: Categories for mobile phone information access and interaction frameworks

Mobile Framework category	**Referenced paper**
M-learning adaptation frameworks *(Discussed in Section 2.6.1)*	• Mobile learning: A framework and evaluation (Motiwalla, 2007). • An adaptive framework for aggregating mobile learning material (Yang, 2007). • M-learning framework for university students (El-Gamil & Badawy, 2010).
M-learning classification frameworks *(Discussed in Section 2.6.2)*	• The mobility hierarchy: Objectives motivating the use of mobile computing applications in education (Gay et al., 2002). • Pedagogical framework for mobile learning (Park, 2011).
M-learning evaluation frameworks *(Discussed in Section 2.6.3)*	• A framework for instantiating pedagogic m-learning objects applications (Muyinda et al., 2011).
Framework for designing m-learning activities *(Discussed in Section 2.6.4)*	• A framework for educational collaborative activities based on mobile devices: A support to the instructional design (Flores & Morteo, 2010). • Setting the new standards with mobile computing in online learning (Shih & Mills, 2007). • A framework for instantiating pedagogic m-learning objects applications (Muyinda et al., 2011).

2.6.1 M-learning adaptation frameworks

M-learning adaptation frameworks are concerned with adapting e-learning systems to be usable on mobile devices. Yang (2007) proposed a framework for adapting E-learning content to be accessible through mobile phones. The weakness of the framework is that it is good for adapting web-based content into m-learning content only. Whilst Yang's (2007) framework specialised on content adaptation, Motiwalla (2007) proposed a framework for adapting learning activities such as interactive forums, posting comments, assignment submission and class announcements to run on mobile devices. The basis of Motiwalla's (2007) framework is the conversational and constructive theories. El-Gamil and Badawy (2010) proposed The M-Learning Framework for University Students for providing a common content authoring interface for producing learning content that is accessible by both mobile devices and desktop computers. The M-Learning Framework for University Students provides lecturers with an interface for communicating with students through different channels such as email, text messaging and voice telephoning. Frameworks in this category were designed to give a seamless environment that meets the needs of learners who have integrated mobile cellular phones in their lives.

2.6.2 M-learning classification frameworks

M-learning classification frameworks are concerned with categorising m-learning activities based on the objectives of the project. The frameworks help in understanding and determining the reason why a project was undertaken. Gay et al., (2002) proposed the mobility hierarchy framework, which classifies m-learning activities based on motives for using mobile devices in learning. The motives are categorised into three levels that are content intensive operations, lightweight operations and synchronous intensive collaborative learning operations. Similarly, Park (2011) proposed a theoretical framework for categorising mobile learning projects in the context of distance learning. The framework adopts and modifies the transactional distance theory. The framework has four dimensions, namely: socialised activity, individualised activity, low transactional distance and high transactional distance. Frameworks in this category were designed to help with grouping m-learning projects.

2.6.3 M-learning evaluation framework

An m-learning evaluation framework is concerned with assessing m-learning project's design, implementation, and processes against a set of principles set by a framework. Muyinda et al., (2011) proposed the Mobile Learning Objects Deployment and Utilisation Framework (MoLODUF) that has two objectives, namely: mobile design guideline and evaluation guideline. MoLODUF evaluates m-learning projects against the following twelve dimensions, namely: m-learning objects, m-learning device, m-learning interface, m-learning connectivity, m-learning

process, m-learning cost, m-learning resources, m-learning context, m-learning pedagogy, m-learning ethics, m-learning policy, and m-learning evaluation. Evaluation frameworks are important in that they reflect on what an m-learning project is trying to achieve, assessing the progress made and identifying necessary changes.

2.6.4 Framework for designing m-learning activities

Frameworks for designing m-learning activities are concerned with the process by which learning experiences are planned to systematically accomplish a learning goal (Wasserman & Richmond-Abbott, 2005). The frameworks help m-learning activity designers in ensuring that students can understand the activities and construct new knowledge when using mobile devices for learning.

To summarise Section 2.6, frameworks that have been developed for mobile information access and interaction in HEIs have been biased towards M-learning as an extension of E-learning. Hence, most of the frameworks put emphasis on the use of mobile devices as tools through which students can learn and less emphasis on mobile devices as tools through which students can access and interact with information. The basis of the frameworks is that learners are always on the move, that is, they can engage in a learning activity wherever they are. Therefore, mobile devices are perceived as alternative learning tools. It can be noted that at times when students are away from university premises the information that they would like to access is administrative more than the actual learning material. Students would like to access information such as assignment due dates, assignment instructions, and exam marks, track a discussion forum, and check their school fees status. The above frameworks do not specifically consider the students' needs.

2.7 Mobile phone constraints

This section discusses various constraints that could confront the provision of mobile centric services. The discussion is structured as follows: Section 2.7.1 discusses usability constraints, Section 2.7.2 discusses network constraints, Section 2.7.3 discusses cost constraints, Section 2.7.4 discusses cognitive constraints and Section 2.7.5 discusses the use of language in socialised learning.

2.7.1 Usability constraints

Smartphones and feature phones dominate the mobile phone market. The usability of feature phones is constrained by hierarchical menus, ambiguous buttons and small display screens (Zhou, Rau, Salvendy 2014). Some of the constraints experienced on feature phones are overcome by smartphones to some extent (Budiu, 2015).

The small display screens of feature phones constrain the interaction between the user and the device. This affects users when reading text (Sanchez & Branaghan, 2011; Schildbach & Rukzio, 2010), and navigating on the screen (Guerreiro et al., 2010). Smartphones are overcoming some of the problems because they are equipped with larger display screens that are between 3.5 –inch and 5 –inch in size. With respect to feature phones, the size of the display screen has an effect on the readability, eligibility and factual recall (Huang, Patrick Rau & Liu, 2009; Sanchez & Goolsbee, 2010; Sanchez & Branaghan, 2011). Sanchez and Goolsbee (2010) observed that when reading on a small display screen, text size and scrolling on the screen have an impact on information recollection. In another study, Sanchez and Branaghan (2011) found that factual recall is relatively unaffected when learning from a small device but reported that reasoning gets negatively affected when information is learnt from a small device. Similarly, Huang et al., (2009) reported that the character size and the resolution of the display screen can affect the reading and searching speed. Even though smartphones have bigger display screens compared to feature phones, they remain constrained by the relatively small display screen compared to desktop computers (Budiu, 2015). Budiu (2015) observed that smartphones allow one window to be displayed at a time and users cannot work on two windows at a time. Like feature phones, if large amounts of content are displayed on one page, users have to incur higher scrolling interactions. With respect to screen navigation, Eicker–Nel and Matthee (2014) observed that teachers and students initially struggled with flipping pages of e-textbooks on a tablet PC and that affected their confidence in using the devices.

The size of a mobile phone device constrains text input because of the small keyboard (Budiu, 2015). There are two dominant types of mobile phone keyboards, the QWERTY keyboard and the ambiguous 12-pad keyboard. Feature phones have either a QWERTY keyboard or a 12–pad keyboard, while smartphones have virtual QWERTY keyboards. Both keyboards share some common text input constraints (Budiu, 2015; Harper, Yesilada & Chen, 2010; Zhou, Rau & Salvendy, 2014). Common text input errors on both keyboards are pressing adjacent keys, long press, deletion errors and modifier keys (Budiu, 2015; Harper et al., 2010; Yesilada, Harper, Chen & Trewin, 2010; Zhou et al., 2014). The pressing adjacent keys error also called fat finger is due to accidently touching nearby keys when typing on a constrained keyboard (Budiu, 2015; Yesilada et al., 2010). The long press error is common to first time users of mobile phone keyboards especially old people who are slow in typing (Weilenmann, 2010; Zhou et al., 2014). Weilenmann (2010) observed that the long press error affects people who are slow in typing because they sometimes hold to a key for a long time, which results in the wrong sequence of keys pressed. On a 12 pad-keyboard the modifier key error is encountered because each button shares several characters. As a result it is difficult to use modifier keys to switch from characters displayed on the keys to the

hidden characters, for example punctuation characters (Harper et al., 2010). In smartphones, the modifier key error is encountered when users want to switch between the displayed characters to hidden characters, for example switching alphabetical characters to decimal characters (Smith & Chaparro, 2015).

2.7.2 Network constraints

The rise in mobile phone adoption, in particular smartphones, has increased the demand for mobile broadband services and risks overloading the spectrum capacity (Reed & Tripathi, 2014; Rysavy Research, 2014). Generally, users want to use their smartphones in the same way they use their desktop computers despite the fact that wireless network capacity is a minute percentage of the optic fibre network capacity (Rysavy Research, 2014). The demand for mobile broadband is growing at a faster pace than the rate at which the broadband infrastructure is growing in many countries (Fraser & Ntoi, 2012; Miller, Wongsaroj & Hogg, 2014). This results in the depletion of broadband strength because it is a shared resource among users under a base station, which affects the speed of downloading and uploading data on the network (Ramburn & Van Belle, 2011). Fraser and Ntoi (2012) argued that an increase in mobile broadband demand translates to an increase in wireless spectrum demand. In many countries, wireless spectrum is a scarce resource due to the outdated spectrum allocation methods and regulatory frameworks (Stroup, 2011). Allocation of wireless spectrum is a matter of policy, which is a government responsibility. The shortage of spectrum allocation space has resulted in some governments amending their regulatory frameworks in order to open new frequencies for providing the spectrum. In the context of South Africa, ICASA is the regulatory authority in charge of spectrum allocation. Through its Strategic Plan for 2015-2019, ICASA plans to open and allocate more spectrums to mobile broadband operators as a way for promoting universal access for all (ICASA, 2014). Earlier in 2010, the USA government authorised the allocation of 500MHz of new spectrum to mobile broadband operators[18]. In 2014, GSMA recommended that Egypt allocate additional spectrum in order to expend the mobile broadband in the country (Miller et al., 2014).

Mobile broadband is constrained by its reliance on radio signal transmission that is prone to interference, packet loss and fading problems (Rysavy Research, 2014). Furthermore, Reed and Tripathi (2014) indicated that signal inference plus noise ratio has an effect on the required radio resources. Additionally, the number of users connected to the network affects the throughput (Chetty, Sundaresan, Muckaden, Feamster & Calandro, 2013). This in turn affects the downlink speed of downloading data from the network. The issue of bandwidth limitation was found to have

[18] https://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution

adverse bottleneck effects on the operation of mobile cloud computing (Fernando et al., 2013; Qi & Gani, 2012; Sanaei et al., 2014).

In the context of South African education system, the provision of e-learning services to students is constrained by the unavailability of network bandwidth especially in remote areas (Eicker-Nel & Matthee, 2014; Herselman & Botha, 2014). Due to limited networking infrastructure in rural South Africa, the ICT4RED project (Herselman & Botha, 2014) provided Wi-Fi infrastructure to 26 schools in the Eastern Cape Province. Similarly, the e-Textbook project at a private school in South Africa (Eicker-Nel & Matthee, 2014) provided Wi-Fi infrastructure to the school for internet connection. Eicker-Nel and Matthee (2014) observed that internet connection through Wi-Fi at the school was slow and negatively impacted the adoption of e-textbooks by both teachers and students.

Many countries in Africa have insufficient power supplies to service the citizens and industries. From 2014 to 2015, South Africa suffered several load-shedding instances that affected the provision of mobile broadband services[19][20][21]. The load shedding timetable was structured in such a way that some areas in the country would be switched off from the electricity grid in instances of overloading. In such circumstances, the transmission base stations in the affected areas would be switched off cutting people from mobile network connection. That means students who rely on mobile broadband for internet connection would be affected.

2.7.3 Cost constraints

The cost of providing mobile broadband affects mobile telecom companies, HEIs and students. Telecom companies would incur costs on sourcing the infrastructure, acquiring the spectrum licenses, and integrating services from one network technology to the other (Fraser & Ntoi, 2012; Miller et al., 2014; UN Broadband Commission for Digital Development, 2015). The dynamic nature of the telecom industry has financial implications on the provision of high speed backbone infrastructure, for example, the expenses for migrating from 3G to 4G and LTE (GSMA, 2015c). Due to infrastructure costs, developing countries always trail behind the developed world in terms of mobile broadband development (Fraser & Ntoi, 2012). In 2015, the dominant mobile broadband technologies in the developed world were 4G and LTE with a penetration rate of over 90% against 15% in the developing world (GSMA, 2015c). Frasser and Ntoi (2012) observed that developing countries can save costs by adopting the infrastructure sharing model. In the context of South

[19] http://www.fin24.com/Tech/News/How-load-shedding-impacts-SAs-mobile-networks-20150211

[20] https://www.enca.com/south-africa/possible-tariff-increases-due-load-shedding-say-cellphone-networks-0

[21] http://businesstech.co.za/news/mobile/74976/mtn-network-hit-by-eskom-load-shedding/

Africa, the Broadband policy of 2013 (Department of Communication, 2013) and ICASA's 2015-2019 strategic plan (ICASA, 2014) encourage infrastructure sharing of resources as an enabler for universal access for all.

HEIs that intend to provide students with mobile centric services incur infrastructure costs in the form of hardware or software. Software costs include mobile apps that enable students to access administrative services and tuition resources. The main software resource that HEIs require for mobile phone access to administrative services and tuition resources is the Mobile Learning Management System (m-LMS) (Wang et al., 2014). Furthermore, HEIs incur costs on software applications that facilitate communication and interaction among students, and between the students and the lecturers, for example, SMS services or applications that allow group discussions (Bon et al., 2012). Apart from communication applications, HEIs incur costs on designing or buying learning applications that allow students to learn in context, for example, data collection apps (Marçal et al., 2014). In terms of hardware, HEIs incur costs on providing Wi-Fi infrastructure at the universities. Wi-Fi infrastructure is important in mobile information access and interaction because it provides students with cheap access to information (Kaushik, 2012). Additionally, HEIs incur costs of buying computer servers for installing and managing the mobile services (Wang et al., 2014). HEIs can reduce the cost of providing mobile centric services to students if they adopt the mobile cloud-computing model (discussed in Section 2.5.9). Mobile cloud computing eliminates the hardware cost of servers but incurs cloud services costs. Renting mobile cloud services is considered as cheaper than buying hardware (Bouyer & Arasteh, 2014).

There are two competing models for providing end users with computing hardware, the Corporate Issued Device model[22] and Bring Your Device (BYOD) model[23]. If the HEIs adopt the Corporate Issued Device model, they have to incur costs for providing mobile phone handsets to its staff and students, as well as ensuring the devices against theft and damages. If the BYOD model is adopted, the HEIs would cut costs on providing mobile phone handsets.

Students incur costs on purchasing mobile phone devices and paying for mobile broadband data. Mobile phones that provide usable internet access and interaction are smartphones. The cost of smartphones is above that of feature phones but the prices are affordable. The estimated cost of cheap smartphones designed for developing countries is between US$25 and US$100 (Ericsson,

[22] http://www.networkworld.com/article/2182394/smartphones/corporate-owned-vs--employee-owned-mobile-devices.html

[23] http://www.gartner.com/newsroom/id/2466615

2015; GSMA, 2014). Apart from mobile phone device costs, students incur costs for mobile phone communication, internet access and app downloads.

2.7.4 Awareness constraints

People cannot make use of services whose existence they are not aware of (Boyera, 2007). One way of making people aware of new products and services is through advertising or promotions (Ramburn & Van Belle, 2011). Users would not discover some mobile phone services on their own unless someone tells them, for example, Mobile Apps, mobile MOOCs, e-textbooks, USSD services or SMS services (Boyera, 2007; Eicker-Nel & Matthee, 2014). Therefore, HEIs should have an awareness strategy as part of their provision of mobile centric services.

2.7.5 Cognitive overload constraints

People always carry mobile phones irrespective of what they are doing, which adds a huge influx of information that demands cognitive attention (Gitau, Marsden & Donner, 2010). Some users find mobile phones disturbing, and demanding attention, hence putting pressure on them, resulting in stress and anxiety (Jarvenpaa, Lang, Takeda & Tuunainen, 2003). Mueller, Wood, Pasquale and Cruikshank (2012) found that some students felt that mobile learning was not giving them time to step out of learning because they are always connected.

Mobile phones distract students from listening and concentrating on the proceedings of a lesson (Junco & Cotten, 2011; Shuler, 2009). Shuler (2009) observed that teachers find it difficult to monitor the use of mobile phones during classes, resulting in some schools discouraging them. Even though the use of mobile phones is discouraged at some schools, Ford and Leinonen (2006) see them acceptable if teachers, students and parents are educated with examples of positive use of mobile phones in a learning environment.

Like any other software application, when learners get introduced to a mobile learning application they have to learn how to use it. Depending on the cognitive and technical aptitude of the user, some quickly grasp the technicalities but others would take a long time (Gilbert & Han, 2005). Some first time mobile phone users struggle with using functions of mobile phones that include installation, configuration, navigation, saving and retrieving information (Boyera, 2007; Donner, 2009). Donner and Gitau (2009) found that in South African townships, immediate family and friends teach other users how to use some functions of mobile phones. In this respect, Naismith et al., (2004) identified that educational instructors also struggle with learning how to use m-learning applications for the first time. Instructors that have no confidence in using M-learning would not use it for teaching. Parson et al., (2007) observed that educational instructors needed time to

familiarise themselves with the M-learning technology and to find ways in which they could incorporate it into their daily teachings.

2.7.6 The use of language in socialised learning

Utilising social networking sites as learning communities is constrained by the syntax of the language used when communicating (Koole, 2009). Koole (2009) argued that when participating on a social forum, the participants must follow the rules of communication and be familiar with the syntax of language used in participation. Makoe (2010) observed that students used abbreviated language when communicating on instant messaging services such as Mxit, which was difficult to understand.

2.7.7 Summary of mobile phone constraints

To summarise Section 2.7, literature analysis established that the constraints that can affect the provision of mobile centric services at HEIs are mobile phone usability constraints, network connection constraints, cost constraints, awareness, cognitive overload constraints and the use of language in socialised learning.

2.8 Summary of literature analysis and the conceptual framework

This Chapter carried out literature analysis that focused on the provision of mobile centric services at Higher Educational Institutions (HEIs). Components that have influence on the provision of mobile centric services were identified. These are Readiness, Needs, Resources, Context of use and Constraints. Table 2-6 presents the identified components, their characteristics and referenced articles.

Table 2-6: Literature review summary: Components for providing mobile centric services at HEIs

Main component	Characteristics	References
1. Mobile technology readiness	1.1 Infrastructure readiness • Hardware infrastructure o Network infrastructure o Wi-Fi o Mobile phone ownership • Software infrastructure o Mobile applications o Content	(Borotis & Poulymenakou, 2004; K. Brown et al., 2011; Darab & Montazer, 2011; Department of Communication, 2013; Economist Intelligence Unit (EIU), 2005; Ericsson, 2015; GSMA, 2015c; Hanafizadeh et al., 2009; Herselman & Botha, 2014; ITU, 2012; ITU, 2014a; ITU, 2015; Jantjies & Joy, 2015; Kearney, 2013; Machado, 2007; K. Matthee, 2012; Mudziwepasi et al., 2014; Mybroadband, 2015; Ntinda et al., 2014; Oxford, 2013; Poushter et al., 2015; Puckree et al., 2015; Rambe & Bere, 2013; Sachs, 2000; Statistics South Africa, 2015; UNESCO, 2014b; Willemse, 2015)
	1.2 Policy readiness • Provide support for: o Lecturer and students training o Content optimization o Gender equity o Communication o Interaction o Access to resources o Infrastructure support	(Calandro et al., 2014; Chetty et al., 2013; Czerniewicz & Ngugi, 2007; Department of Communication, 2013; Isaacs et al., 2012; Kraut, 2013; Traxler & Vosloo, 2014; UNESCO, 2011; UNESCO, 2013a; UNESCO, 2013b; UNESCO, 2014a; UNESCO, 2014b; Vosloo, 2012; West & Vosloo, 2013)
	1.3 Lecturer readiness • Training • Workload • Motivation	(Botha, Batchelor, Traxler, De Waard & Herselman, 2012; Cheon, Lee, Crooks & Song, 2012; Dykes & Knight, 2012; Ekamayake & Wishart, 2011; Fritschi et al., 2012; Gloria & Abimbade, 2013; Goundar, 2011; Isaacs et al., 2012; Makoe, 2010; Ozdamli & Uzunboylu, 2014; Rambe & Bere, 2013; Ramburn & Van Belle, 2011; Sridharan, 2013; Traxler & Vosloo, 2014)
	1.4 Students readiness o Gender o Age o Economic status o Multitasking o Appreciation of device portability	(Almutairy et al., 2014; Bakay et al., 2015; Banda, 2010; Beger et al., 2012; Brown & Czerniewicz, 2010; De Villiers, 2010; Department of Higher Education and Technology, 2014; Ellis et al., 2010; Ertmer et al., 2012; Forgays et al., 2014; Forgays et al., 2014; GSMA, 2015a; Gurumurthy & Chami, 2014; Hussin et al., 2012; Hwang et al., 2014; Intel, 2013; ITU, 2013; Judd, 2013; Judd, 2014; Mayisela, 2013; Meyer, 2011; Muller, 2011; Niehaves & Plattfaut, 2014; North et al., 2014; Porter, 2012; Rice & Katz, 2003; Smith, 2014; Tapscott, 2009;

Main component	Characteristics	References
		UNESCO, 2014b; Wasserman & Richmond-Abbott, 2005; Wiese et al., 2014)
	1.5 Financial readiness • Non funded projects • Institutionally funded projects • Externally funded projects	(Calandro et al., 2014; Ericsson, 2015; Ford & Leinonen, 2006; Gregson & Jordaan, 2009a; GSMA, 2015c; Herselman & Botha, 2014; Internet Society, 2015; Jantjies & Joy, 2015; Mybroadband, 2015; Ntinda et al., 2014; Rambe & Bere, 2013; UNESCO, 2014b; Vermeulen, 2015; Willemse, 2015)
2. Mobile phone context of use	2.1 Physical context • Weather effects • Terrain	(Barnard et al., 2007; Brewster, 2002; De Groot & van Welie, 2002; Kiljander, 2004; Schmidt et al., 1999; Sears et al., 2003)
	2.2 User context • Goals • Engaged tasks • Emotional state	(Kim et al., 2002; Preece et al., 2002; Schmidt et al., 1999; Sears et al., 2003)
	2.3 Social context • Social interaction • Group dynamics	(Kiljander, 2004; Schmidt et al., 1999; Sears et al., 2003; Tamminen et al., 2004)
3. Mobile phone information needs	3.1 Mobile phone interaction needs • Practical demonstrations • Group work • Getting help • Peer tutoring • Assessment	(Bester, 2014; Block, 2010; Broder, 2002; Chan, 2014; Cui & Roto, 2008; Ekanayake & Wishart, 2014; Evans & Moore, 2013; Falchikov, 2013; Hickey & Donnelly, 2011; Hodgkinson-Williams & Ng'ambi, 2009; Madiope & Ranko-Ramaili, 2013; Marçal et al., 2014; Nilsson et al., 2014; Park, 2011; Rose & Levinson, 2004; Sellen & Murphy, 2002; Tymms et al., 2011; Zhang & Choi, 2015)
	3.3 Mobile phone communication needs • Tuition communication o Students to student o Students to lecturer • Administrative communication • Disaster management communication	(Abas, Peng, & Mansor, 2009; American Red Cross, 2015; Broder, 2002; Charron & Raschke, 2014; Cui & Roto, 2008; GSMA, 2012; GSMA, 2015b; Kay & Lauricella, 2015; Lauricella & Kay, 2013; McKay, 2015; Rose & Levinson, 2004; ScienceDaily, 2015; Seeholzer & Salem Jr, 2011; Sellen & Murphy, 2002; Steen, 2014; Young et al., 2010)

Main component	Characteristics	References
	3.3 Mobile phone access to resources needs • Tuition resources o m-LMS ▪ Reading material ▪ Podcasts ▪ Assignment instructions ▪ Grade books ▪ Mobile apps ▪ Administrative resources • Communication and interaction resources	(Abas et al., 2009; Akeriwa et al., 2015; Ally, Grimus, & Ebner, 2014; Bon et al., 2012; Bon et al., 2012; Evans, 2008; Kinash, Brand, & Mathew, 2012; Li, 2013; Lonn & Teasley, 2009; McKinney & Page, 2009; Mtebe, 2015; Richardson & Lenarcic, 2009; Schultz, 2013; Ssekakubo et al., 2014; Ssekakubo et al., 2014)
4. Mobile phone resources	4.1 Interaction resources • Peer tutoring resources o Discussion forums o Telephone calls o SMS o Social media • Group work o Discussion forums o Telephone calls o SMS o Social media Assessment apps	(Adagunodo, Awodele, & Idowu, 2009; Balasundaram & Ramadoss, 2007; Bansal & Dhananjay Joshi, 2014; Cuesta et al., 2015; Dabbagh & Reo, 2011; Dabbagh & Kitsantas, 2012; Danis et al., 2010; De Villiers, 2010; Lim, Fadzil, & Mansor, 2011; Mayisela, 2013; Nagel & Verster, 2012)
	4.2 Communication resources • SMS • USSD • Email • Telephone calls • Bulletin boards (discussion forums) • VoIP (Skype) • Mobile apps (BBM, Mxit, Whatspp) • Social media	(Albrecht & Pirani, 2009; Aldrich, 2010; Gokhale, 1998; Hayati et al., 2013; Klein et al., 2015; Lai et al., 2014; Peersman et al., 2000; Rivera, 2007; van Rooyen, 2008; J. R. Young, 2007)

Main component	Characteristics	References
	4.3 Learning resources • Mobi Apps • Assessment • Resource sharing apps • Library access • Content adaptation • Tuition	(Abdous, Facer, & Yen, 2012; Anderson, 2005; Bonifacio, 2012; IBM, 2015; Lee, 2012; Martin et al., 2010; Muyinda et al., 2011; Park, 2011; Rikala & Kankaanranta, 2012; Schultz, 2013; Ullrich et al., 2008; van der Velde & Ernst, 2009; Viswanathan, 2015; Walch & Lafferty, 2006)
5. Mobile phone technologies	5.1 Simple Message Service (SMS)	(Gokhale, 1998; Hayati et al., 2013; Klein et al., 2015; Lai et al., 2014; Peersman et al., 2000; van Rooyen, 2008)
	5.2 Unstructured Supplementary Services data (USSD)	(Fripp, 2012; Ogunleye et al., 2009; Wang et al., 2008)
	5.3 Mobile web sites	(Anderson, 2005; O'Reilly, 2005; Ullrich et al., 2008)
	5.4 E-books	(IPC Media, 2013; Lee, 2012; van der Velde & Ernst, 2009)
	5.5 Podcasting	(Abdous et al., 2012; Walch & Lafferty, 2006)
	5.6 Social media technologies	(Bansal & Dhananjay Joshi, 2014; Cuesta et al., 2015; Dabbagh & Reo, 2011; Dabbagh & Kitsantas, 2012; De Villiers, 2010; Mayisela, 2013; Nagel & Verster, 2012)
	5.7 Quick response (QR) code	(Bonifacio, 2012; Denso ADC, 2011; Lai et al., 2013; Mohamed, 2013; Rikala & Kankaanranta, 2012; Schultz, 2013)
	5.8 Mobile apps	(IBM, 2015; Viswanathan, 2015)
	5.9 Mobile cloud computing	(Almrot et al., 2013; Branon et al., 2012; Chen et al., 2013; Dennerlein et al., 2015; Kumar et al., 2013; Lin et al., 2014; Sanaei et al., 2014; Sharma & Singh, 2012; Stein et al., 2013; Sundeen & Sundeen, 2013; Wang et al., 2014)
6. Constraints	6.1 Usability constraints • Text input constraints • Display screen constraints	(Budiu, 2015; Guerreiro, Nicolau, Jorge, & Gonçalves, 2010; Harper et al., 2010; Huang et al., 2009; Sanchez & Goolsbee, 2010; Sanchez & Branaghan, 2011; Schildbach & Rukzio, 2010; Smith & Chaparro, 2015; Weilenmann, 2010; Yesilada et al., 2010; Zhou et al., 2014)
	6.2 Network constraints • Scarcity of broadband spectrum • Network contestation	(Chetty et al., 2013; Fernando et al., 2013; Fraser & Ntoi, 2012; ICASA, 2014; Miller et al., 2014; Miller et al., 2014; Qi & Gani, 2012; Ramburn & Van Belle, 2011; Reed & Tripathi, 2014; Rysavy

Main component	Characteristics	References
	• Signal interference causes packet loss • Insufficient power supply for bases stations.	Research, 2014; Stroup, 2011)
	6.3 Financial constraints • Spectrum licensing • Backbone infrastructure • Wi-Fi infrastructure • Technology integration, from 3G to 4G • Mobile devices • Broadband cost	(Bon et al., 2012; Department of Communication, 2013; Fraser & Ntoi, 2012; GSMA, 2014; GSMA, 2015c; Kaushik, 2012; Marçal et al., 2014; Miller et al., 2014; UN Broadband Commission for Digital Development, 2015; Wang et al., 2014)
	6.4 Awareness constraints • Mobile technology advancements	(Boyera, 2007; Ramburn & Van Belle, 2011)
	6.5 Cognitive overload constraints • Huge influx of information • Mobile phone needs continuous attention	(Gilbert & Han, 2005; Gitau et al., 2010; Jarvenpaa et al., 2003; Junco & Cotten, 2011; Mueller, Wood, De Pasquale, & Cruikshank, 2012; Naismith, Lonsdale, Vavoula, & Sharples, 2004; Naismith, 2007; Parsons, Ryu, & Cranshaw, 2007; Shuler, 2009)
	6.6 The use of language in socialized learning • A mixture of languages can be used • Abbreviated words • Lack of respect • Inappropriate words	(Butgereit, 2007; Koole, 2009; Makoe, 2010)

With reference to the identified components and their characteristics as presented in Table 2-6, a *Conceptual framework for providing mobile centric services to students at HEIs* is presented in Figure 2-6. The conceptual framework provides an answer to Research question 2.1 (Section 1.4), "*What are the components for providing mobile centric services that facilitate students' information access and interaction at HEIs?*" The discussion on each of the components of the conceptual framework follows.

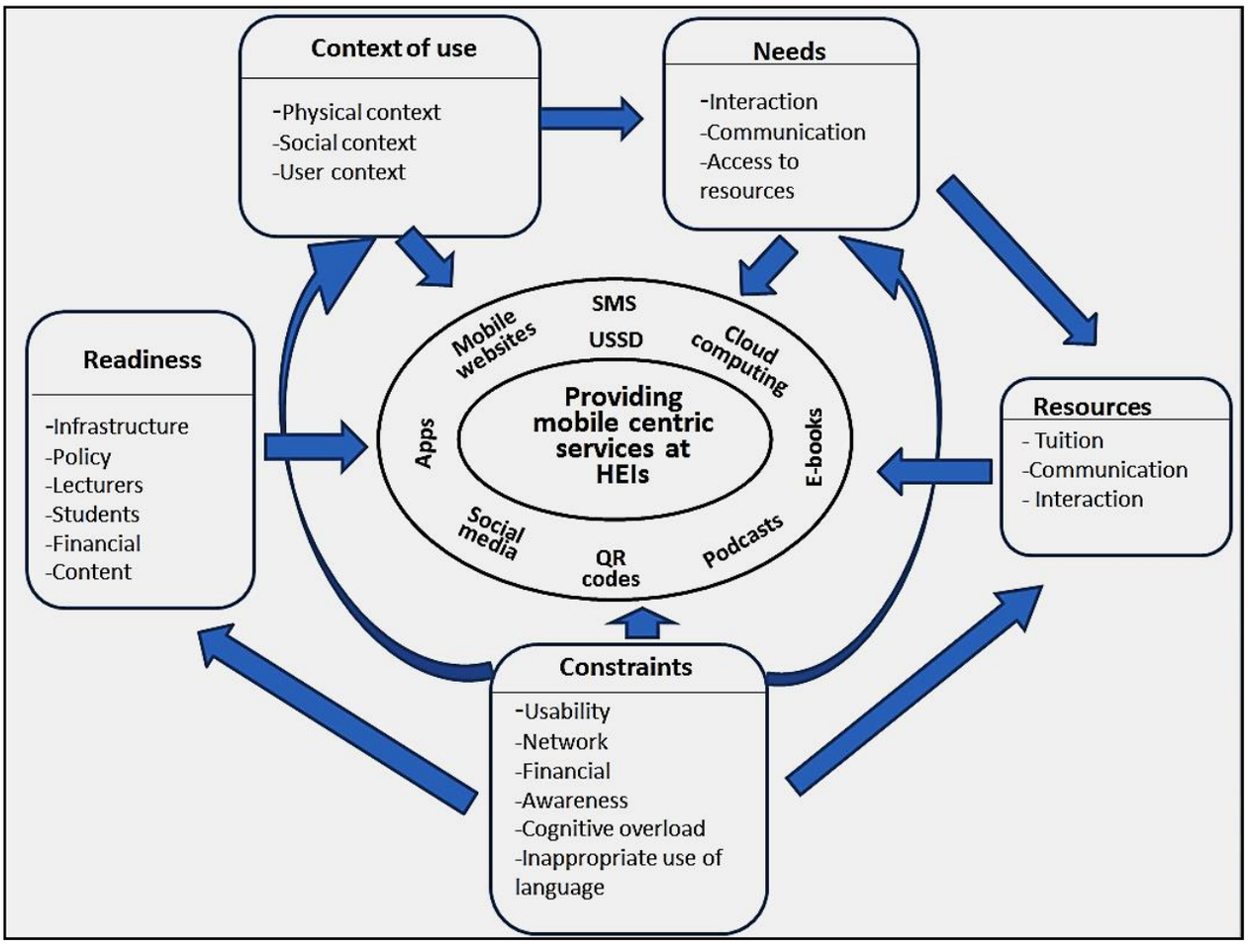


Figure 2-6: Conceptual framework for providing mobile centric services to students at HEIs

2.8.1 Readiness

Readiness is the preparedness of an institution to provide mobile phone information access and interaction services to its students. The readiness of an institution is determined by the readiness of its mobile technology infrastructure, finance, policies, lecturers and students.

- *Mobile technology infrastructure readiness:* Mobile technology infrastructure includes hardware and software. Hardware infrastructure includes mobile cellular wireless network infrastructure, Wi-Fi network infrastructure and mobile phone handsets. Software infrastructure includes mobile phone applications for accessing and interacting with resources.

- *Policy readiness:* HEIs require policies that support the provision of mobile centric infrastructure, communication, access to resources, content optimisation, lecturer and students training.
- *Financial readiness*: The funding that is required to purchase the infrastructure as well as to fund operational costs. Successful provision of mobile centric services of an institution depends on the institution's readiness to provide the necessary funding.
- *Lecturer readiness:* Lecturers are ready to provide mobile centric services when they have received training, have manageable workloads and are motivated.
- *Student readiness:* Students are ready to use mobile phones as information access and interaction tools when they can afford to buy usable mobile devices, pay for bandwidth and are motivated.

As depicted in Figure 2.6, the readiness of an institution in providing mobile centric services is constrained by factors such as mobile phone usability, network constraints, funding and technical expertise.

2.8.2 Needs

Needs are the perceived requirements that lead someone to undertake a mobile phone transaction. Mobile centric needs at HEIs are interaction needs, communication needs and access to resources needs.

- *Interaction needs:* Mobile phones provide distance learning students with a medium that facilitates interaction with teaching and learning services. Interactions that students can undertake on mobile phones include practical demonstrations, group work, peer tutoring and assessments.
- *Communication needs:* Mobile phones give distance learning students leverage to communicate with other students or consult on academic and administrative matters from their lecturers. Communication can be achieved through texting, voice, video chats or a combination of all.
- *Access to resources:* Mobile phones provide distance learning students with a medium for accessing learning resources at anytime from anywhere. The resources can be accessed through m-LMS, which includes reading material, podcasts, gradebooks, mobile apps and library resources.

As depicted in Figure 2.6, mobile centric needs are constrained by factors such as the usability of mobile phone devices, wireless network limitations and funding. Mobile centric needs are also affected by the context of use and the available mobile phone technologies. Contextual factors have an effect on how mobile phone services would satisfy the needs of users in a given context. With

respect to mobile phone technologies, technologies that execute on a specific mobile phone device determine the services that can be accessed on that phone.

2.8.3 Context of use

Context of use refers to the prevailing conditions under which users would interact with mobile centric services. The factors that affect the context of use include the physical, social and user contexts.

- *Physical context:* The mobile phone interaction takes place in this environment. Environmental factors that affect mobile phone interaction include terrain, time of the day, and weather conditions such as rain, light intensity and wind.
- *Social context:* This is the co-location of the mobile phone user with respect to other people. Using a mobile phone in a public place exposes the user to disturbances that require the user to divide attention between the phone and the other people.
- *User context:* Relates to individual conditions of the user when interacting with a mobile phone. Interacting with a mobile phone is affected by the emotional state of the person, bio-physiological conditions and the effects of the social context.

Contextual factors do not affect the use of mobile phones in isolation but they have an overlapping effect. Taking cognisance of the dynamic contexts under which students would interact with mobile phones, the provision of mobile phone information access and interaction would be achieved if information access and interaction services were designed to meet the needs of users in varying contexts. The context in which mobile phone interactions take place is constrained by factors such as the usability of the device, wireless network limitations and cognitive overload of the user.

2.8.4 Mobile phone resources

Resources provided to students and lecturers by a HEI. The resources facilitate lecturers with content creation, deployment of learning material, and interacting and communicating with students. With respect to students, the resources facilitate them with access to tuition material, and interacting and communicating with each other through mobile phones. With respect to Figure 2-6, the Resources component is affected by the Needs component and the Constraints component. The needs of students and lecturers determine the resources that the university should provide. The constraints that need to be managed include usability, financial and network constraints.

2.8.5 Constraints

Constraints are restrictions that HEIs need to overcome in order to provide mobile centric services. The constraints that need to be managed include device usability, network limitation, funding, technology awareness, cognitive overload of users and inappropriate use of language on socialised learning.

2.9 Chapter summary

This chapter carried out literature analysis on the provision of mobile centric services at HEIs. The outcome of the literature analysis is the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). The conceptual framework answered sub research question 2 (Section 1.4). The main components of the conceptual framework are Readiness, Needs, Context of use, Resources and Constraints. The conceptual framework was essential in providing a structure from which to collect data, present the results, draw conclusions and the base for developing a *Framework for providing mobile centric services to students at HEIs in the context of ODeL in South Africa*. Hence, the literature analysis completes Phase 1 of this study. The conceptual framework is essential in identifying the units of analysis, formulating investigative research questions and designing data collection instruments as discussed in Chapter 3.

Chapter 3: Research design and methodology

3.1 Introduction

This Chapter presents the research design and methods for answering research questions posed in Chapter 1. As specified in Section 1.6, this study was undertaken in four phases and this Chapter constitutes phase 2. This phase focuses on research design, research philosophy, research approach, research strategy, data collection, assumptions and ethical considerations. Figure 3.1 gives an overview of the topics covered in this Chapter.

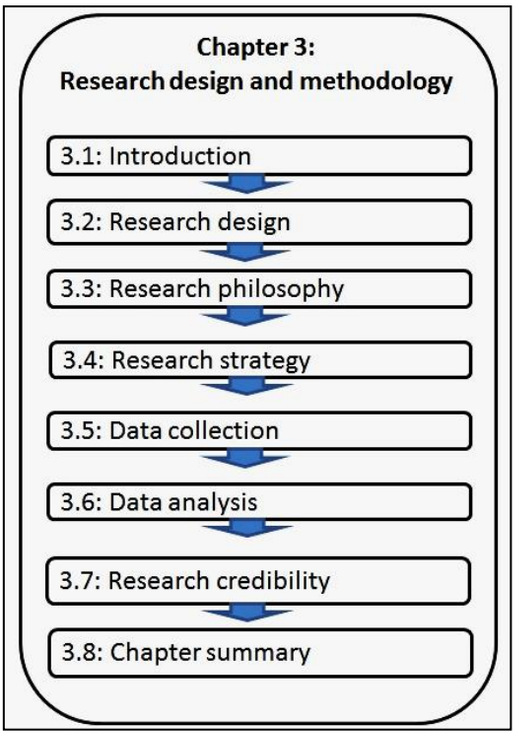


Figure 3-1: Overview of Chapter 3

The discussion continues as follows: Section 3.2 discusses the research design, Section 3.3 discusses research philosophy, Section 3.4 discusses research approach, Section 3.5 discusses strategy, Section 3.6 discusses data collection, Section 3.7 discusses data analysis, Section 3.8 discusses research credibility and Section 3.9 discusses data triangulation and Section 3.10 presents the research methodology summary.

3.2 Research design

This study adapted the Research Onion model (Saunders, Lewis & Thornhill, 2009) to design this study. Figure 3-2 depicts the adaptation of the Research Onion model layers. The Research Onion model is presented as concentric layers, which define the stages undertaken in doing a research. The Research Onion was instrumental in defining the philosophical stance (discussed in Section

3.3), the approach (discussed in Section 3.4), the strategy (discussed in Section 3.5) and data collection (discussed in Section 3.6).

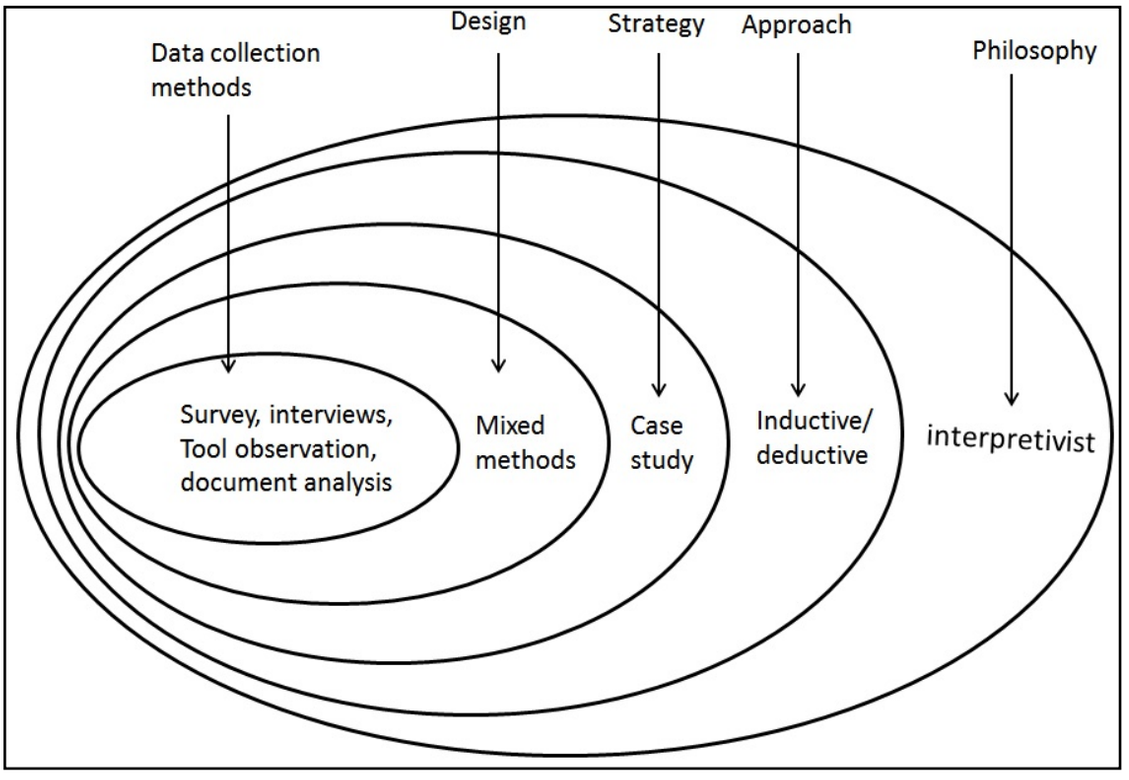


Figure 3-2: Research Onion model (adapted from Saunders et al., 2009)

3.3 Research philosophy

This study adopted an interpretivist philosophical paradigm as it exposes the realities of a complex research objective that need to be investigated. Guba and Lincoln (1994, p.107) defined a paradigm as "… a worldview that defines for its holder, the nature of the world, the individual's place in it, and the range of possible relationships to that world and its parts." The aim of this study is to *investigate the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*. The literature analysis revealed a complex relationship between HEIs, students and lecturers in terms of the provision of mobile centric services, and the expectations of students. The relationship is complex because mobile technology is dynamic and students' needs are ever changing. In order to have a full understanding of this situation, this study sought to understand the realities for providing mobile centric services in an ODeL context in South Africa. The philosophical assumptions of this study are presented in Table 3-1.

Table 3-1: Research assumptions of this study (adapted from Cohen, Manion & Morrison, 2007)

Assumption	Characteristics	Assumptions of this study
Ontology	• Form and nature of reality is subjective and multiple as seen by the observer (Guba & Lincoln, 1994). • What is there and can be known about the reality (Guba & Lincoln, 1994). • Observer's lived experiences and history determines the lived reality (Snape & Spencer, 2003).	• Recognises that reality is subjective and is an individual's perspective. • Admits that individuals infer and make meaning from lived experiences. • Acknowledges that cases of similar events are unique and cannot be generalised.
Epistemology	• The nature of the relationship between the knower and what can be known (Guba & Lincoln, 1994). • The study is undertaken in its natural environment and the researchers have influence on the phenomena they study (Schwandt, 2000). • Knowledge of reality is gained through social constructions (Klein & Myers, 1999).	• Knowledge was gained through respecting the experiences of the participants and inferring the social meaning of their action (Bryman & Bell, 2007). • Inductive and deductive approaches were employed to gain knowledge and to create a theory. • Knowledge gained from this study was not reduced to simplistic interpretation.
Axiology	• Concerned with ethics, aesthetics and religion (Denzin & Lincoln, 2005). • Researcher's principles, standards or the quality considered worthwhile during all stages of the research processes (Saunders et al., 2009).	• It is acknowledged that interpretive research is value laden. • To improve the credibility and validity of the results, this study employed mixed methods design to collect data and examined the phenomena under study from different units of analysis.

3.4 Research approach

Research approach is concerned with the use of theory within the research design (Saunders et al., 2009). The use of theory can be deductive or inductive. Saunders et al., (2009) differentiated the two approaches as follows: deductive approach requires a theory and a hypothesis to be developed first and then design a research strategy to test that theory. On the other hand, inductive approach requires that you collect the data, and develop a theory based on the analysis of the data (Cohen, Manion & Morrison, 2007). This research followed an interpretivist philosophy and adopted the inductive approach with an embedded deductive approach. The deductive approach was embedded because mixed methods design was employed to collect and analyse qualitative data, which was supported with quantitative data (discussed in Section 3.5.3 for data collection design).

3.5 Research strategy

Saunders et al., (2009) described a research strategy as a general plan that guides a researcher to get some specific results. A research strategy comprises of a "bundle of skills, assumptions and practices that the researcher employs for moving from the philosophical paradigm to the empirical world" (Denzin & Lincoln 2005, p.25). The strategy of enquiry connects the researcher to specific methods for collecting and analysing empirical data. The research strategy adopted in this study is a Case study. Before motivating and discussing the Case study research strategy, an overview of selected research strategies is provided.

Several research strategies are appropriate for designing research. In this study, only a few strategies regarded as facilitating interpretive enquiry were selected and reviewed. The reviewed strategies comprised Ethnography, Action research, Case studies, and Grounded theory. The review is based on an adaptation of the Taxonomy for structuring research styles (Cohen et al., 2007). The taxonomy presents a way of analysing research strategies in terms of the purpose, foci, key terms and characteristics. The taxonomy is modified so that the research strategies can be analysed in terms of their purpose and characteristics as depicted in Table 3-2.

Table 3-2: Research strategies (adapted from Cohen et al., 2007)

Strategy	Purpose	Characteristics
Ethnography	• Portrayal of events in subjects' terms • Subjective and reporting of multiple perspectives • Description, understanding and explanation of a specific situation	• Context specific • Formative and emerging • Responsive to emerging features • Allows room for judgement and multiple perspectives • Wide database gathered over a long period of time • Time consuming to process data
Action research	• To plan, implement, review and evaluate an intervention designed to improve practice/solve local problems • To empower participants through research involvement and ideology critique • To develop reflective practice • To promote equality democracy • To link practice and research • To promote collaborative research	• Context-specific • Participants as researchers • Reflection on practice • Interventionist – leading to solution of 'real' problems and meeting 'real' needs • Empowering for participants • Collaborative • Promoting praxis and equality • Stakeholder research
Case study	• To portray, analyse and interpret the uniqueness of real individuals and situations through accessible accounts • To catch the complexity and situatedness of behaviour • To contribute to action and intervention	• In-depth, detailed data from wide data source • Participant and non-participant observation • Non-interventionist • Empathic • Holistic treatment of phenomena • What can be learned from the

Strategy	Purpose	Characteristics
	• To present and represent reality to give a sense of 'being there'	particular case
Grounded theory	• To generate theory from data • To rigorously analyse data in order to identify concepts and hypothesis • For analysing data as it is collected and using the emerging categories to lead the forth coming data collection • For handling large and diverse amounts of data	• Start with selection of a research area • No predefined research questions • Data collection is pragmatic, can be quantitative or qualitative • Data collection and analysis is simultaneous but systematic • Account for variation in behaviour by defining categories (De Villiers 2005) • Emerging categories must fit the realities being studied (De Villiers 2005)

Table 3-2 provides an overview of research strategies and is the basis for selecting an appropriate strategy for this study.

Van der Merwe at al., (2005) proposed a technique for selecting an appropriate strategy for a research study as depicted in Table 3-3. The dimensions of Table 3-3 are: the *Approach*, which shows the research strategy, the *Characteristics*, which gives a summary of the main characteristics of each research strategy, and the *Research questions* for the study. This study has two main sub research questions under investigation. To select the best research strategy for this study, each research question was compared against the characteristics of each strategy. If a relationship existed between the research question and the characteristics, a tick (✓) was used to highlight the criteria. Even though the indicators showed that this study had some characteristics of Ethnography and Action research strategies, it is predominantly a Case study research. Hence, based on Van der Merwe at al's., (2005) criteria, this study satisfied the Case study research strategy. In addition, this study satisfied the criteria for a Case study as specified by Yin (2003), "an enquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003, p.13). The natural setting of this study is the provision of mobile centric services in the context of ODeL Institutions in developing countries. The study was done within its natural settings and the researcher did not disturb the existing settings in terms of business processes either administratively or academically during data collection. Hence, this study chose the Case study as strategy.

Table 3-3: Research approach characteristics and research questions (adapted from Van der Merwe et al., 2005)

Approach	Characteristics	**Research question 1:** What are the components for providing mobile centric services that facilitate students' information access and interaction at HEIs?	**Research question2:** To what extent does practice in HEIs reflect the components for providing mobile centric services that facilitate students' information access and interaction?
Case Study	In-depth, detailed data derived from wide data sources	✓	✓
	Participant and non-participant observations	✓	✓
	Non-interventionist	✓	✓
	Empathic	✓	✓
	Holistic treatment of phenomenon	✓	✓
	What can be learned from a particular case	✓	✓
Grounded Theory	Meaning emerges from the phenomenon		
	Collection and analysis of data is a simultaneous process		
	Hierarchical coding processes		
	Categories/concepts and their qualities/properties are generated from the data		
	Conceptual relationships are grounded in the data		
	Data collection proceeds until so called theoretical saturation is achieved		
Ethnography	Context specific	✓	✓
	Formative and emergent		
	Responsive to emerging features		
	Allows room for judgements and multiple perspectives		
	Wide data base gathering over a long period of time		
	Time consuming to process data		
Action Research	Context-specific		✓
	Participant as researcher		
	Reflection on practice		✓
	Interventionist-leading to solution of 'real' problems and meeting 'real' needs		
	Empowering participants		
	Collaborative		

3.5.1 The case study

Case study research can be either a single case study or a multiple case study (Yin 2009). Yin (2009) stated that the use of a single case study is justified in circumstances where the case represents an extreme case, or a unique case, or a typical case, or a revelatory case. A case study is typical if it presents an opportunity for studying a unique case whose results shed light on what has been unknown. Based on this definition, UNISA was selected because it is a typical university in a developing country that is confronted by the problem under study and the only ODeL institution in the country. Hence, this study adopted a single case study with embedded units of analysis design.

Case study research enables a holistic approach to a study, in which the researcher focuses on the complexity of relationships and processes, and how they are interconnected and interrelated, rather than trying to isolate individual factors (Oates, 2006). The phenomenon under study presents a complex situation that requires the establishment of relationships between several objects of the study. The study wanted to establish the institutional standing on the issue of mobile information access by its students and lecturers. In this regard, the voice of the institution could be heard through policy document analysis, tool observation and lecturer interviews. In addition, the study wanted to establish the mobile needs of students and to match them with the mobile services provided by the university. Hence, the case study approach employed the mixed methods design to facilitate data collection from different stakeholders in order to give a holistic view of the phenomenon under study.

UNISA has a student population of over 400 000 that is not homogenous in terms of economic status, residential location and culture (UNISA, 2015a). Some students are from disadvantaged backgrounds and cannot afford to buy ICT devices necessary for learning such as computers and paying for broadband (Ali, 2011). As discussed in Chapter 1 (Section 1.2), some students rely on mobile cellular phones for internet access. This presents an opportunity for investigating the components of a Framework for providing mobile centric services to students at HEIs in the ODeL context in South Africa. In addition to the unique characteristics of the case study outlined above, the intrinsic and instrumental purposes of the study were considered (Stake, 1995). Intrinsically, the study aimed at investigating the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa. Exploration of the research aim within the case study helped in uncovering the status quo of mobile information access at the university. Instrumentally, the study uncovered some problems that could affect other HEIs when providing mobile centric services. The case study helped in understanding the research problem under investigation and resulted in the development of a *Framework for providing Mobile Centric Service to students at HEIs in ODeL context in South Africa* (presented in Section 6.3).

3.5.2 Units of analysis

An important question that needs to be answered is what exactly is this study observing and analysing? That is, what are the units of analysis for this study? Grunbaum (2007) argued that the key issue in selecting units of analysis is to decide on, "what is it you want to be able to say something about at the end of the study" (Grunbaum, 2007, p.83). Similarly, Khan and Van Wynsberghe (2008) argued that units of analysis could be based on the phenomenon being observed for which evidence is collected. Therefore, at the end of this study we should be able to say something on the components of a *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*.

As stated in Section 3.5.1, the exploration of this phenomenon was undertaken as a single case study with embedded units of analysis as depicted in Figure 3-3. The context of the study is ODeL HEIs in South Africa and UNISA serviced as a specific instance.

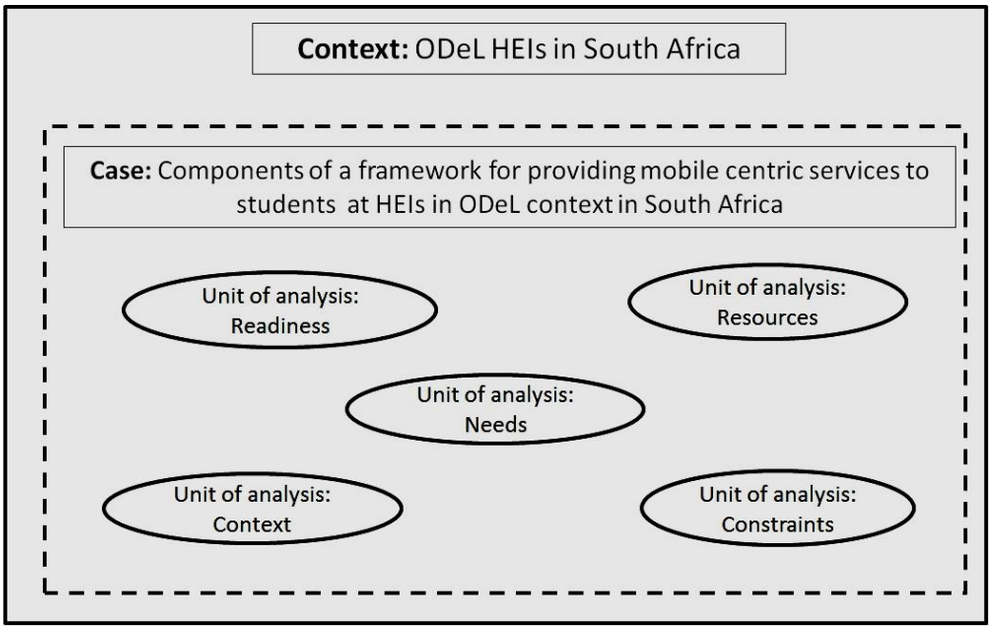


Figure 3-3: Case study units of analysis (adapted from Yin 2009)

The units of analysis were selected based on the components of the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). The conceptual framework provided a prior view of the general constructs that this study intended to study (McCutcheon & Meredith, 1993). Therefore, the embedded units of analysis were identified as Readiness, Needs, Resources, Context of use and Constraints.

Sources of evidence in the study included the lecturers, students, policy documents and mobile phone infrastructure. Mixed method data collection design was employed to collect data from the

sources of evidence. Data collection methods included policy document analysis, tool observation, surveys and interviews. Table 3.4 matches the units of analysis, sources of evidence and data collection instruments.

Table 3-4: Embedded units of analysis, sources of data and data collection

Embedded unit of analysis	Source of evidence	Data collection instruments	Evidence sought
Readiness	Lecturers	- Interviews (discussed in Section 3.6.4)	- To determine the readiness of lecturers in providing mobile centric services.
	Students	- Survey (discussed in Section 3.6.3)	- To determine the readiness of students in using mobile centric services.
	Policies	- Policy document analysis (discussed in Section 3.6.1)	- To determine the readiness of policies in support of the provision of mobile centric services at the university; that is, the support given to students and lecturers.
	Infrastructure	- Tool observation (discussed in Section 3.6.2)	- To determine the mobile services that are provided to students that facilitates information access and interaction. - To determine which mobile phone services are provided to lecturers in providing mobile centric services to students.
Needs	Lecturers	- Interviews (discussed in Section 3.6.4)	- To determine the mobile centric needs of lecturers in order to provide them with services that they can use.
	Students	- Survey (discussed in Section 3.6.3)	- To determine the mobile centric needs of students in order to provide services that they need.
Resources	Lecturers	- Interviews (discussed in Section 3.6.4)	- To determine the mobile resources which the lecturers are providing to students.
	Students	- Survey (discussed in Section 3.6.3)	- To determine resources that the students are using.
Context of use	Students	- Survey (discussed in Section 3.6.3)	- To determine the context in which students would interact with mobile centric services.
Constraints	Lecturers	- Interviews (discussed in Section 3.6.4)	- To determine the constraints that can obstruct lecturers from providing mobile centric services to students.
	Students	- Survey (discussed in Section 3.6.3)	- To determine the constraints that can obstruct students from using mobile centric services.
	Infrastructure	- Literature analysis (discussed in Section 2.8.5)	- To determine mobile infrastructure constraints.

3.5.3 Mixed method data collection design

Creswell and Plano Clark (2011) characterised the mixed method design as collecting and rigorously analysing both qualitative (QUAL) and quantitative (QUAN) data in a single study, mixing the collected data in a sequential way or concurrently or embedding one within the other, and carrying the study within a philosophical worldview or a theoretical length.

Bryman (2006) provided some reasons for employing the mixed method design. Among the reasons provided by Bryman (2006), three reasons are applicable in this study and they are completeness, diversity of views and triangulation. Completeness was an essential reason for mixing methods because the main research question could only be answered by collecting data from multiple sources. Diversity of views was essential in gathering different views from different data sources that included students, lecturers, documents and the mobile centric tools at the university. Triangulation was essential in seeking convergence of results from different sources of data (discussed in Section 3.8). Additionally, the mixed method design allowed both inductive and deductive data analysis to be used within a single study.

At a higher level, Creswell and Plano Clark (2011) categorised the mixed method research design into fixed design and emergent design. Fixed design is where both qualitative and quantitative data collection and analysis are planned at the start of the research. Emergent design is where quantitative or qualitative data collection and data analysis are integrated during the course of the study. This study employed the fixed design method because data collection was informed by the categories of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* that was developed from literature analysis (depicted in Figure 2-6).

At a lower level, Creswell and Plano Clark (2011) categorised the mixed methods design into the following designs: convergent parallel design, explanatory sequential design, exploratory sequential design, embedded design, transformative design and multipurpose design. This study adopted the embedded design.

The embedded design is a method in which one data set provides a supportive secondary role in the study (Creswell & Plano Clark, 2011). This is encountered in situations where one data set is not sufficient to answer all the research questions. That is, each research question requires a different data source and type, which is the case in this study. Research questions in this study mainly collected qualitative data through policy document analysis, tool observation, lecturer interviews, and student qualitative surveys. Quantitative data was also collected through student quantitative surveys. Figure 3-4 presents the design map to illustrate the components of the mixed method design and their interrelationships. Each of the data collection methods employed in this study is discussed in Section 3.6.

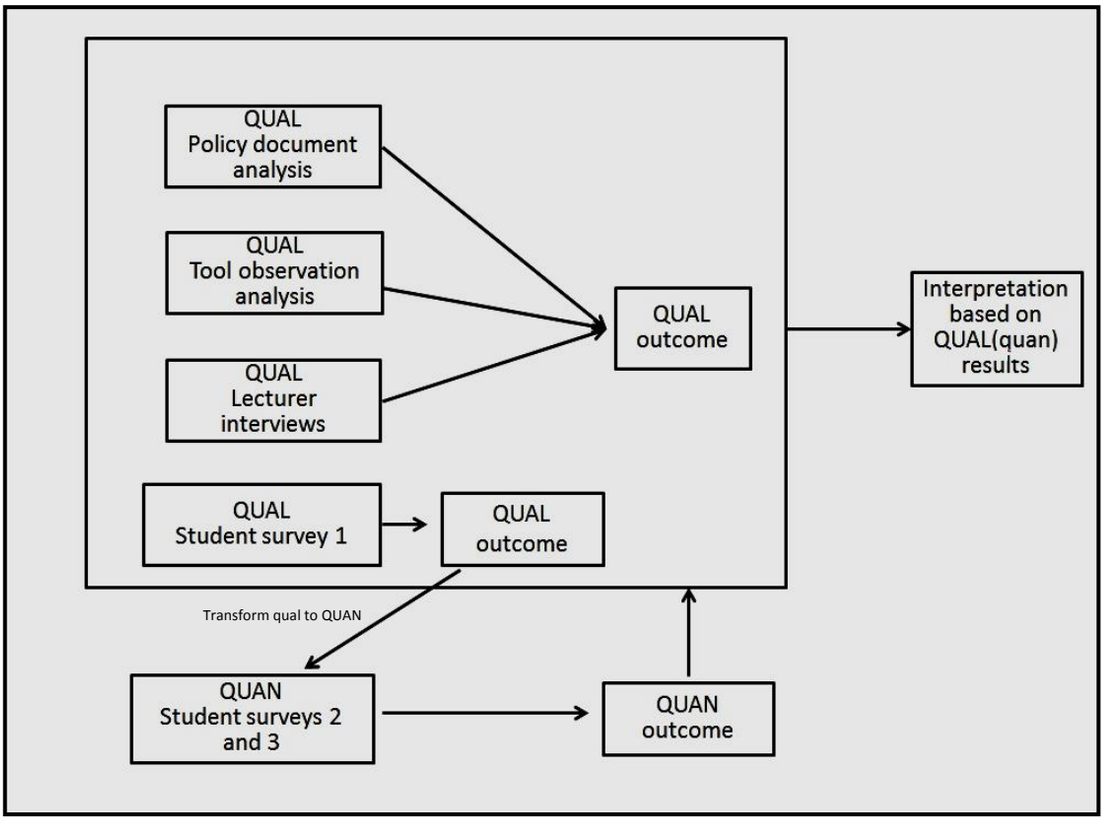


Figure 3-4: Mixed method design (adapted from Yin, 2009)

As illustrated in Figure 3-4, the quantitative strand was embedded within the qualitative strand. Three instruments were employed to concurrently collect and analyse qualitative data. Two instruments were employed to collect quantitative data from students and were both informed by the outcome of the qualitative student survey 1 analysis. The outcome of the quantitative strand was integrated with the outcome of the qualitative strand. The interpretation of the results was based on the qualitative results as supported by the quantitative results.

3.6 Data collection

Benbasat et al., (1987) claimed that data collection in a Case study should be guided by a data collection protocol that outlines data sources, and data capturing methods. Table 3-5 serves as a data collection protocol for this study. The table matches the main components of the conceptual framework (depicted in Figure 2-6) with the research questions, data collection methods, and data sources.

Table 3-5: Research protocol

Main research question	**Aim**			
What are the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa?	The aim of this study is to investigate the components of a framework providing mobile centric services to students at HEIs in ODeL context in South Africa.			
Sub research question	**Objective**			**Data collection method**
1. What are the components for providing mobile centric services that facilitate student information access and interaction at HEIs?	To identify the components for providing mobile centric services that facilitate student information access and interaction at HEIs.			Literature analysis
2. To what extent does practice in HEI reflect the components for providing mobile centric services that facilitate students' information access and interaction?	To reflect on HEIs' practice relative to the identified critical components for providing students with mobile cellular phone services that facilitate access and interaction by collecting evidence from UNISA as a single case study with embedded units of analysis.			See investigative questions
Investigative research questions for sub research question 2	**Conceptual framework component**	**Data collection method**	**Data type**	**Source**
2.1 What is the status of the university policy on the provision of mobile centric services?	Readiness	Document analysis	Qualitative	University policy documents
2.2 Which mobile cellular technology tools are provided by the university that facilitate student information access and interaction?	Resources	Tool observation analysis	Qualitative	Mobile information access tools
2.3 Which services do students want to access and interact with through mobile cellular technology?	Needs, Resources and Context of use	Survey 1	Qualitative	Students
		Survey 2	Quantitative	Students
		Survey 3	Quantitative	Students
2.4 How ready are the students in accessing and interacting with mobile centric services at the university?	Readiness	Survey 2	Quantitative	Students
		Survey 3	Quantitative	Students
2.5 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?	Readiness	Interviews	Qualitative	Lecturers
2.6 Which mobile centric resources do lecturers provide to students that facilitate information access and interaction?	Resources	Interviews	Qualitative	Lecturers
2.7 Which constraints affect the provision of mobile centric services at the university?	Constraints	Interview	Qualitative	Lecturers
		Survey 3	Quantitative	Students,
		Document analysis	Qualitative	University policy documents

The data collection methods employed in this study are discussed in the following order: Section 3.6.1 discusses policy document analysis, Section 3.6.2 discusses tool observation, Section 3.6.3 discusses student surveys and Section 3.6.4 discusses lecturer interviews.

3.6.1 Policy document analysis

The aim of the policy document analysis was to collect and analyse data based on the Readiness component of the *Conceptual Framework for Providing Mobile centric Services to students at HEIs.* The analysis focused on the readiness of institutional policies in supporting the provision of mobile centric services at the university. Policies were chosen because they are a rich source of information, stable, legally valid, contextually relevant, and grounded in the institutional environment (Lincoln & Guba, 1985). In this study, document analysis provided a view of the current situation and the support that the university guarantees when providing mobile centric services. Scott (2006) warns that documents targeted for document analysis should be authentic, credible, representative and meaningful. The policy documents analysed in this study met Scott's (2006) criteria because they are official university documents.

A sample of eight UNISA policy documents from the university were analysed, of which four were Teaching and Learning policies, and four were ICT policies. The Teaching and Learning policies were:

- the Tuition policy,
- the Curriculum policy,
- the Open distance learning (ODL) policy, and
- the Prescribed books and journal articles policy.

The ICT policies were

- the ICT mobile device policy,
- the Telephone and cell phone policy,
- the Policy on sending SMS's and Emails to students,
- the Internet, electronic communication and web management policy.

The policies are available on the university's website and are accessible to all members of the university (UNISA, 2015b). The policy document analysis was done between 1 September 2014 and 30 October 2014.

The UNESCO 2013 mobile learning policy guidelines (Kraut, 2013) informed the design of the document analysis protocol used in this study. The UNESCO m-learning policy guidelines are important because they provide balanced strategic direction for using mobile technology in

teaching and learning. Table 3-6 presents the document analysis protocol. The policy documents analysis followed the Framework Analysis method (Ritchie & Spencer, 1994).

Table 3-6: Document analysis protocol

Name of policy /date of publication	**What is the name of the policy?**
Purpose	What is the purpose of the policy?
Implications on lecturer training	What does the policy say on the role of lecturers?
Implications on provision of infrastructure	How is the infrastructure provided and supported by the university to lecturers and students?
Implications on communication	How are mobile phones supposed to be used when communicating?
Implications on provision of learning resources	What are the guidelines for providing students with access to learning resources?
Implications on interacting with students	What are the guidelines for lecturer to student interactions?

3.6.2 Tool observation analysis

The aim of tool observation analysis was to collect and analyse data based on the Resources component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs*. The analysis focused on observing mobile phone tools provided by the university, which are accessible to lecturers and students. The advantage of Tool observation analysis is that it is not dependent on respondents' personal views but seeks explicit evidence through the eyes of the observer (Patton, 1980). This gave an opportunity for understanding the mobile phone information access context at the university and the perceptions of the participants.

To achieve this, the researcher assumed the role of a participant as an observer. The researcher is a lecturer at the university and has access to the university systems. In circumstances were access to privileged resources was required, permission was sought from the authorities. Table 3-7 presents the design of the observation protocol employed for data collection and analysis. The observation protocol was developed based on one of the main categories of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs.*

Table 3-7: Tool observation protocol

Investigated factor	Tools found	Tool platform	Lecturer activities	Student activities
Communication: • Which mobile phone tools are available for lecturers to communicate with students? • Which mobile phone tools are available for students to communicate with other students or the lecturers?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers use these tools to communicate with students?	How do students use these tools to communicate with other students, lecturers or the university?
Access to resources: • Which mobile phone tools are available for lecturers to provide students with learning resources? • Which mobile phone tools are available for students to access resources?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers use these tools to provide students with learning resources?	How do students use these resources to access the resources?
Interaction: • Which mobile phone tools are available that enables lecturers to provide students with collaborative learning activities? • Which mobile phone tools are available that enables lecturers to interact with students? • Which mobile phone tools are available that enables students to interact with each other?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers use these tools to provide students with learning resources?	How do students use these resources to access the resources?
Social media services: Does the university provide social media services to students?	List of services found.		Lecturer activities.	Students activities.

3.6.3 Student surveys

The aim of student surveys was to collect data on the components of the *Conceptual Framework for Providing Mobile centric Services to students at HEIs,* which are Readiness, Needs, Resources, Context of use, and Constraints. Three different groups of students responded to three different sets of surveys in 2011, 2012 and 2013. The three surveys were designed differently in order to get as much information as possible from students. The following sections present the design, data collection, sample selection and data analysis for each of the three surveys.

3.6.3.1 Students survey 1

Student survey 1 collected data on the mobile centric needs of students at the university. The survey collected qualitative data through three open-ended questions, which were scenario based. The reason for structuring the survey as a scenario was to give the students a chance to visualise the situation under study and to stimulate them to think deeply (see Appendix 5). The approach was necessary for gaining rich data from the students. Table 3-8 summarises the survey questions.

Table 3-8: Student survey 1 questions

Scenario: Given the maturity advantage of e-learning and the fact that many of the decision makers at universities may be pc-centric, a total redesign of the information systems is needed to accommodate the mobile-centric learning needs of distance education students. Reflecting on your own experiences, answer the following questions towards constructing a framework for providing students with mobile centric services at an ODeL higher educational institution.	
Question	**Objective**
1. What are the general information needs of students?	To determine if students know their general information needs.
2. What kind of information and resources would students prefer to access and interact with on a mobile phone?	To determine the students' mobile centric information needs.
3. What kind of learning activities would students prefer to do on a mobile phone?	To determine the learning activities that students would want to do on their mobile phones.

The limitation of open-ended questions could be that students would fail to identify all the important needs at the time of data capturing. However, given the intention to gather the needs as perceived by the students, this approach was followed as a point of departure.

The survey was distributed to students through the university's e-learning portal. The students were invited to participate to the survey through email. To participate in the survey, the students were supposed to download the survey, respond and upload the responses on the e-learning portal. The advantage of distributing the survey through the e-learning portal was that it reduced the distribution time and postal costs.

This study employed purposeful sampling to select the respondents. The targeted sample was a class of 100 students registered for a fourth year E-learning (INF4860) course in 2011. The fourth year class was selected because it was considered mature enough to have an understanding of the topic under discussion. Out of the 100 students, only 50 students completed and uploaded responses on the e-learning portal. The responses from the students were downloaded and printed for analysis.

The Framework Analysis method (Ritchie & Spencer, 1994) was followed in analysing the captured data. The aim of data analysis was to identify the mobile centric needs of students. This involved coding the identified themes from the data set. Data coding was manual and used the pencil and paper technique. This involved selecting a sample of scripts, reading a script at a time and decoding the mobile centric needs. The decoded themes were tagged with codes that described the type of the need, for example, *Due date reminder*. The process was repeated for each script until the saturation point. Saturation point was reached after reading a sample of thirteen scripts. The identified codes from the data were recorded on a master list to create a thematic framework. The codes were cleaned by merging similar codes, deleting the unnecessary or creating new codes where necessary. The thematic framework was used for analysing the rest of the 50 scripts that were received from the respondents, and codes were recorded on an Excel spreadsheet presented in Table 3-9. For each script analysed, if a need was identified from the script, it was recorded on a spreadsheet with a one (1) and if it did not exist, with a zero (0). After analysing all the scripts, frequencies were calculated to see the needs which were identified most frequently by the students as presented in Section 4.4, results section.

Table 3-9: Student survey 1 data capturing tool

	Needs					
Participant	**Due date reminders**	**Fees updates**	**Results**	**Feedback**	**Timetable**	**…..**
1	1	1	0	0	0	… …
2	1	0	1	0	0	…..
3	0	1	0	0	0	…..
.	..	..	..	..	..	

3.6.3.2 Student survey 2

The limitation of using open-ended questions in the survey was that they could not be used to empirically rate or prioritise categories. While the qualitative data and interpretation thereof was necessary to provide a comprehensive, rich and authentic set of student needs, the second survey (Student survey 2) aimed at prioritising the needs identified in the first survey (see Appendix 6). Student survey 2 was constructed based on the categories of the needs that emerged from analysing

the results of the first survey. Student survey 2 collected quantitative data through two closed ended questions whose responses were rated on a five point Likert scale. The questions asked students to rank the importance of the 16 needs identified from Student survey 1 on a scale of 1 (not important) to 5 (very important). The students were also asked to rate the frequency at which they would access the need on a scale of 1 (not often) to 5 (very often). Table 3-10 provides the survey questions and their objectives.

Table 3-10: Student survey 2 questions

Question Number	Objectives
1. How would you rank the importance of each of the needs on a scale of 1 to 5, where 1 = not important and 5 = very important, for the implementation of a mobile information access in the ODL environment?	To determine how students would rank the importance of each of the needs for implementing on a mobile phone information access system.
2. How often would you access the needs if they are implemented on a mobile phone system on a scale of 1 to 5, where 1 = not often and 5 very often?	To determine the frequency at which the students would access the needs if they are implemented on a mobile phone information access system.

The survey targeted 89 students registered for an E-learning course in the School of Computing in 2012. The group was purposively selected to provide an informed opinion on mobile information access since the E- learning course addresses issues of m-learning. Students were invited through email to respond to the survey questions. In total, 84 students responded to the survey. Responses from the students were downloaded from the portal and cleaned in preparation for analysis.

Data collected from Student survey 2 was analysed descriptively. The aim of the analysis was to identify the most relevant needs and rank them according to the students' perceived preferences. Student survey 2 captured ordinal data from students using a five point Likert scale questionnaire. To identify the most relevant needs from the data, frequencies per category were calculated and the results are presented in Section 4.5 (Chapter 4). A frequency count is a simple count of how many individuals fall into each category and expressed as a percentage.

3.6.3.3 Student survey 3

Having gained some insights from Student survey 1 and Student survey 2, Student survey 3 data was captured to quantitatively test the constructs that made up the components of the *Conceptual Framework for Providing Mobile centric Services to students at HEIs*. The survey captured quantitative data from sixteen closed ended questions. The questions included multiple choice based questions and Likert scale questions. Table 3-11 presents the design of survey questions and their objectives. Student survey 3 is attached in Appendix 7.

Table 3-11: Student survey 3 questions

Question Number	Objective/s
1. What is your gender? 2. How old are you? 3. At what level of education are you at? 4. How are your studies funded?	To collect biographic data.
5. Which of the following electronic communication devices do you own? 6. Specify the brand of your mobile cellular phone. 7. Which of the following features are available on your mobile phone?	To determine students' mobile phone information access and interaction readiness, focusing on mobile phone ownership and knowledge of the device.
8. Where do you access the Internet (for example via a desktop computer and/ laptop) and how often do you do this per week?	Probing students to tell us if they have internet access through PCs.
9. As part of your normal routine, to what extent do you engage in the following activities on your mobile phone? Tell us if you do this very often, often, seldom, never or whether this is not applicable to you.	Probing students to tell us to what extent they use their mobile phones on daily basis.
10. How do you pay for your cell phone bills? 11. Please indicate the amount spent on airtime per week (if you have a monthly contract, please divide monthly contract amount by four to convert to weeks)?	To determine if students can afford mobile phone information access.
12. Please select from the statements below those that best describe your mobile phone use?	To determine the context in which students use their mobile phones.
13. Which of the following resources are important for mobile phone access?	To determine the resources that the students would want to access through mobile phones.
14. Which of the following activities are important for mobile phone interaction?	To determine interaction activities that students would want to do on their mobile phones.
15. Which of the following communication messages do you consider important to receive on your mobile phone?	To determine the communication activities that the students would want to engage in.
16. Which mobile phone limitations have you encountered when interacting with your mobile phone?	To determine the constraints that may discourage the use of mobile phones.

Student survey 3 targeted 250 students registered for a third year Database design course (INF3707) in 2013. Unlike fourth year classes selected for Student survey 1 and Student survey 2, the third year class had more students. A total of 129 participants completed the questionnaire.

Student survey 3 questions (Appendix 7) were created and distributed using Google forms. Students were invited to respond to the survey through emails. Follow up emails were sent every two weeks reminding students to participate in the survey if they had not done so or thanking them if they had. The advantage of distributing the survey through Google forms was that Google forms

are accessible from any web browser, including those that run on mobile devices. Google forms capture and store data in a spreadsheet and this reduces data capturing time.

The data captured through Google forms was downloaded and cleaned in preparation for analysis. Data analysis employed both descriptive and inferential methods. Descriptive statistics gave a summary of how the group responded to each of the survey questions. Inferential statistics uncovered trends that were not visible from descriptive analysis. The inferential statistical methods employed to analyse the data were reliability test, association test in the form of Chi-squared and MANOVA, data reduction test in the form of Factor analysis. Data analysis results are presented in Section 4.6 (Chapter 4).

3.6.4 Lecturer interviews

The aim of the lecturer interviews was to get a reflection on the extent to which practice in HEIs reflect the components of the *Conceptual Framework for Providing Mobile centric Services to students at HEIs*. The reflection focused on the following components, Readiness, Needs, Resources, Context of use and Constraints as depicted in Table 3-12.

Kvale (2006) argued that through a conversation, other people can get to understand the lives of others, their experiences, feelings, and how they see the world that they live in. This study sought to understand the perceptions of lecturers on their readiness, needs, access to resources and constraints in providing students with mobile centric services.

Fourteen lecturers from the School of Computing at UNISA participated in the interviews between 01 October and 20 December 2013. The demographic ratios of the interviewed participants were five females and nine males. Their ages ranged from twenty-eight years to sixty years. The proportions and the job ranks of the interviewed participants were five lecturers, six senior lecturers and three professors. Table 3-12 presents the profiles of the lecturers who participated in the interviews.

The lecturers who participated in the interviews were sampled using the maximal variation sampling technique. Maximal variation sampling is a subset of purposeful sampling (Patton, 1980). Purposeful sampling is a technique where researchers intentionally select participants who have experienced the central phenomenon or the key concepts being explored (Creswell & Plano Clark, 2011). Maximal variation sampling aims at recording different occurrences within a small sample to be studied extensively (Rubin & Babbie, 2008).

Table 3-12: Profiles of interviewed lecturer participants

Participant	Gender	Rank	Age range
P1	Male	Senior lecturer	35-39
P2	Male	Professor	46-50
P3	Male	Professor	46-50
P4	Female	Professor	40-45
P5	Male	Senior lecturer	35-39
P6	Male	Senior lecturer	46-50
P7	Female	Senior lecturer	46-50
P8	Male	Lecturer	35-39
P9	Male	Lecturer	35-39
P10	Female	Lecturer	46-50
P11	Female	Lecturer	31-35
P12	Male	Senior lecturer	35-39
P13	Male	Senior lecturer	Over 50
P14	Female	Lecturer	31-35

The lecturers were invited to participate in the interviews through emails and in person. The invitation letters asked for permission to interview the participant, sought for an appointment and venue of the interview, and the permission to record the interviews. Most of the interviews took place in the offices of the lecturers except three interviews, which took place at a Computer Science and Information Systems conference in September 2013. All the participants signed consent forms and the interviews were audio recorded and later transcribed.

All the participants were interviewed from the same interview guide, which contained nine open-ended questions (see Appendix 3). The interview questions were designed in such a way that they captured issues identified in the *Conceptual Framework for Providing Mobile centric Services to students at HEIs*. Table 3-13 presents the interview questions and their objectives.

Table 3-13: lecturer interview questions

Question Number	Issue identified from the conceptual framework
1. To what degree do you consider the provision of mobile centric services in teaching? 2. Do you think you are ready to provide students with mobile centric services that facilitate students with information access and interaction in learning? 3. What would you need in order to do that?	• Evaluating the readiness of lecturers in providing mobile centric services. • To determine the needs of lecturers.
4. Which resources are provided by the university that support the provision of mobile centric services? • Which resources would you expect from the university?	• Perceived readiness of university infrastructure by the lecturers. • To determine the needs of the lecturers.
5. Which learning resources do you make accessible to students through mobile	• Reflections on providing resources for mobile phone interaction.

Question Number	Issue identified from the conceptual framework
cellular phones?	• To determine the needs of the lecturers when providing resources to students.
6. Which learning interactions do you provide to students through mobile cellular phone? • Which other interactions would you consider? • Which resources would lecturers need in order to achieve that?	• Reflections on mobile phone interactions with students. • To determine the needs of lecturers when communicating with students.
7. How do you communicate with students through mobile cellular phones? • Which other ways would you want to consider? • Which resources would lecturers need in order to achieve that?	• Reflections on how lecturers communicate with students through mobile phones. • To determine the communication needs of lecturers.
8. Do you prepare any learning content specifically for mobile phone access and interaction? • Which other content formats would you consider? • Which resources would you need in order to achieve that?	• Reflections on content design for mobile phone access. • To determine the content design needs of lecturers.
9. What do you think are the challenges that would be encountered by the lecturers in providing mobile cellular phone information access and interaction?	• To determine what the lecturers consider as the limitations that may discourage the use of mobile phones.

All interviews were audio recorded and later transcribed. The advantage of audio recorded interviews is that they can be listened to several times and other researchers can listen and check the authenticity of the data (Oates, 2006). Data transcription involved translating the interview conversions into a text document word by word together with the comments captured during the interviews. The comments were important in giving a transcript a complete picture of the proceedings, giving visuals of the feelings and experiences of the interviewee.

The data analysis method employed in this study was the Framework Analysis method (Ritchie & Spencer, 1994). The advantage of the Framework Analysis method is that it is inductive and has systematic stages of analysing data. It allows the incorporation of prior categories and themes that arose from literature analysis to lead data classification. The stages for data analysis were familiarisation, identifying a thematic framework, indexing, charting, mapping and interpretation. This study employed NVivo CAQDAS software for data management and analysis.

Denscombe (2007, p.200) warned that there is no "absolute way of verifying what someone tells you about their thoughts and feelings". Denscombe (2007) suggested four ways in which the researchers could check the authenticity of what the interviewee has said, and they are:

- Compare the captured data with other sources.
- Verify the transcript recording with the informant.

- Check the believability of the data.
- Look for themes in the transcript(s).

This research adopted these validity checks in authenticating the interview data.

3.7 Data analysis

This study was designed as a single case study with embedded units of analysis and the data analysis was done at two levels. The first level of analysis was the *within case analysis*, where each embedded unit of analysis was analysed and emerging themes were compared (Creswell, 2009). The second level of analysis was the *holistic case analysis*, where the entire case was analysed and presented as descriptions, themes and interpretations (Creswell, 2009).

This study employed mixed methods to collect data that included qualitative and quantitative data. Qualitative data included policy document analysis (discussed in Section 3.6.1), tool observation analysis (discussed in Section 3.6.2) and one of the student surveys (discussed in Section 3.6.3.1) and lecture interviews (discussed in Section 3.6.4). Policy document analysis, student survey and lecturer interviews were analysed using the Framework Analysis method (Ritchie, Spencer 1994). For the tool observation analysis (discussed in Section 3.6.4), data was qualitatively analysed using a protocol developed in this study. The quantitative data analysis was used for analysing student data collected through surveys (discussed in Section 3.6.3.2 and 3.6.3.3).

The themes that emerged from each stage of data analysis were compared with the existing literature (Eisenhardt, 1989). Eisenhardt (1989) argued that "tying the emergent theory to extant literature enhances the internal validity, generalisability and theoretical level of theory building from case research" (Eisenhardt, 1989, p.545). On the other hand, data analysis was grounded in the context of the case study, since one of the strengths of case study research is studying a phenomenon in its natural setting (Benbasat et al., 1987). Finally, data from different sources was triangulated in Chapter 6, where the *holistic case analysis* was undertaken to build the *Framework for providing mobile centric services to students at HEIs in the context of ODeL in South Africa.*

3.8 Research credibility

The credibility or the trustworthiness of research results is measured in terms of validity and reliability (Brink, 1993). The terms validity and reliability have been defined differently depending on whether the study is quantitative or qualitative (Golafshani, 2003). Section 3.8.1 discusses validity and reliability of quantitative data collected in this study and Section 3.8.2 discusses the trustworthiness of qualitative data collected in this study.

3.8.1 Quantitative data validity

Validity is concerned with whether the research truly measures what it was intended to measure, which is the accuracy and truthfulness of scientific findings (Saunders et al., 2009). This is also known as construct validity. Construct validity is concerned with the extent to which the theoretical constructs of the study are adequately translated into a data collection instrument that measures a phenomenon (Wynd, Schmidt, & Schaefer, 2003). Literature agrees on three stages of developing an assessment instrument that meets the construct validity criteria (Agarwal, 2011; Tojib & Sugianto, 2006; Westen & Rosenthal, 2003). The three stages are presented below and validated on how each of the stages was achieved in this study.

- Stage 1: Literature analysis and domain conceptualisation, which is concerned with defining the constructs to be measured. The sub dimensions of each construct are identified and converted into specific elements of an assessment instrument. In this study, literature analysis described in Chapter 2 resulted in the development of the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). The constructs of the conceptual framework informed the design of questionnaires for student surveys (discussed in Section 3.6.2).
- Stage 2: Expert evaluation, which is concerned with asking a panel of experts to evaluate the validity of each of the identified constructs of the conceptual framework and the elements of the data collection instrument. The conceptual framework developed in this study was peer reviewed and published in the proceedings of a conference (Chipangura, 2013). The promoters who supervised this study also served as the experts who evaluated the validity of the elements of the data collection instruments.
- Stage 3: Compilation of the data collection instrument, which is concerned with retaining important constructs and elements identified by the experts. In this study, the compilation of data collection instruments was a cyclic process. That is, after constructing a data collection instrument, it was sent to supervisors and then to a statistician for reviewing. Feedback from supervisors and statisticians was incorporated and sent back for further review until consensus was reached.

  The questionnaires developed in this stage were evaluated for face validity. Face validity is defined as the degree to which a measure is clearly and unambiguously tapping the constructs it purports to measure (Bornstein, Rossner, Hill, & Stepanian, 1994). It is concerned with how the respondents perceive the asked questions as being clear and understandable (Nevo, 1985). Nevo (1985) suggested that face validity can be evaluated by asking participants to evaluate the purpose of an instrument. In this study, the questionnaires were pilot tested by a group of seventeen Honours Computer Science students. The students were requested to ask for clarification whenever the questions were

not clear. The input from the pilot test was used to update the respective data collection instruments.

3.8.2 Reliability

Reliability refers to the consistency of a measuring instrument when applied to similar circumstances (Antonius, 2012). In this study, the statistical method used to test the reliability of the constructs of the questionnaire for Students survey 3 was Cronbach's alpha. The results of the reliability test are provided in Section 4.6 (Chapter 4).

3.8.3 Qualitative trustworthiness

In qualitative research, the terms validity and reliability are considered inappropriate for measuring the trustworthiness of qualitative studies (Creswell & Miller, 2000; Davies & Dodd, 2002; Fidel, 1993; Lincoln & Guba, 1985). Lincoln and Guba (1985) deviated from the terms validity and reliability and proposed measures of qualitative trustworthiness as credibility, transferability, dependability and confirmability. The terms were explained as follows:

- Credibility is concerned with the truth of the findings of an enquiry (Guba & Lincoln, 1985). That is, the findings should match the reality (Merriam, 1998). Guba and Lincoln (1985) suggested five strategies that researchers can employ for improving the credibility of a study. The strategies are prolonged engagement, reflexivity, triangulation, peer and participants debriefing, and member checks. Similarly, Creswell and Miller (2000) suggested eight strategies and they are prolonged engagement and persistent observation in the field, triangulation, peer review debriefing, negative case analysis, clarifying, member checking, thick descriptions and external audits.
- Transferability is concerned with showing that the findings of a research can be applied to a similar situation. To ensure transferability of research findings, Lincoln and Guba (1985) recommended researchers to provide detailed research methodology that outlines the methods used for data collection, analysis and sampling criteria. During the research, the investigators are recommended to collect thick descriptive data that define the characteristics of the research context. Thick descriptions would provide the necessary documentation from which other researchers can learn about how the findings can be used.
- Dependability is concerned with consistently producing accurate results from a research if it is repeated under the same conditions (Oates, 2006). Fidel (1993) argued that it would be impossible to replicate qualitative findings because life is dynamic and ever changing. To increase the chances of dependability in qualitative research Lincoln and Guba (1985) recommended researchers to employ stepwise replication and inquiry audits.
- Confirmability is concerned with ensuring that the research findings are free from the researcher's bias. The results have to reflect the lived experiences and perceptions of the

informants. To guard against researcher bias, Lincoln and Guba (1985) recommended researchers to do triangulation of methods and data sources, to practice reflexivity and to carry a confirmability audit trail.

Lincoln and Guba (1985)'s model has been criticised by other scholars (Morse, Barrett, Mayan, Olson & Spiers, 2002) as providing external post hoc research verification measures that do not focus on providing a researcher with verification measures during the study. Without a verification measure during the course of the research, the fear is that the researcher would not realise reliability and validity threats until it is too late to correct them. Morse et al., (2002) argued that the trustworthiness measures proposed by Lincoln and Guba (1985) are appropriate evaluation measures for external reviewers at the end of a research rather than the researcher. In such circumstances, Morse et al., (2002) observed that there would be clashes between the ideal world perspectives of the evaluator and real world perspectives of the researcher. In this respect, Morse et al., (2002), viewed trustworthiness measures introduced by Lincoln and Guba (1985) as useful for evaluating rigor yet they do not ensure rigor themselves.

Based on the weakness of Lincoln and Guba's (1985) trustworthiness measures, the following strategies for ensuring research rigour were proposed: investigator responsiveness, methodological coherence, sampling adequacy, active analytic stance (Morse et al., 2002). The strategies were defined as follows:

- Investigator responsiveness refers to the researcher's creative, flexibility, sensitivity and skill in using verification strategies.
- Methodological coherence is concerned with aligning the research question with data collection methods.
- Sampling adequacy is concerned with the researcher's ability to select the appropriate samples that are made up of people with knowledge of the topic.
- Active analytic stance is concerned with collecting and analysing data concurrently.

In this study, the measures that were taken to improve the credibility of the study are summarised in Table 3.14.

Table 3-14: Research credibility validation

Validation strategy	Application in this study
Prolonged engagement	The researcher joined the university in 2009 as a lecturer and started researching on the provision of mobile centric services to students at the university in 2011. The researcher acclimatised with the university environment and established relationships with other lecturers and students. Therefore, the researcher has been at the university long enough to understand how the university operates.
Methodological coherence	The research started with the main research question that guided literature analysis. Literature analysis led to the development of a conceptual framework (Chapter 2). The components of the conceptual framework informed the selection of units of analysis, construction of data collection tools and sampling of data sources. Purposeful sampling was employed to select knowledgeable participants (discussed in Section 3.5).
Triangulation	The research employed multi methods to collect data. The methods included literature analysis (discussed in Chapter 2), lecturer interviews, student surveys, document analysis and tool observation (discussed in Section 3.5). Methodological triangulation and data triangulation were performed in this study (discussed in Section 3.8).
Peer review or debriefing	The research was supervised by two promoters who monitored all the research processes, which included literature analysis, research design, data collection, analysis and the write-up. In addition, expert peer blind reviews were performed through the publication of this research in two journal papers, and, local and international conference proceedings (discussed in Section 7.4.1).
Rich and thick descriptions	The research provides data about the participants and research context. Thick descriptions were provided on qualitative data results to give readers enough information.
Audit trail	The research process is documented in this study and all data analysis reports are attached as appendices in this study.
Inquiring audit	The supervisors were the main auditors of this study.

3.9 Triangulation

The strength of case study research is in gathering and validating the same evidence from multiple sources in order to get a holistic view of a phenomenon under study (Benbasat et al., 1987). This is called triangulation (Benbasat et al., 1987; Cohen et al., 2007; Creswell, 2009). The approach of collecting the same evidence from multiple sources is called the mixed method approach (Gillham, 2000; Kohlbacher, 2006). Kohlbacher (2006) maintains that the strength of mixed method data collection is that the weakness of each method is overcome by other methods and triangulation of data improves credibility of the results. The strength of triangulation is to establish consistency across evidence collected from different sources (Yin, 2009). Gillham (2000) argues that if evidence obtained from multi sources converges, the true picture of the phenomenon is revealed. If there is no convergence, then cautiousness should be exercised in making conclusions about the phenomenon.

Triangulation of evidence can be achieved in four ways, namely data triangulation, investigator triangulation, theory triangulation and methodological triangulation (Denzin & Lincoln, 2005).

This study adopted methodological triangulation and data triangulation. Methodological triangulation was achieved by employing multi methods to collect data, which included policy document analysis (discussed in Section 3.6.1), tool observation analysis (discussed in Section 3.6.2), student surveys (discussed in Section 3.6.3) and lecturer interviews (discussed in section 3.6.4). Data triangulation was based on data collected from different sources but analysed based on the same units of analysis (discussed in Section 3.5.2).

3.10 Chapter summary

This Chapter discussed the philosophical stance, the strategy, identified the units of analysis, formulated investigative research questions and designed the data collection instruments. The Chapter completes Phase 2 of this study. The data collection instruments designed in this Chapter were employed to collect data within a single case study with embedded units of analysis. The following Chapter focuses on data analysis.

Chapter 4: Data analysis results (Part 1: Policy analysis, Tool observation and Student surveys)

4.1 Introduction

This Chapter presents the first part of data analysis results that answers sub research question 2, which reads *"To what extent does practice in HEIs reflect the components for providing students with mobile centric information access and interaction at HEIs?"* The answer to the research question provides the knowledge base for developing the *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa (presented in Section 6.3).* Data that was analysed in this Chapter was collected using the mixed methods design, therefore both qualitative and quantitative data were analysed. Figure 4.1 gives an overview of the Chapter.

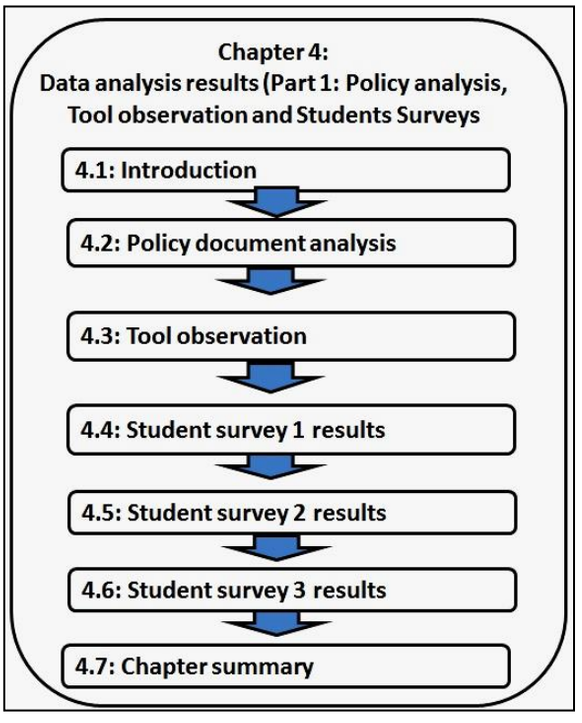


Figure 4-1: Overview of Chapter 4

The discussion continues as follows: Section 4.2 discusses policy document analysis, Section 4.3 discusses tool observation analysis, Section 4.4 focuses on student survey 1, Section 4.5 discusses student survey 2, Section 4.6 discusses student survey 3 and Section 4.7 presents the chapter summary.

4.2 Policy document analysis results

The goal of policy document analysis was to reflect on the readiness of university policies in supporting the provision of mobile centric services. The reflection focused on the support given to lecturers and students in terms of mobile centric resources. The research question that guided the

document analysis was, "*What is the status of the university policy on the provision of mobile centric services?"*

The policies sampled and analysed fall into two categories, which are ICT related policies, and Teaching and Learning related policies. The ICT related policies were:

- the ICT Mobile Device policy,
- the Telephone and Cellphone policy,
- the Policy on Sending SMS and
- the Email, the Internet, Electronic Communication and Web Management policy.

The Teaching and Learning related polices were:

- the Tuition policy,
- the Assessment policy,
- the Curriculum policy and
- the Open and Distance Learning (ODL) policy.

The policies are available on the university website and are accessible to all members of the university (UNISA, 2015b). The policy document analysis was carried out between 1 September 2014 and 30 October 2014.

The discussion continues as follows: Section 4.2.1 discusses the purpose of the analysed policies, Section 4.2.2 discusses the implications of the policies on lecturers and students, Section 4.2.3 discusses the mobile infrastructure support, Section 4.2.4 discusses mobile communication and interaction support, Section 4.2.5 discusses the provision of mobile services support, and Section 4.2.6 discusses the provision of mobile content support. Appendix 11 presents the policy analysis protocol.

4.2.1 Purpose of the policies

Policy document analysis examined the purpose of the policies and the support that they give in providing mobile centric services. The results revealed that the university has three policies specifically written to regulate information access and interaction through mobile cellular technology. The policies are the *ICT mobile device policy; the Telephone and cellphone policy; and the Policy on sending SMS and email to students*. The other analysed policies were written for other purposes rather than providing guidelines for the use and provision of mobile centric services at the university. For example, *the ODL policy; Tuition policy;* and *the Curriculum policy,* which all provide direction on teaching and learning. Even though the purpose of the Teaching and Learning policies is not to regulate the use and provision of mobile centric services at the university, they inform on the integration of technologies in teaching and learning.

4.2.2 Implications of the policy on lecturer and student training

The policies that address the issue of lecturer training are *the Tuition policy, the Open distance learning policy* and *the Curriculum policy*. Two of the policies, *the Tuition policy* and *the Open and distance learning policy* address the issue of lecturer training in general and do not specify the type of training that a lecturer could receive from the university. The two policies state that the university provides lecturers with opportunities for professional development. In this respect, *the Curriculum policy* explicitly states that lecturers would receive adequate training that would enable them to develop, implement, and experience e-learning or m-learning. Therefore, the policy explicitly supports training for providing mobile technology services. That is, lecturers could receive training on mobile technology communication, interaction and content design. With respect to students, the Teaching and Learning policies generically require lecturers to support students through technologies in terms of communication, access to resources and interaction.

4.2.3 Mobile infrastructure support

Policy document analysis examined the strategy that the university employs in providing mobile infrastructure to lecturers and students. Three of the ICT polices specify the infrastructure that the university provides to the users. The three policies are *the Internet, electronic communication and web management policy; the ICT policy;* and *the Telephone and cellphone policy*. The other policies do not address the provision of infrastructure. In terms of mobile technologies hardware, the university supports the use of cellphones and any other handheld devices. The university employs three models in supporting the provision of infrastructure to the users. The models are *Bring Your Own device (BYOD) model*, *University funded devices and Research funded devices*. The BYOD allows students, lecturers and visitors to access the university networks on condition that their devices meet the security regulations of the university. The *ICT mobile device policy* requires users to be responsible for the security and cost of their BYODs. The other models, *the University funded device model* and *Research funded device model* require that the users purchase and insure the devices in their names and receive reimbursements from the university.

4.2.4 Mobile phone communication and interaction support

The Teaching and Learning policies addressed the issue of mobile communication and interaction in a broad way, only mentioning the use of ICT in general. The issue of mobile communication and interaction is addressed more specifically by the ICT policies. The policies provide guidelines on how lecturers could use university resources for communicating with students. The university expects lecturers to use the landline telephone systems during working hours and only provides professors who work from home with a telephone allowance. The *Policy on sending SMSs and emails to students* provides a code of conduct of how lecturers could communicate and interact with students. The lecturers are obliged to oversee and quality control all subject specific messages

sent to their students. On the students' side, the policy stipulates that it is compulsory that all students receive subject specific SMSs or emails. The policy also stipulates that students could use SMSs to interact with some university systems that provide them with services such as exam results, retrieving contact information, or general enquiries.

Document analysis in this study established that *the Policy on Sending SMS and email to students* requires line managers to approve all SMS messages before they are sent to students. This bureaucratic condition could block some lecturers from communicating with students through SMS. In this regard, the UNESCO policy guideline on mobile learning advised that policies should strive to provide access for all (Kraut, 2013).

The *Internet, electronic communication, and web management policy* encourages lecturers to use communication technologies innovatively to enhance teaching and learning in ODeL. The policy recommends internet resources that could be used on the university network for communicating and interacting with students. For example, the policy discourages the use of video-based telephone applications such as SKYPE due to the limited bandwidth. On the other hand, the policy recommends the use of Instant messaging applications for communicating with students. Therefore, the university policies seem to support mobile technology communication and interaction.

4.2.5 Mobile phone resources support

Policy document analysis examined how the policies support the provision of mobile centric services at the university. Five policies support the provision of mobile centric services at the university. Three of the policies generically support the provision of mobile centric services to students and do not specify the supported services. The three policies are *the ODL policy; the Tuition policy; and the ICT policy and the Internet, electronic communication and web management policy*. The other two policies, *the ICT mobile device policy* and *the Policy on sending SMS and email to students* explicitly state the mobile centric services supported by the university. The *Policy on sending SMS and email to students* listed services that students could access and interact with through mobile devices. The services include SMS based applications for tracking study material courier, checking exam timetables, tracking library book requests and reminders, just to mention a few. The other policy, the *ICT mobile device policy* specified that students could access Eduroam services through their mobile phones.

4.2.6 Mobile phone content support

Policy document analysis examined how the policies support the provision of mobile phone content. Three policies address the issue of providing mobile content broadly. The three policies

are *the Internet, electronic communication and web management policy; the ODL policy;* and *the Tuition policy*.

The *Tuition policy* and *the Internet, electronic communication and web management policy* only state that students should be supported with electronic resources that facilitate learning. The ODL policy states that learning material should be formatted in a form that facilitates electronic delivery. Therefore, if the policy requires content to be formatted for electronic delivery, it caters for mobile phone delivery. On the other hand, policy document analysis could not find guidelines or frameworks that guide lecturers in designing and providing mobile content.

4.2.7 Summary of policy document analysis

The university has several policies that guide the provision of teaching and learning services through mobile technology. Furthermore, policy document analysis could not find concrete frameworks or models for providing lecturers with best practices or guidelines that support lecturers when providing mobile centric services.

4.3 Tool observation analysis results

The goal of the Tool observation analysis was to reflect on the Resources component of the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). The analysis focused on identifying mobile phone tools that the university provides to lecturers and students. The research question that guided the document analysis was, *"Which mobile cellular technology tools are provided by HEIs that facilitate students' information access and interaction?"*

The results are discussed under the following themes: Section 4.3.1 discusses communication resources, Section 4.3.2 discusses access to learning resources, Section 4.3.3 discusses interaction tools and Section 4.3.4 discusses mobile apps. Appendix 10 presents the Tool observation data analysis.

4.3.1 Communication resources

Four tools that provide mobile phone communication were identified. The tools are SMS, email, fixed telephone and discussion forums. The tools provide interfaces for communication between students and lecturers. Three of the tools, the SMS, email and discussion forums are accessible through the Learning Management Systems (LMS) mobile website. Lecturers have administrative privileges and could access the tools from a desktop computer as well as from a mobile phone. On the other hand, students do not have administrative privileges on the university SMS tool and

cannot use it to send messages to lecturers or other students. The students use SMS on their phones and have to pay for the cost.

Lecturers and administrators have access to fixed line telephones, which they use for calling students on their mobile phones. Officially, students can call and seek for help from any lecturer at any time during working hours. When out of office, lecturers either route their office numbers to their mobile phone numbers or provide students with their mobile phone numbers in order for students to reach them. The study established that the university discontinued call centre services for students' administrative enquiry. The students are required to either SMS or email messages to enquire with the university's administration department.

4.3.2 Access to learning resources

The LMS mobile website provides services that allow lecturers to provide students with learning resources. Through the LMS mobile website, lecturers can provide reading material, lecture summaries (learning units), assignments, self-assessments and podcasts. Students can access learning resources through the LMS mobile website. The LMS mobile website has a Drop box facility, which enables lecturers to share documents with students. Students can use the Drop box facility for submitting portfolios of evidence to lecturers or share reading material.

4.3.3 Interaction tools

The interaction tools accessible to students and lecturers were discussion forums, SMS and fixed telephone. Fixed telephone is the official real time interaction channel between students and lecturers. Lecturers have unlimited access to the fixed telephone systems when doing university business. University business includes calling students on their mobile phones with regard to teaching and learning matters. Discussion forums are the main asynchronous platform that provides interaction amongst students and lecturers. The other tool that provides interaction is the SMS tool. The university's SMS system does not provide interaction opportunities amongst students and lecturers. Lecturers can broadcast SMS announcements to students but do not have the privilege to receive messages from students.

4.3.4 Mobile apps

Tool observation analysis identified some specialised mobile phone applications provided by the university. The applications are the SMS application tool, Interactive Voice Response tool, Multiple Choice Assignment (MCQ) submission tool.

SMS application tool

The SMS application tool provides an interface for broadcasting important notifications such as exam results, due dates for assignments, exam dates, and registration dates to students. An SMS broadcast could be targeted at all the students, or a group of students. The SMS application tool also provides a service for tracking students' courier parcels. A message indicating a track number, trace number and dispatch date is forwarded to students. Students can also send SMS administrative queries to the university and the university would in turn call or email them a response.

Interactive Voice Response (IVR) tool

IVR is a tool that allows a computer to interact with humans using voice and Dual Tone Multi Frequency Signalling keypad inputs. The IVR tool allows students to interact with the examination results database via mobile phone voice call. Students access the IVR by dialling some specific telephone number to get their results.

Mobile Multiple Choice (MCQ) Assignment submission tool

The MCQ assignment submission tool is a Java based application that is downloadable from the LMS mobi site. To submit an assignment on the application, students must first login. The tool provides an interface where students can capture answers to the assignment questions, submit answers, receive an immediate confirmation for a successful submission, and view the memorandum after submission.

4.3.5 Summary of tool observation analysis

The results established that the university provides lecturers and students with tools that facilitate mobile phone communication, interaction and access to resources. The tools are accessible through the LMS mobile web site. Table 4-1 categorises and summarises the mobile phone resources observed during tool observation.

Table 4-1: Mobile phone tools provided by the university

Communication tools	Interaction tools	Access to resources tools
• SMS • Email • Telephone • Discussion forums	• MCQ assignment submission tool • IVR tool • SMS parcel tracking tool • Discussion forum	LMS Mobi site: Lecturers can provide students with: • Learning units • Reading material • Self-assessment • Podcast • Drop box

4.4 Student Survey 1 results

This section reflects on the Needs component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The research question that directed

data collection was, "*Which services do students want to access and interact with through mobile cellular technology?*" A survey was used to collect qualitative data from students.

Student survey 1 had three open-ended questions (see Appendix 5). The first question asked students their general information access and interaction needs (discussed in Section 4.4.1). The second question asked students their mobile centric information access and interaction needs (discussed in Section 4.4.2), and the third question asked students the activities that they would want to do on their mobile phone devices (discussed in Section 4.4.3).

4.4.1 Students' general information needs

The first question asked students about their general information needs and the question was, *"What are the general information needs of students?"* A total of 50 students responded to the question and all the scripts were qualitatively analysed. From the 50 scripts that were analysed, 27 themes of student needs were identified. The identified student needs are presented in Table 4-2 and Figure 4-2.

Table 4-2: General student needs

General students' needs		
1. Study material	2. Due date reminders	3. Discussion forums
4. Reference articles downloads	5. Announcements	6. Timetable/calendar
7. Course information	8. Results	9. Reminders
10. Email	11. Student fees	12. Assignment solutions
13. Contact details	14. Assignment submission	15. Prescribed books
16. E-library	17. Talk to lecturer	18. Registration procedures
19. Talk to other students	20. Multimedia material	21. Tutorial material
22. Venues	23. Feedback	24. Exam tips
25. Counselling information	26. Parcel tracking	27. Rules and procedures

Figure 4-2 presents the General needs frequency graph. The five most popular students' general needs were study material, assignment due dates, discussion material, reference article downloads and course announcements. The least popular needs were rules and procedures, parcel tracking and counselling information.

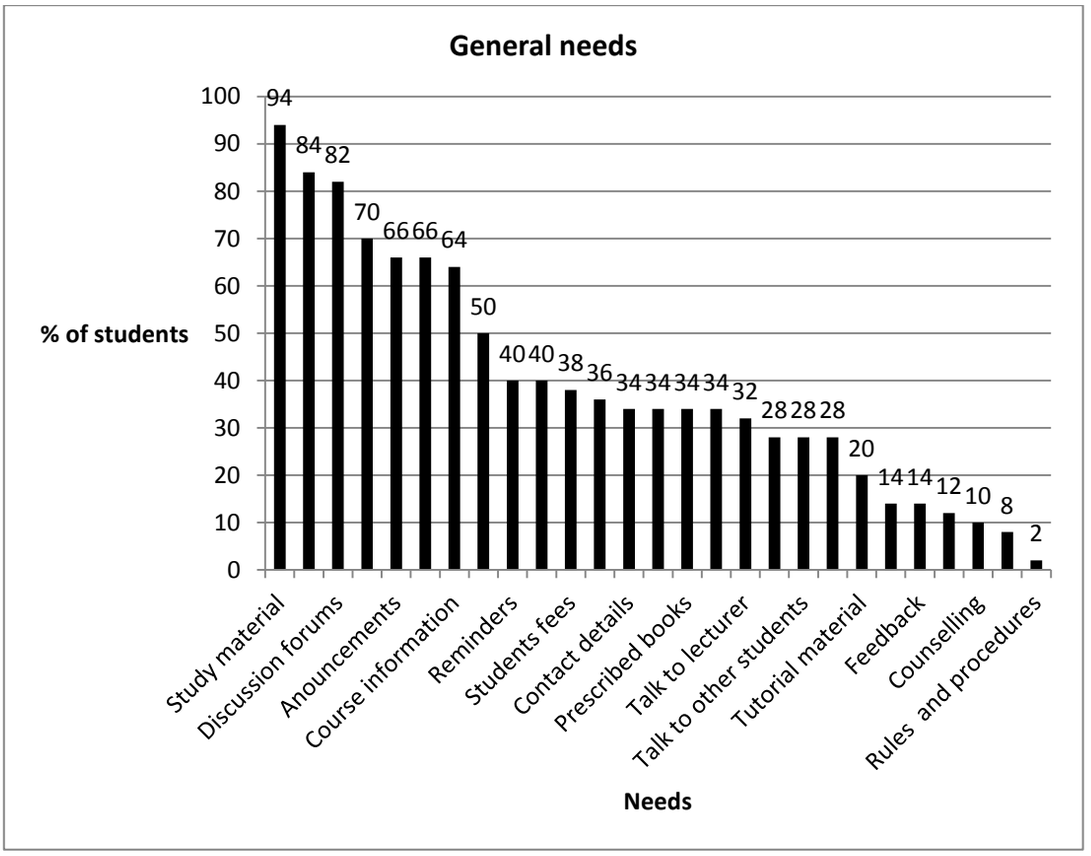


Figure 4-2: General needs frequency graph

4.4.2 Students' mobile centric needs

The second question asked students about the information and resources that they would like to access and interact with on their mobile phones and the question was, *"What kind of information and resources would students prefer to access and interact with on a mobile phone?"* A total of 50 students responded to the question. Qualitative data analysis of the 50 scripts identified 18 themes of students' needs. Table 4-3 and Figure 4-3 present the identified needs.

Table 4-3: Mobile phone needs of students

Mobile centric needs		
1. Announcements	2. Assignment results	3. Due date reminders
4. Exam results	5. Discussion forums	6. Timetable/calendar
7. Venues	8. Student fees	9. Study material
10. Podcasts	11. Registration dates	12. E-library
13. Feedback	14. Lecture summaries	15. Exam tips
16. Photos	17. Maps/directions	18. Self-assessment

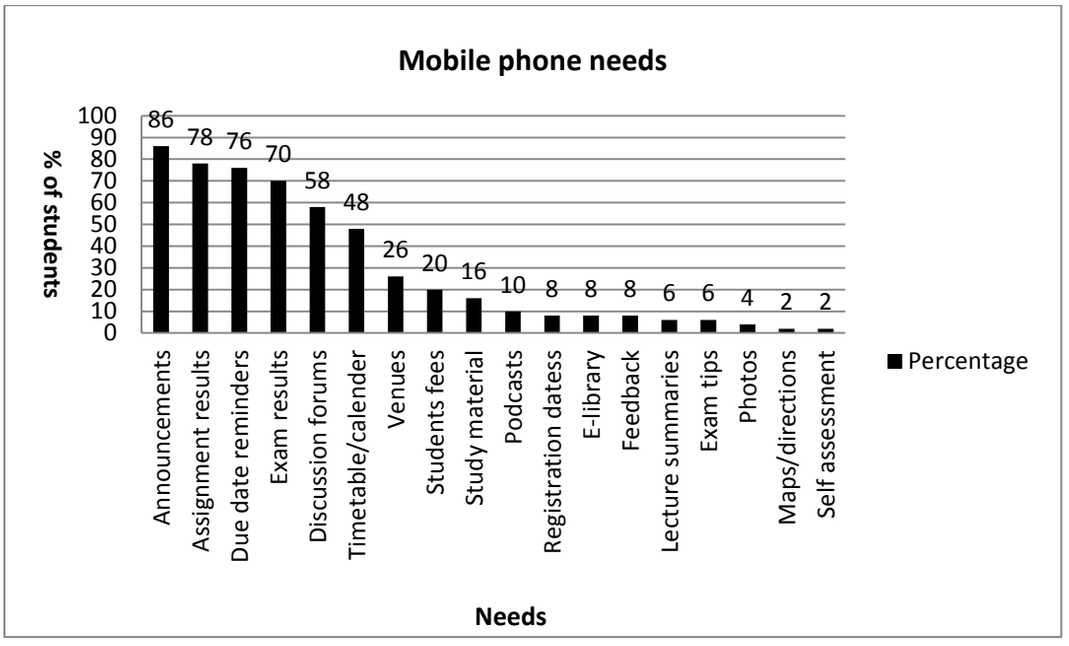


Figure 4-3: Mobile phone needs frequency graph

Figure 4-3 presents the Mobile phone needs frequency graph. The results show that the five most popular mobile phone needs were announcements, assignment results, due date reminders, exam results and discussion forums. The least popular mobile phone needs were self-assessment, maps/directions, photos, exam tips and lecture summaries.

4.4.3 Mobile learning activities needs

The third question asked students about the activities that they would want to do on a mobile phone, and the question was, "*What kind of learning activities would students prefer to do on a mobile phone?"* Qualitative data analysis identified 15 themes of activities that students would like to do on mobile phones. The identified themes are presented in Table 4-4 and Figure 4-4.

Table 4-4: Mobile learning activities

Activities	
1. Discussion forum	2. MCQ assignments
3. Feedback	4. SMS
5. Podcasting	6. Sharing information
7. Study material	8. E-booking
9. M-library	10. Mobile researching
11. Downloads	12. Telephone conversations
13. Surveys	14. Exam preparation
15. M-dictionary	

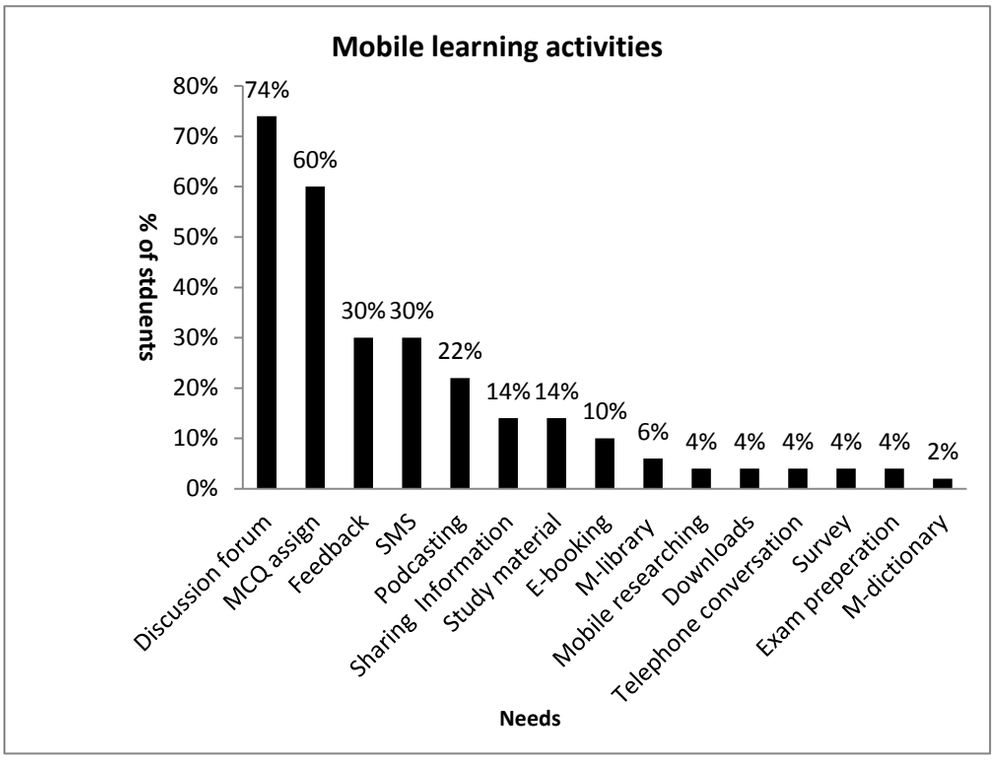


Figure 4-4: Mobile learning activities frequency graph

Figure 4-4 presents the Mobile learning activities frequency graph. The graph shows that the most popular learning activities that the students would prefer to do on mobile phones are discussion forum interactions, MCQ assignments and SMS interactions. The least popular activities that the students would want to do on a mobile phone are searching an online dictionary, exam preparations, responding to surveys, telephone conversations and downloading reading material.

4.4.4 Summary of survey 1 results

The results from the second and third questions were combined to come up with a complete list of mobile centric needs of students. The mobile centric needs were compared with the general information access and interaction needs of students as presented in Table 4-5.

Table 4-5: Comparison of general information needs against mobile centric needs

General information needs	Mobile centric information needs	Final list of mobile centric needs
Announcements	Announcements	Announcements
Assignment solutions	-	-
Assignment submission(Written)	Assignment submission(Written)	Assignment submission(Written)
Contact details	-	Contact details
Course Information	-	Course information
Discussion forums	Discussion forums	Discussion forums
e-library	e-library	e-library
Maps and directions	Maps and directions	Maps and directions

General information needs	Mobile centric information needs	Final list of mobile centric needs
Multimedia course resources	Multimedia course resources	Multimedia course resources
Parcel tracking	-	Parcel tracking
Practice exams	Practice exams	Practice exams
Article downloads	Downloads	Downloads
Registration procedures	Registration procedures	Registration procedures
Reminders	Reminders	Reminders
Rules and procedures	-	Summary of rules and procedures
Counselling services	-	-
Students fees	Student fees	Student fees
Students results	Student results	Student results
Study material	Study material	Study material
Talk to the lecturer	Telephone conversation	Telephone conversation
Timetables	Timetables	Timetables
Tutorial material	-	-
Unisa venues	Unisa venues	Unisa venues
	Feedback	Feedback
	Lecture summaries	Lecture summaries
	SMS chatting	SMS chatting
	e-books	e-books
	m-library	m-library
	m-research	m-research
	m-dictionary	m-dictionary
	MCQ assignment	MCQ assignment
	Course survey feedback	Course survey feedback
	Share information	Share information
	Self-assessment	Self-assessment

Table 4-5 shows that the mobile centric needs are almost similar to the general information access and interaction needs but with some differences. There are information needs that students would not want to interact with through a mobile phone. Examples of the needs include assignment solutions, contact details, course information, parcel tracking, rules and procedures, counselling services and tutorial material. There are activities that students would only like to do on mobile phones. The activities are at the bottom of the table and they include feedback, lecture summaries, SMS chatting, e-books, m-library, m-research, m-dictionary, MCQ assignments, course survey feedback, sharing information and self-assessment. The difference between the general information access and interaction needs, and the mobile centric needs of students does not present a large gap between the needs. Hence, the two lists of needs were combined to come up with a list of mobile centric needs of students. On the final list, three needs from the general information access and interaction needs were omitted and they are assignment solutions, counselling services and tutorial material. The elements were omitted because they were not important to access and interact with on mobile phones. The final list of the mobile centric information access and interaction needs of

students informed the design of the second questionnaire of this study. The following section discusses the second questionnaire results.

4.5 Student survey 2 results

The aim of the data analysis was to rank the needs according to student needs. Ranking the needs is important since it is difficult to provide for all the needs. Focusing on the essential needs can allow a more effective approach to dealing with the provision of the mobile centric needs. The needs were ranked based on two measures, the perceived importance of the need and the perceived frequency of access of the need. The survey consisted of two questions (see Appendix 6), one question focused on the perceived importance of the needs (Section 4.5.1) and other focused on the perceived frequency of access of the needs (Section 4.5.2). Both questions were Likert scale based. A total of 84 honours students responded to the survey questions.

4.5.1 Perceived importance of the needs

Question 1 asked students to rank the importance of 16 mobile centric needs that were identified from Student survey 1.

Table 4-6: Importance of mobile centric needs

	Not Important		**2**		**3**		**4**		**Very important**	
Item	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**
1. Exam results	0.00%	0	1.19%	1	7.14%	6	17.86%	15	**73.81%**	62
2. Assignment results	0.00%	0	0.00%	0	6.98%	6	23.26%	20	**69.77%**	60
3. Exam timetable	1.18%	1	4.71%	4	15.29%	13	15.29%	13	**63.53%**	54
4. Study material	4.65%	4	6.98%	6	15.12%	13	11.63%	10	**61.63%**	53
5. Assignment feedback	1.16%	1	4.65%	4	5.81%	5	29.07%	25	**59.30%**	51
6. Due date reminders	1.18%	1	3.53%	3	18.82%	16	18.82%	16	**57.65%**	49
7. Announcements	3.53%	3	5.88%	5	7.06%	6	34.12%	29	**49.41%**	42
8. Lecture summaries	2.33%	2	10.47%	9	19.77%	17	24.42%	21	**43.02%**	37
9. Course podcasts	4.71%	4	8.24%	7	20.00%	17	24.71%	21	**42.35%**	36
10. Tutorial and exam venues	2.33%	2	9.30%	8	23.26%	20	26.74%	23	**38.37%**	33
11. Library access	11.76%	10	10.59%	9	23.53%	20	16.47%	14	**37.65%**	32
12. Discussion forums	3.53%	3	9.41%	8	23.53%	20	27.06%	23	**36.47%**	31
13. Registration dates	3.49%	3	9.30%	8	24.42%	21	26.74%	23	**36.05%**	31
14. Self-assessment	14.29%	12	5.95%	5	19.05%	16	36.90%	31	**23.81%**	20
15. Student fees enquiry	18.82%	16	17.65%	15	24.71%	21	22.35%	19	**16.47%**	14
16. Campus maps and directions	29.27%	24	24.39%	20	19.51%	16	14.63%	12	**12.20%**	10

The question reads, *"How would you rank the importance of each of the needs on a scale of 1 to 5, where 1 = not important and 5 = very important, for the implementation of a mobile information*

access in the ODL environment?" Table 4-6 presents the results of students' responses to the question. The results are presented as a percentage of population (N) responses per Likert scale.

The results presented in Table 4-6 shows the perceived importance of the needs based on a Likert scale rating. The needs that had the highest responses on the *Very important* category were regarded as the most important and are at the top of the list. The reverse is true for the least important needs.

The results presented in Table 4-6 shows that the top five needs that students perceived as important for mobile phone access are related to assessments. The needs are exam *result (73.81%), assignment results* (69.77%), *exam timetable* (63.53%), *study material (61.63%)* and *assignment feedback* (59.30%). Even though the S*tudy material* need ranked among the top five, the frequency count of students who regarded it as *Not important* (4.65%) was above that of the other needs, for example *Assignment feedback (1.16%), Due date reminders (1.18%), Announcements (3.53%).*

The results presented in Table 4-6 show that the least important needs for mobile phone information access are *Campus maps and directions (12.20%), Student fees enquiry (16.47%), Self-assessment (23.81), Registration dates (36.05%) and Discussion forums (36.47%).*

Among the least important needs, two of the needs, *registration dates* and *student fees enquiry* require minimum interaction with the system. Students could have found the needs not important because they are administrative needs that do not have a direct effect on daily learning. The other three needs that received low ranking were *Discussion forums, Self-assessment* and *Campus maps and direction*. These services could have received low ranking because they would require a lot of interaction through a mobile device.

4.5.2 Frequency of accessing the needs

The students were asked to rank how often they would access a given need when implemented on a system for mobile phone access. The question reads, *"How often would you access the need if it is implemented on a mobile phone system on a scale of 1 to 5, where 1 = not often and 5 very often?"* Table 4-7 presents the results and are presented as a percentage of population (N) responses per Likert scale.

Table 4-7: Frequency of accessing the needs

	Not Often		2		3		4		Very Often	
Item	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**	**% of Total**	**N**
1. Assignment results	3.53%	3	4.71%	4	25.88%	22	20.00%	17	**45.88%**	39
2. Exam results	14.29%	12	8.33%	7	19.05%	16	15.48%	13	**42.86%**	36
3. Announcements	6.02%	5	10.84%	9	9.64%	8	31.33%	26	**42.17%**	35
4. Due date reminders	7.06%	6	14.12%	12	23.53%	20	16.47%	14	**38.82%**	33
5. Course podcasts	16.87%	14	8.43%	7	15.66%	13	22.89%	19	**36.14%**	30
6. Discussion forums	14.29%	12	10.71%	9	19.05%	16	25.00%	21	**30.95%**	26
7. Study material	16.47%	14	14.12%	12	16.47%	14	23.53%	20	**29.41%**	25
8. Assignment feedback	9.30%	8	11.63%	10	18.60%	16	31.40%	27	**29.07%**	25
9. Lecture summaries	12.94%	11	20.00%	17	21.18%	18	14.12%	12	**31.76%**	27
10. Tutorial and exam venues	16.47%	14	12.94%	11	29.41%	25	15.29%	13	**25.88%**	22
11. Self-assessment	21.18%	18	10.59%	9	25.88%	22	17.65%	15	**24.71%**	21
12. Exam timetable	13.41%	11	17.07%	14	34.15%	28	14.63%	12	**20.73%**	17
13. Library access	27.38%	23	14.29%	12	21.43%	18	15.48%	13	**21.43%**	18
14. Registration dates	20.48%	17	21.69%	18	26.51%	22	13.25%	11	**18.07%**	15
15. Student fees enquiry	37.65%	32	24.71%	21	30.59%	26	4.71%	4	**2.35%**	2
16. Campus maps and directions	47.56%	39	26.83%	22	10.98%	9	3.66%	3	**10.98%**	9

Table 4-7 shows the prioritised order in which students would want to access the mobile centric needs. The prioritised order of access is based on a Likert scale rating. The need that received the highest frequency score on the *Very often* rating was ranked as the need that would be accessed frequently.

The top five needs that students would want to access are *Assignment results (45.88%), Exam results (42.86%), Announcements (42.17%), Due date reminders (38.82%) and Course podcasts (36.14%).* None of the top five needs has a frequency of access that is over 50%. The preferences of students in accessing the needs are spread across the Likert scale. Hence, students had different views on how they would access the mobile phone services.

Comparing the results presented in Table 4-7 and Table 4-6, the perceived importance of the needs are different from the perceived frequency of accessing the needs. For example, Table 4-6 shows that students perceived accessing *Exam results* as the most important need. Whilst Table 4-7 shows that students would most frequently access *Assignment results*. *Assignment result* had a high frequency of access because students write more assignments than they do exams.

Five needs with least frequency of access are *Exam timetable (20.73%), Library access (21.43%), Registration dates (18.07%), Campus maps and directions (10.98%) and Student fees enquiry (2.35).*The needs are similar to those regarded as least important in Table 4-6 except *Exam timetable*. *Exam timetable* was considered as an important need and was number 4 on the list with

63.53% of the students. The *Exam timetable* need could have received a low ranking on the frequency of access list because exams are written once a semester and there is no need for continuously accessing the need throughout the semester. Hence, importance of need does result in high frequency of access.

4.5.3 Summary of Student survey 2 results

Student survey 2 ranked mobile phone needs according to their importance and frequency of access. Data analysis established that the perceived importance of a need is not the same as the perceived frequency of access. However, needs that ranked on top of both tables are core in addressing challenges of accessing resources, communicating and interacting in ODeL. Students at ODeL universities are physically detached from the university and would need fast and reliable access to learning information. The learning information includes exam results, assignment results, course feedback, due dates and exam timetable. This is the information that the students indicated as important to receive on their mobile phones. The students also indicated that it is important to have access to resources such as discussion forums and assignment submission tools on a mobile phone. In ODeL context, lecturers are physically distant from students and can increase their presence by communicating with students frequently. The identified needs that can help in addressing the problem include sending announcements, alerts and reminders to the students.

4.6 Student survey 3 results

This section enhances the components of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6), which are Readiness, Needs, Resources, Context of use, and Constraints. The enhancement is based on the quantitative data collected from students through a survey (Appendix 7). A total of 129 students responded to the questionnaire. All the participants were third year students registered for a database course in 2013 in the School of Computing at the University of South Africa. The gender ratios of the students were 32% female and 68% male. The bar graph in Figure 4-5 shows the age distribution of the participants and has two outstanding bars. The first bar shows that 33% of the students were in the range of 25-29 years and the second bar shows that 32% of the students were over 35 years old. Students over 25 years were many because distance learning students tend to be mature students.

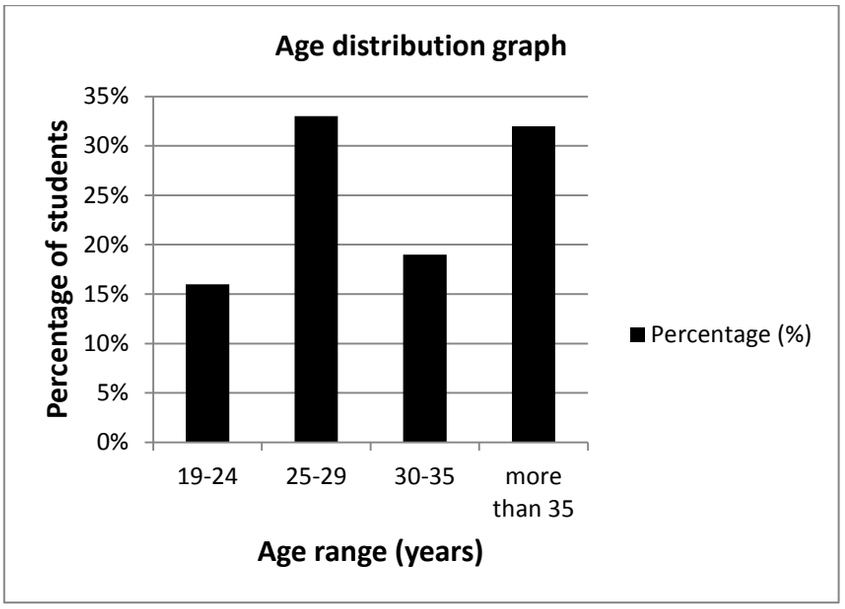


Figure 4-5: Age distribution graph

Regarding how students pay for their studies, the bar graph in Figure 4-6 shows that many students (60%) pay for their own studies. A small number of students (22%) indicated that their families pay for their studies. Few students had bursaries (16%) to pay for their studies and very few received funding from their employers (2%).

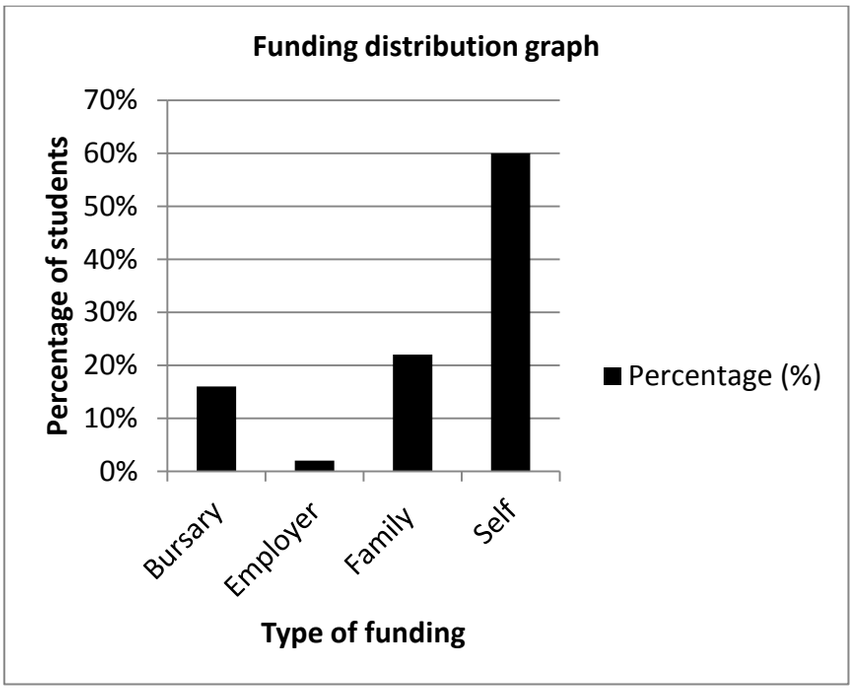


Figure 4-6: Study funding distribution graph

The presentation of Student survey 3 results continues in the following sections and reflects on the Readiness, Needs, Context of use and Constraints components of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs*.

4.6.1 Student readiness: ICT Infrastructure ownership

Section B of Student survey 3 (Appendix 7) measured students' mobile centric readiness. Question 5 measured students' mobile centric readiness based on ICT infrastructure ownership. Determining the ICT infrastructure ownership helped in comparing mobile phone ownership against other devices owned by the students. The students responded to a multiple choice question that required them to choose the ICT devices that they own from a list with a "*Yes" or "No"*. The question reads: *"Which of the following electronic communication devices do you own?"*

The data analysis results are presented in Table 4-8. All the students (100%) owned a mobile phone, followed by a laptop (81%), a printer (54%), a desktop computer (53%) and lastly an iPad/Tablet (53%).

Table 4-8: Device ownership

Which of the following electronic communication devices do you own?	**Yes**
Desktop computer	53.1%
Laptop computer	81.3%
Printer	53.9%
iPad/tablet	18.8%
Mobile phone	100.0%

This study investigated if *Gender*, *Age* and *Funding of studies* had an effect on infrastructure ownership using the Chi-squared test at $p = 0.05$.

i. Gender and Infrastructure ownership

The Chi-squared results showed that gender seemed to have a significant effect on owning a desktop computer ($\chi^2 = 4.025, DF = 1, p = 0.045$) or a printer ($\chi^2 = 4.528, DF = 1, p = 0.033$). On the other hand, gender seemed not to have a significant effect on owning a laptop computer or an iPad/Table PC.

ii. Age and Infrastructure ownership

The Chi-squared results showed that age seemed not to have a significant effect on owning a desktop computer, a laptop computer, or an iPad/Table PC. However, age seemed to have a significant effect on owning a printer ($\chi^2 = 9.731, DF = 3, p = 0.0210$).

iii. Funding and Infrastructure ownership

The Chi-squared results showed that funding seemed not to have a significant effect on owning a desktop computer, a laptop computer, printer or an iPad/Tablet PC.

The results presented in this section show that all the students own a mobile phone irrespective of *Gender*, *Age* and *Funding of studies*. Infrastructure ownership is one of the factors that determine if a group of people is ready to use a technology (Darab & Montazer, 2011; Machado, 2007). The results of this study established that mobile phones were the only IT devices owned by all the students if compared to other devices. Hence, students seemed to be ready to use mobile phones as information access and interaction tools because they already own the devices regardless of their gender and age. If ownership of mobile phones (100%) is compared with iPad/Tablets computers (20%), it is important to note that few students owned iPad/Tablet computers. Therefore, mobile phones are accessible to most students and present a readily available channel for information access and interaction in teaching and learning. In the end, the results of this study showed that all the students own a mobile phone and this presents an opportunity for providing students with mobile centric services at HEIs.

4.6.2 Student readiness: Knowledge of mobile brands and features

Student survey 3 included two questions that evaluated students' knowledge of their mobile phone brands and functionality (Question 6 and 7). Question 6 asked students to identify their mobile phone brands, *"What is the brand of your mobile phone?"* Question 7 presented a list of features and asked students to confirm if the features were available on their mobile phone with a *"Yes"*, *"No" or "I don't know"*. The question reads, "*Which of the following features are available on your mobile phone?*" Knowledge of mobile phone features helped in determining if the students were ready to use their mobile phones because they only use features that they are familiar with.

All the students managed to identify the brands of their mobile phones. The popular mobile phone brands owned by the students were Blackberry (33%), Samsung (29%) and Nokia (21%) as depicted in Figure 4-7.

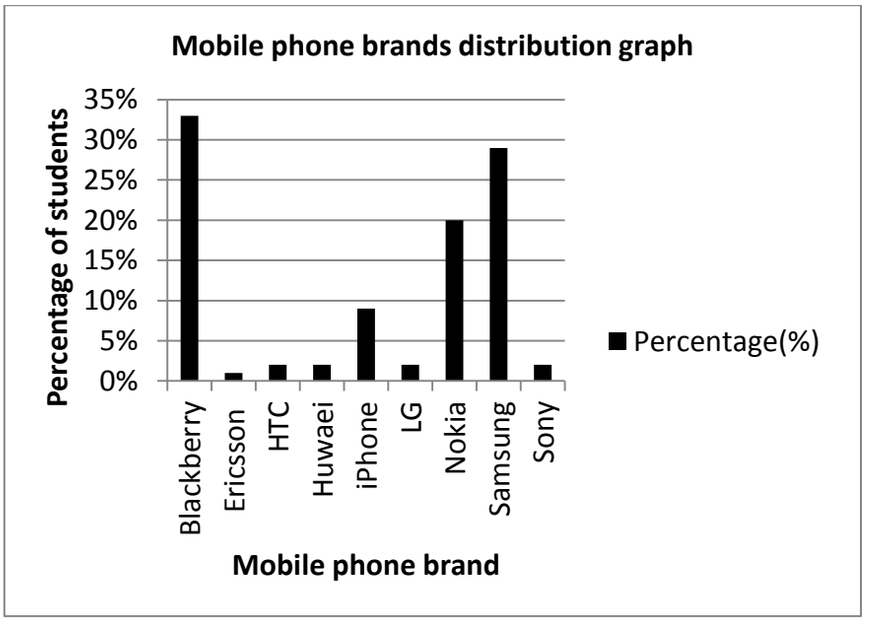


Figure 4-7: Mobile phone brands distribution graph

With respect to identifying mobile phone features (Question 7), descriptive statistical results are presented in the graph in Figure 4-8.

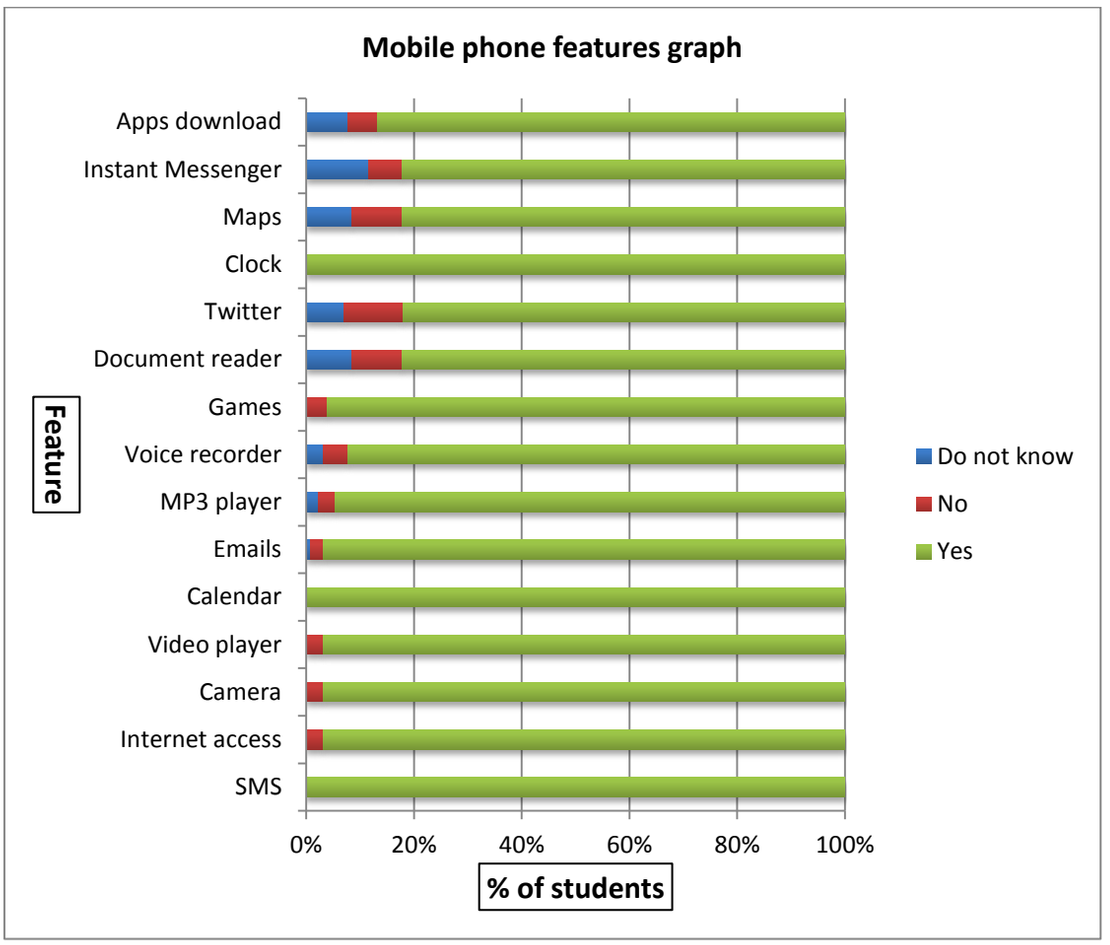


Figure 4-8: Mobile phone features graph

The students identified features on their mobile phones as Internet access (97%), email (97%), camera (97%), video player (97%), apps download (87%) voice recorder (92%) and document reader (82%). All the students identified that their mobile phones had SMS, a calendar and a clock. There were some mobile phone features that other students failed to identify, for example apps download (8%), voice recorder (3%), or document reader (9%). Notably, some students indicated that their mobile phones had no features such as internet access (3%), emails (2%), camera (3%), video player (3%), apps download (5%), voice recorder (5%) or document reader (9%).

The data analysis results established that a few students failed to identify all the features on their mobile phones. Therefore, students who were not aware of all the features on their mobile phones were not fully ready to use their mobile phones. The implication is that it would be problematic for the university to implement mobile information access and interaction services simply on the assumption that students have mobile phones.

4.6.3 Student readiness: Sources of Internet access

Students were asked to reveal their sources of Internet access (Question 8). The question reads, "*Where do you access the Internet and how often do you do this per week?"* The question was Likert scale based, explored where the students access the Internet and their frequency of access. Understanding the sources of Internet access helped in comparing mobile phone access readiness of students with other sources of internet access. The data analysis results for Question 8 are presented in Figure 4-9.

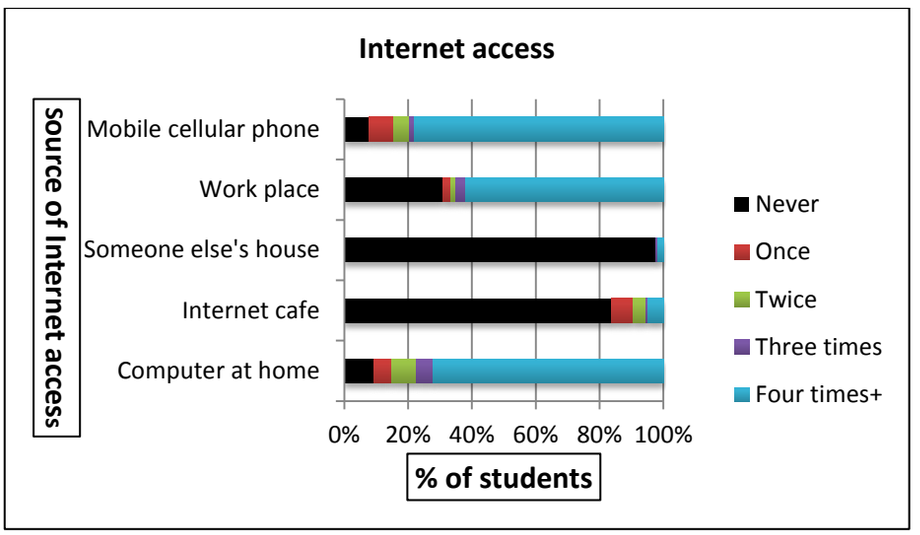


Figure 4-9: Frequency of Internet access per category graph

The results established that 72.1% of the students access the Internet from a computer at home but 9.3% have no access at home. The results indicated that 4.7% of the students access the Internet from the Internet cafes more than four times a week but 83.7% have never done that. Concerning

accessing the Internet from someone else's house, 1.6% of the students indicated that they do that more than four times a week but 97.7% have never done that. Notably, 62% of the students access the Internet at their workplaces more than four times a week but 31% of the students have never done that. Remarkably, 78.3% of the students access the Internet from their mobile phones more than four times a week but 7.8% have never done that.

The margins between mobile phone access (78.3%) and computer at home access (72.05%) were 6.15% and between mobile phone (78.3%) and work place (62%) was 16.3%. The margins are small and may suggest that even though mobile phones dominate Internet access, the students also depend on computer access especially when they are at their homes or at their work places. Inversely, the results established that some students have never accessed the Internet from a mobile phone (7.8%), computer at home (9.3%) and computer at work place (31%). The results revealed that few students access the Internet from Internet cafes (4.7%) or from other people's houses (1.6%).

This study investigated if *Gender, Age and Student funding* had an effect on how often the students accessed the internet from different devices. The investigation was carried out with a Chi-squared test at $p = 0.05$. The Chi-squared test results follow.

i. Gender and Internet access

The Chi-squared results showed that gender seemed not to have a significant effect on where the students access the Internet, whether on a computer at home, Internet cafes, computer at someone else' house, computer at workplace or mobile phone.

ii. Age and Internet access

The Chi-squared results showed that age seemed to have a significant effect on how students access the Internet in the Internet cafes $(\chi^2 = 11.454, DF = 3, p = 0.0095)$ and on a computer at workplace ($\chi^2 = 18.691, DF = 3, p = 0.003$). However, age seemed not to have a significant effect on how students access the Internet on a computer at home, computer at someone else' house or through a mobile phone.

iii. Funding and Internet access

The Chi-squared results showed that funding of students' studies seemed not to have a significant effect on how the students access the Internet, whether on a computer at home, internet cafes, computer at someone else' house, computer at workplace or mobile phone.

The data analysis results established that mobile phone Internet access dominated Internet access but the students also depended on other forms of Internet access such as computer access from home, at work as well as from Internet cafes.

4.6.4 Student readiness: Mobile phone internet activities

Students were asked to reflect on the internet activities that they usually do on their mobile phones in Question 9. The question reads, *"As part of your normal routine, to what extent do you engage in the following activities on your mobile phone?"*

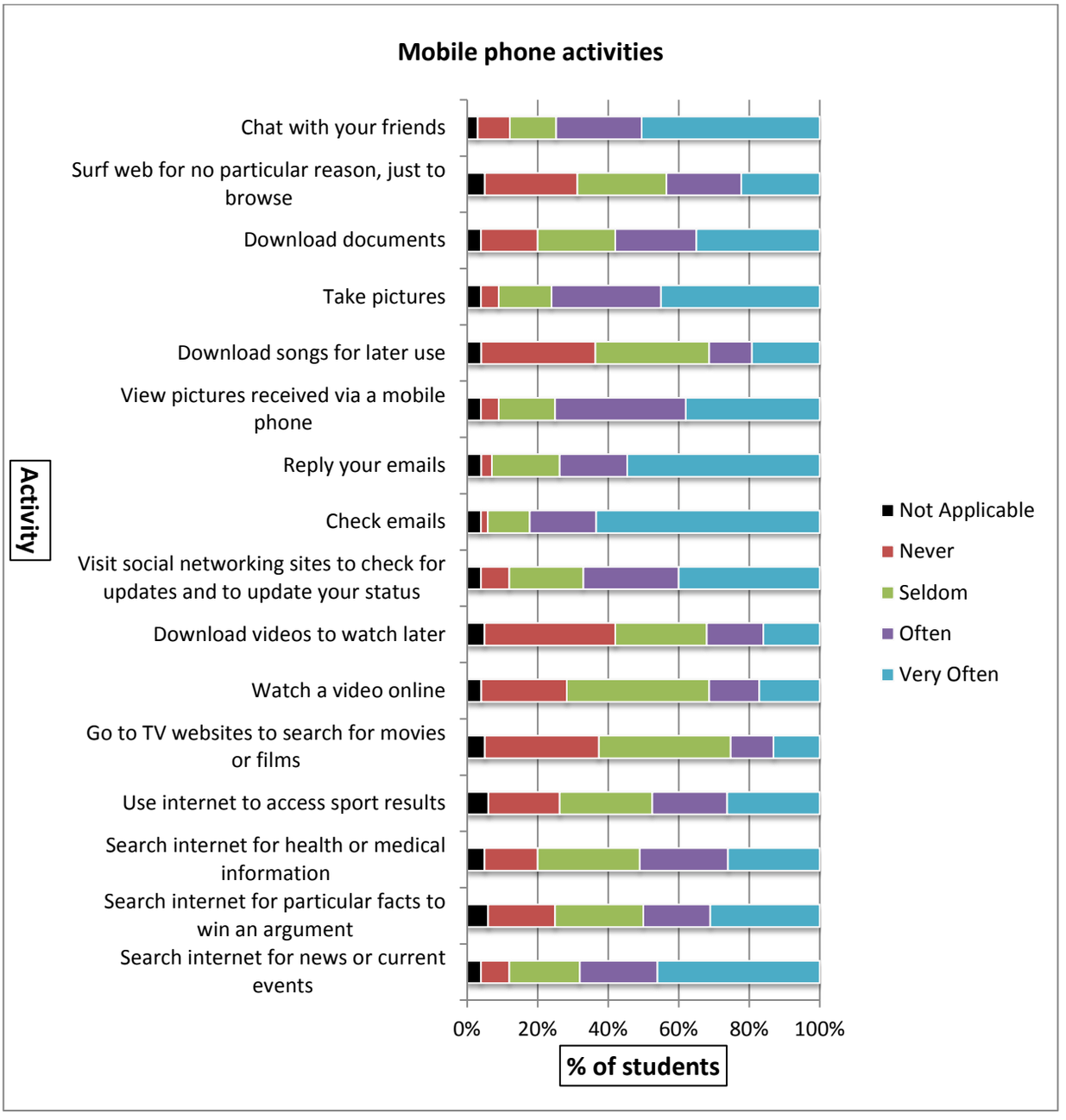


Figure 4-10: Mobile phone activities frequency graph

The question was based on a Likert scale rating and required students to indicate the frequency at which they do an activity. The data analysis results for Question 9 are presented in Figure 4-10. The activities that the students often and very often engage with included checking emails (83%),

replying to emails (73%), viewing pictures received on a mobile phone (75%), taking pictures (76%), charting with friends (74%) and searching internet for news (68%). There were some activities that some students would never do, which included downloading videos (37%), downloading songs (32%), watching online videos (24%), searching for movies on TV websites (32%) and surfing the web for no apparent reason (26%).

There were certain activities that the students tended to perform more than others as depicted in Figure 4-10. Further investigation using Factor analysis was undertaken to see if there were some latent variables within the dataset and the results are now discussed.

i. Categories of mobile phone internet activities

The results of Factor analysis are presented in Table 4-9. The factors were determined based on the Eigenvalues, Cumulative percentage of variance, and the Scree plots. The Factor analysis extraction methods used was the Maximum Likelihood and the rotation method was Varimax. An initial analysis to get the Eigenvalues for each factor extracted 3 factors with Kaiser's criterion greater or equal to 1.

Table 4-9: Rotated factor loadings of mobile phone activities

Item	**Factor 1 Information gathering activities**	**Factor 2 Communication activities**	**Factor 3 Social connection activities**
9.1 Search internet for news or information on current events	**0.59**	0.42	0.23
9.2 Search internet for particular facts to win an argument	**0.56**	0.19	0.15
9.3 Search internet for health or medical information	**0.59**	0.34	0.25
9.4 Use internet to access sports results	**0.50**	0.27	0.22
9.5 Go to TV websites to search for movies or films	**0.60**	0.17	0.04
9.6 Watch a video online	**0.65**	0.09	0.34
9.7 Download videos to watch later	**0.75**	0.13	0.12
9.8 Visit social networking sites to check for updates and to update your status	0.26	0.31	**0.46**
9.9 Check emails	0.23	**0.84**	0.25
9.10 Reply to your emails	0.28	**0.81**	0.24
9.11 View pictures received via mobile phone	0.26	0.30	**0.66**
9.12 Download songs for later use	**0.70**	0.19	0.23
9.13 Take pictures	0.12	0.09	**0.78**
9.14 Download email documents	0.53	**0.52**	0.24
9.15 Surf the web for no particular reason just to browse	**0.55**	0.26	0.34
9.16 Chat with your friends	0.25	0.38	**0.45**
Eigenvalues	**7.3205**	**1.4975**	**1.0974**
% Variance	**45.753%**	**9.359%**	**6.842%**
Cronbach Alpha	**0.90**	**0.90**	**0.84**

The percentage variance for each factor was also recorded. The 3 factors had Eigenvalues and cumulative percentage of variance of 7.3205 (45.753%), 1.4975 (9.359%) and 1.0974 (6.842%). The 3 factors contributed a total variance of 61.95%, which is above the 60% threshold. The 3 factors were returned for analysing the data and the items with factor loading greater than 0.4 were considered to be valid. Table 4-9 shows the results after rotation.

The factors that group under Factor 1 represented the general internet access *Information gathering activities*. Factors that group under Factor 2 represented internet *Communication activities*. The factors that group under Factor 3 represented *Social connection activities*.

There were some overlaps on item 9.1 (*Search internet for news or information on current events*) and item 9.14 (*Download documents*) between Factor 1 and Factor 2. In such circumstances, the items were classified based on either the highest score or on theoretical perspectives. For example, item 9.1 was classified under a factor with the highest score. On the other hand, item 9.14 was classified on a factor with a lower score because downloading email documents is theoretically more of an internet communication activity than information gathering.

Reliability analysis was applied to each of the factors identified during factor analysis. The results show that all the factors were reliable, with Cronbach Alpha coefficients above 0.7. The Cronbach Alpha coefficients values were: $\alpha = 0.90$ for Factor 1 (*Information gathering activities*), $\alpha = 0.9036$ for Factor 2 (*Communication activities*) and $\alpha = 0.8434$ for Factor 3 (*Social connection activities*). The coefficient value of item 9.4 *Using internet to access sport results* ($\alpha = 0.9006$) was above the overall reliability coefficient value by a margin of 0.006 and could have been deleted. Since the value of the overall coefficient of α is high, deleting the value would make a minimum contribution in improving the value of the overall α.

ii. Effect of age, gender and funding of students on mobile phone internet activities

MANOVA tests were performed to test the effect of age, gender and funding of students on how students perceive mobile phone internet activities based on the three factors. The results of the MANOVA tests showed that gender, age and student funding seemed not to have a significant effect on how students perceive mobile phone internet activities.

The Factor analysis results established that students' mobile phone internet activities clustered around three categories of activities, which are *Information gathering activities*, *Communication activities*, and *Social connection activities*.

4.6.5 Student readiness: Cell phone operational costs

Student survey 3 included two questions that investigated if the students can afford to fund their mobile phone information access and interaction (question 10 and 11). Question 10 was based on multiple choice answers and asked students how they paid their cell phone bills, *"How do you pay for your cell phone bills?"* Question 11 was based on multiple choice answers and asked students to select the amount of money that they spent on air time credit, the question reads, *"Please indicate the amount spent on air time per week (if you have a monthly contract, please divide monthly contract amount by four to convert to weeks)"*.

The data analysis results for Question 10 established that 53% of the students used monthly contract subscriptions and 47% used prepaid air time vouchers. Data analysis results for Question 11 are presented in Figure 4-11.

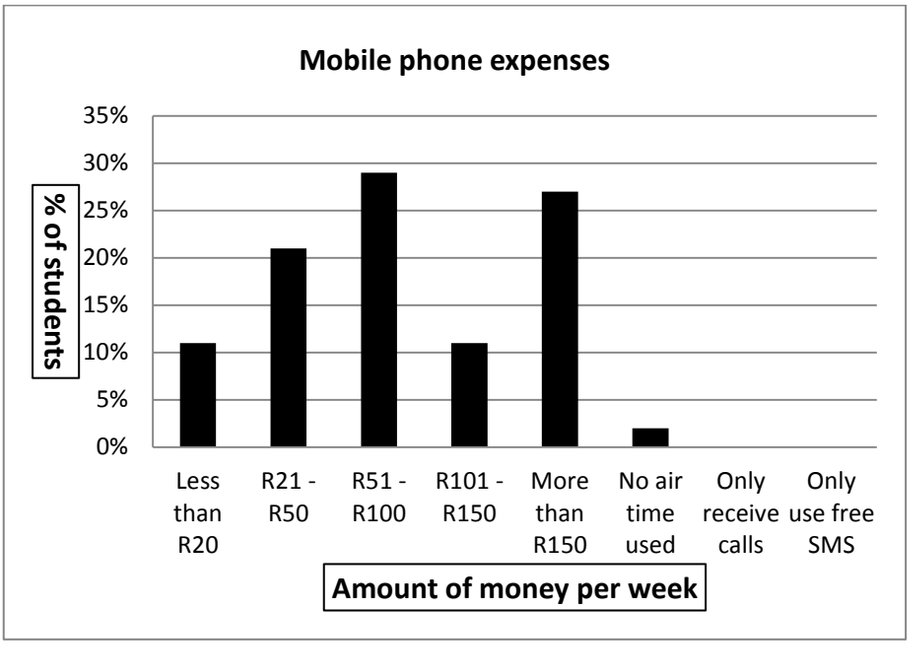


Figure 4-11: Mobile phone expenses graph

The students spend different amounts of money on their mobile phones per week. The largest group of students (29%) spend between R51-R100 per week, the second largest group (27%) spend more than R150 per week, the third largest group 21% spend between R21-R50 per week. There were two groups with 11% of the students each, with one group spending less than R20 per week and the other group spending between R101 –R150 per week.

The results reflect that the students' financial status is not homogeneous. The funding structure for mobile phone access and interaction is divided between *Contract subscription* and *prepaid subscription,* with almost an equal amount of students on each side. Within these two groups, the students spend different amounts of money on air time per week.

4.6.6 Mobile phone context of use

Students were asked the context in which they use their mobile phones in Question 12. The question required the students to agree with a *"yes" or a "no"* on a set of statements that described mobile phone use. The question was, *"Please select from the statements below those that best describe your mobile phone use in the given context?"*

The majority of the students agreed that they always carry their mobile phones (96%), they use their mobile phones when travelling (93%), they use their mobile phones to capture situated interesting events (84%), they use their mobile phones while doing other things (70%), and they use their mobile phones at bus or train stations as depicted in Figure 4-12.

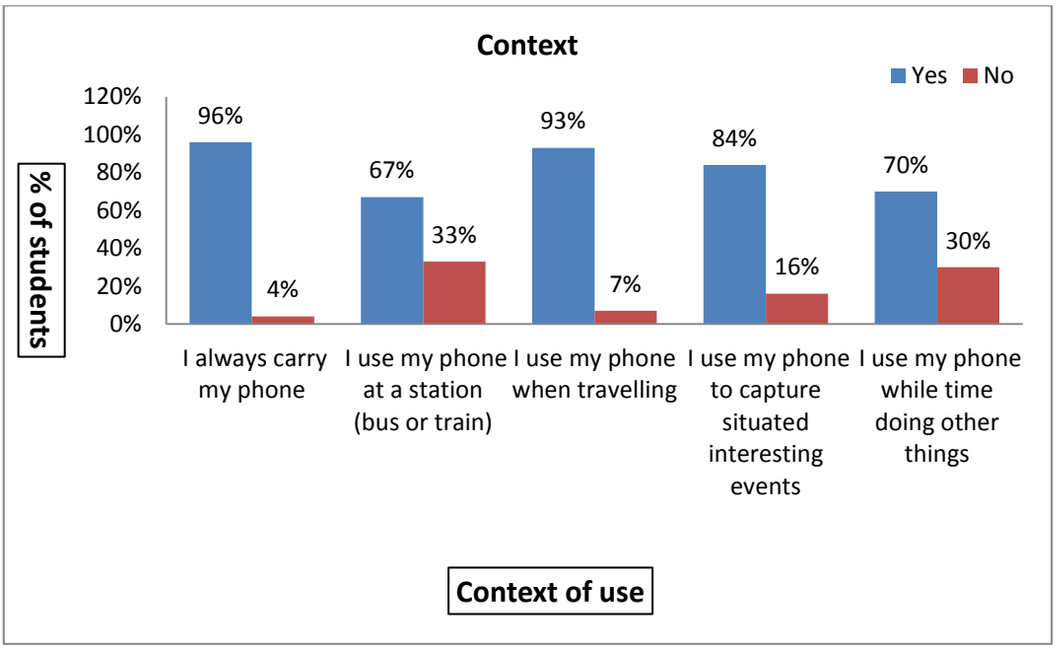


Figure 4-12: Context of use graph

The results in this section indicated that students always carry their mobile phones and use them at any given time and anywhere. The students indicated that they use their mobile phones when they are in public environments such as bus or train stations, and when they are travelling.

4.6.7 Students' mobile phone needs: Access to resources

The students were asked to identify resources they considered important for mobile phone access in Question 13, *"Which of the following resources are important for mobile phone access?"* The question listed 16 electronic resources that students could want to access from a mobile phone. The students were asked to rate the importance of each of the listed resources on a scale of 1 to 5, where 1 depicts *strongly disagree* and 5 depicts *strongly agree*. Statistical tests used to analyse the data were Descriptive analysis, Factor analysis and Association test using Chi-squared test or MANOVA.

Descriptive statistical analysis results are presented in Figure 4-13 and shows that the frequency of agree and strongly agree of all the listed resources ranged from 58% to over 90%.

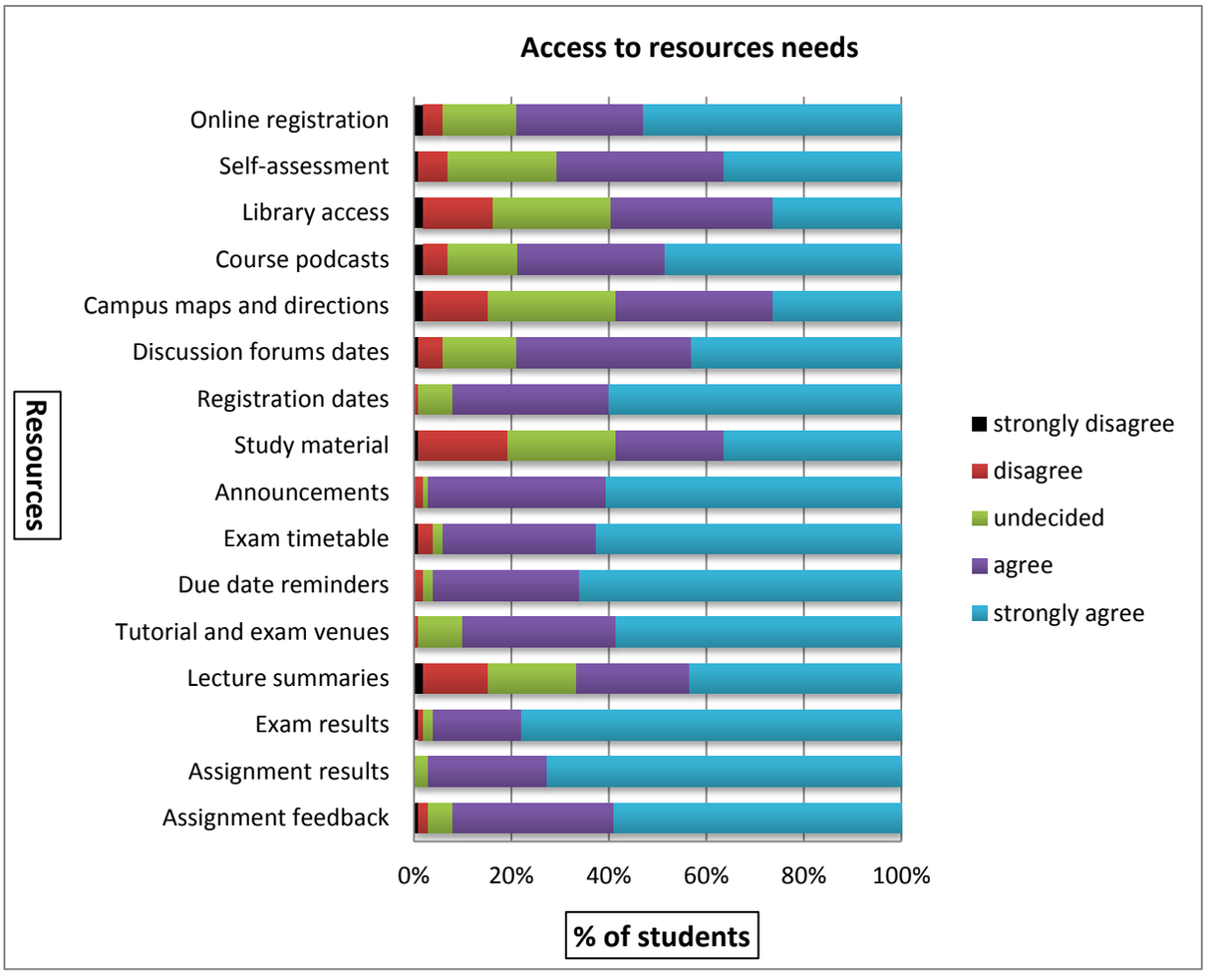


Figure 4-13: Access to resources frequency graph

The resources that received the frequency of 58% were *Library access, Campus maps and directions* and *Study material*. Some students were undecided on whether they wanted to access resources that received frequencies of 58%. For example, the proportions of undecided students were *Library access (24%), Campus maps and directions (26%)* and *Study material (22%)*. The reason for the indecision could not be established in this study.

The resources that received frequencies of over 90% were *Assignment results*, *Exam results*, *Exam timetable, Registration dates, Due date reminders and Announcement*s. The resources have a common characteristic, which is the requirement for students to get small chunks of data from the system. Factor analysis was carried to find if the listed resources in the dataset could form some groups or clusters.

i. Factor analysis results for access to resources needs

The results of the Factor analysis are presented in Table 4-10. Three factors with Kaiser's criterion above 1 were extracted after running the initial Eigenvalues analysis. The extracted three factors had Eigenvalues and cumultive percentages of variance of: 6.8551(42.845%), 1.7716(11.072%), and 1.2026 (7.516%). The total percentage variance of the three factors was 61.43%, which is above the 60% threshold. The three factors were returned for Factor Analysis.

The factors that clustered under Factor 1 represent *Administrative resources*, Factor 2 represents *Learning resources* and Factor 3 represents *Informational resources*. Table 4-10 shows that there were two overlaps, one on item 13.1 (*Assignment feedback*) and the other on item 13.14 (*Library access*). The overlaps were resolved by assigning the item into a factor with the highest score.

The three factor clusters identified in Table 4-10 were tested for reliability. All the factors were reliable with high scores of Cronbach Alpha coefficients above 0.7. The Cronbach Alpha coefficients scores were $\alpha = 0.8342$ for Factor 1(*Administrative resources*), $\alpha = 0.8452$ for Factor 2 (*Learning resources*) and $\alpha = 0.8133$ for Factor 3(*Informational resources*).

Table 4-10: Access to resources needs factor loadings

	Factor 1 (Administrative resources)	**Factor 2 (Learning resources)**	**Factor 3 (Informational resources)**
13.1 Assignment feedback	0.43	**0.50**	0.19
13.2 Assignment results	**0.73**	0.21	-0.0
13.3 Exam results	**0.41**	0.35	-0.0
13.4 Lecture summaries	0.16	**0.72**	0.33
13.5 Tutorial and exam venues	**0.55**	0.23	0.32
13.6 Due date reminders	**0.67**	0.16	0.15
13.7 Exam timetable	**0.46**	0.28	0.36
13.8 Announcements	**0.56**	0.15	0.37
13.9 Study material	0.18	**0.75**	0.20
13.10 Registration dates	**0.72**	0.14	0.19
13.11 Discussion forums	0.29	**0.47**	0.40
13.12 Campus maps and directions	0.08	0.13	**0.75**
13.13 Course podcasts	0.22	0.30	**0.70**
13.14 Library access	0.09	0.41	**0.65**
13.15 Self-assessment	0.33	**0.57**	0.40
13.16 Online registration	0.30	**0.57**	0.31
Eigenvalues	**6.8551**	**1.7716**	**1.2026**
% Variance	**42.845**	**11.072**	**7.516**
Cronbach Alpha	**0.8342**	**0.8452**	**0.8133**

ii. Effects of Age, Gender and Funding on mobile phone access to resources

MANOVA tests were performed to investigate how A*ge, gender* and *funding of students* affect how students perceive mobile phone access to resources. The A*ge, gender* and *funding of students* variables were tested on each of the three factors that came from factor analysis. The results of the

MANOVA tests showed that A*ge*, *gender* and *funding of students* seemed not to have a significant effect on how students perceive mobile phone access to resources at HEIs.

The results in this section established that there are certain resources on which all students agreed that they are important to access through a mobile phone. There were some resources which the students had different opinions on the value of accessing them through a mobile phone. Factor analysis found that the resources needs of students falls into three categories and they are A*dministrative resources, Learning resources and Informational resources.*

4.6.8 Students' mobile phone needs: Interaction activities

The students were asked about the interaction activities that they consider important to do on a mobile phone in Question 14, "*Which of the following activities are important for mobile phone interaction?*" The question listed 16 activities that students could perform on a mobile phone. The students were required to rank the importance of the interaction activities based on a Likert scale, with values 1 to 5 depicting strongly disagree to strongly agree. Statistical tests performed on data were Descriptive analysis, Factor analysis and Association test using MANOVA. The descriptive data analysis results are presented in Figure 4-14.

The frequency graph shows that there were 4 activities on which more than 80% of the students agreed and strongly agreed that they were important to do on a mobile phone. The activities were *Checking fees status (89%), Accessing e-learning portal (84%), Tracking study material courier (84%) and Doing multiple choice assignments (87%).* There were 9 activities on which more than 70% of the students agreed and strongly agreed that they were important to do on a mobile phone. Activities that were not popular with students were *Paying school fees (58%), Downloading study material (56%), and Ordering books from the library (57%).* The results confirm that students see value in undertaking mobile phone interaction.

The graph in Figure 4-14 shows that there are some activities that the students favour to do more on mobile phones than others. Further analysis was performed using Factor analysis to find if the listed resources in the dataset form some groups or clusters that depict their perceived importance.

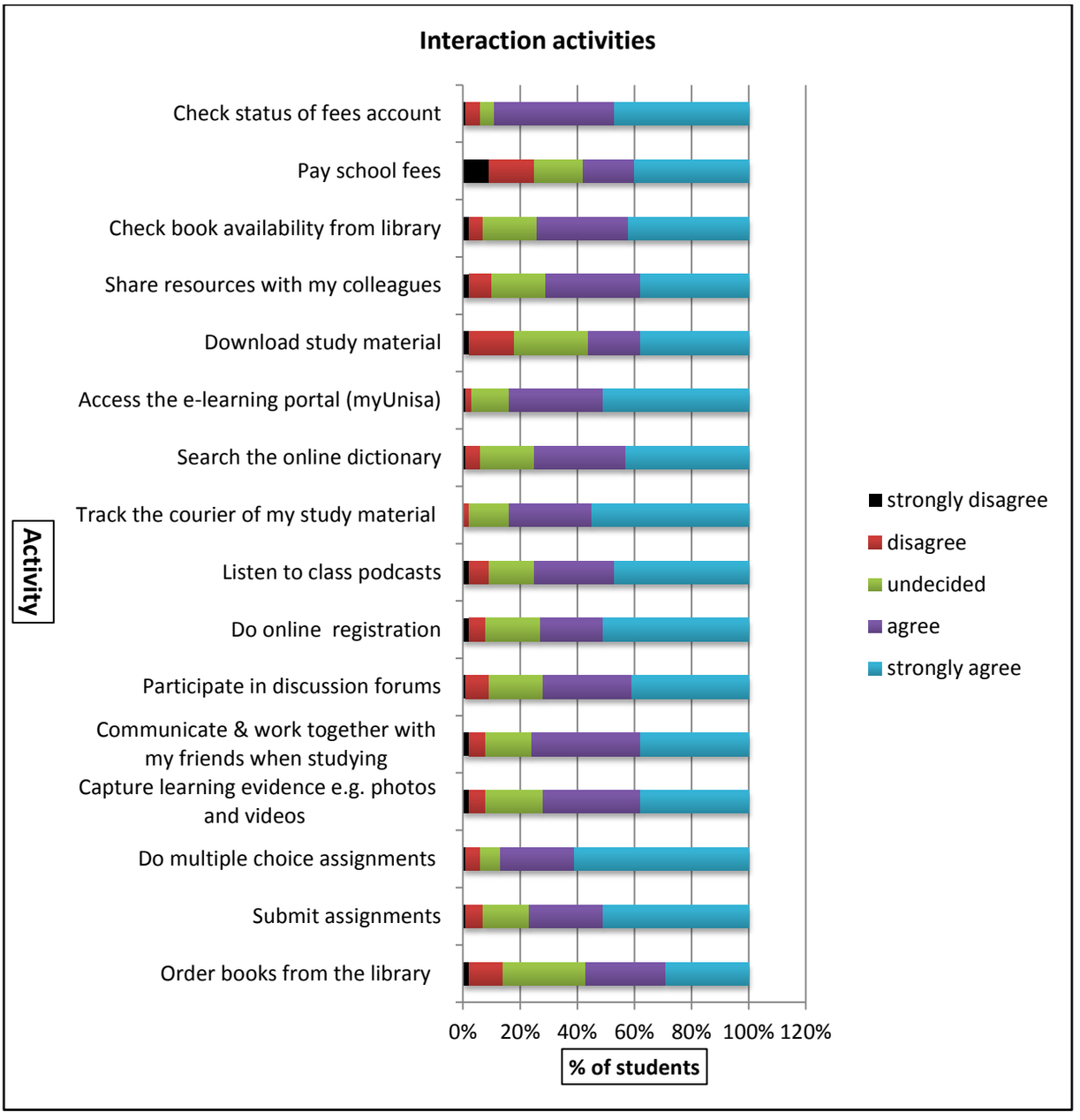


Figure 4-14: Interaction activities frequency graph

i. Factor analysis results for interaction activities

The results of the Factor Analysis are presented in Table 4-11. Factor Analysis grouped 16 interaction activities into 3 factor clusters. The 3 factors with Kaiser's criterion above 1 were extracted after running the initial Eigenvalues analysis. The Eigenvalues of the three factors and the cumulative percentages of variance were 8.9746 (56.091%), 1.2591 (7.869%), and 1.1085 (6.928%). The total percentage variance of the three factors was 70.89%, which is above the 60% threshold.

The 3 factor clusters represented Factor 1(*Learning interaction activities)*, Factor 2 (*Administrative interaction activities)* and Factor 3 (*Assessment interaction activities)*. Either some overlaps were identified in the data and were resolved by assigning the items to the highest score or theoretically, that is an item would be put under a factor where it makes more sense.

Table 4-11: Rotated factor loadings of interaction activities

		Factor 1 Learning interaction activities	Factor 2 Administrative interaction activities	Factor 3 Assessment interaction activities
14.1	Access online books	**0.61**	0.17	0.14
14.2	Submit assignments	0.24	0.44	**0.70**
14.3	Do multiple choice assignments	0.41	0.16	**0.90**
14.4	Capture learning evidence e.g. photos and videos	**0.57**	0.25	0.28
14.5	Communicate and work together with other students when studying	**0.84**	0.29	0.23
14.6	Participate in discussion forums	**0.68**	0.41	0.30
14.7	Do online registration	0.56	**0.40**	0.29
14.8	Listen to podcasts	**0.57**	0.13	0.43
14.9	Track the courier of my study material	0.26	**0.61**	0.04
14.10	Search online dictionary	**0.51**	0.63	0.25
14.11	Access E-learning portal (myUnisa)	0.32	**0.60**	0.41
14.12	Download study material	0.28	**0.68**	0.35
14.13	Share resources with my colleagues	**0.59**	0.44	0.25
14.14	Check book availability from the library	**0.67**	0.40	0.18
14.15	Pay school fees	0.17	**0.75**	0.16
14.16	Check the status of fees account	0.47	**0.52**	0.46
Eigenvalues		**8.9746**	**1.2591**	**1.1085**
% Variance		**56.091%**	**7.869%**	**6.928%**
Cronbach Alpha		**0.9129**	**0.8668**	**0.8859**

The 3 factor clusters were tested for internal consistence using the Reliability test. All the factors were reliable with high Cronbach Alpha coefficients scores above 0.7. The Cronbach Alpha coefficients scores were $\alpha = 0.9129$ for Factor 1 (*Learning interactions needs*), $\alpha = 0.8668$ for Factor 2 (*Administrative needs*) and $\alpha = 0.8859$ for Factor 3 (*Assessment interaction needs*).

ii. Effects of Age, Gender and Student funding on mobile phone interaction activities

MANOVA tests were performed to find how *Gender, Age* and *Student funding affects* how students perceived mobile phone interaction activities. The results of MANOVA tests showed that *age, gender* and *Student funding* seemed not to have a significant effect on how the students perceived mobile phone interaction activities. Using the Roy's Max Root test, the factor S*tudent funding* seemed to have a significant effect on the three factors, with $\Theta = 0.082$, $F(3, 121) = 3.295$ and $p = 0.023$. However, further separate ANOVA investigations on the effect of funding on each of the three factors seemed not to have a significant effect on each of the factors.

Factor analysis established that the interaction activities needs of students could be categorised into *Learning interaction activities, Administrative interaction activities and Assessment interaction activities*.

4.6.9 Students' mobile phone needs: Communication

Question 15 investigated communication messages that the students perceived as important to receive on their mobile phones. The question reads, *"Which of the following communication messages do you consider important to receive on your mobile phone?"* The question listed 8 communication messages for which the students rated their acceptance or rejection of receiving the message on a Likert scale. The Likert scale values were from 1 to 5, where 1 depicts *Strongly disagree* and 5 depicts *Strongly agree*. The descriptive data analysis results are presented in a Frequency graph in Figure 4-15.

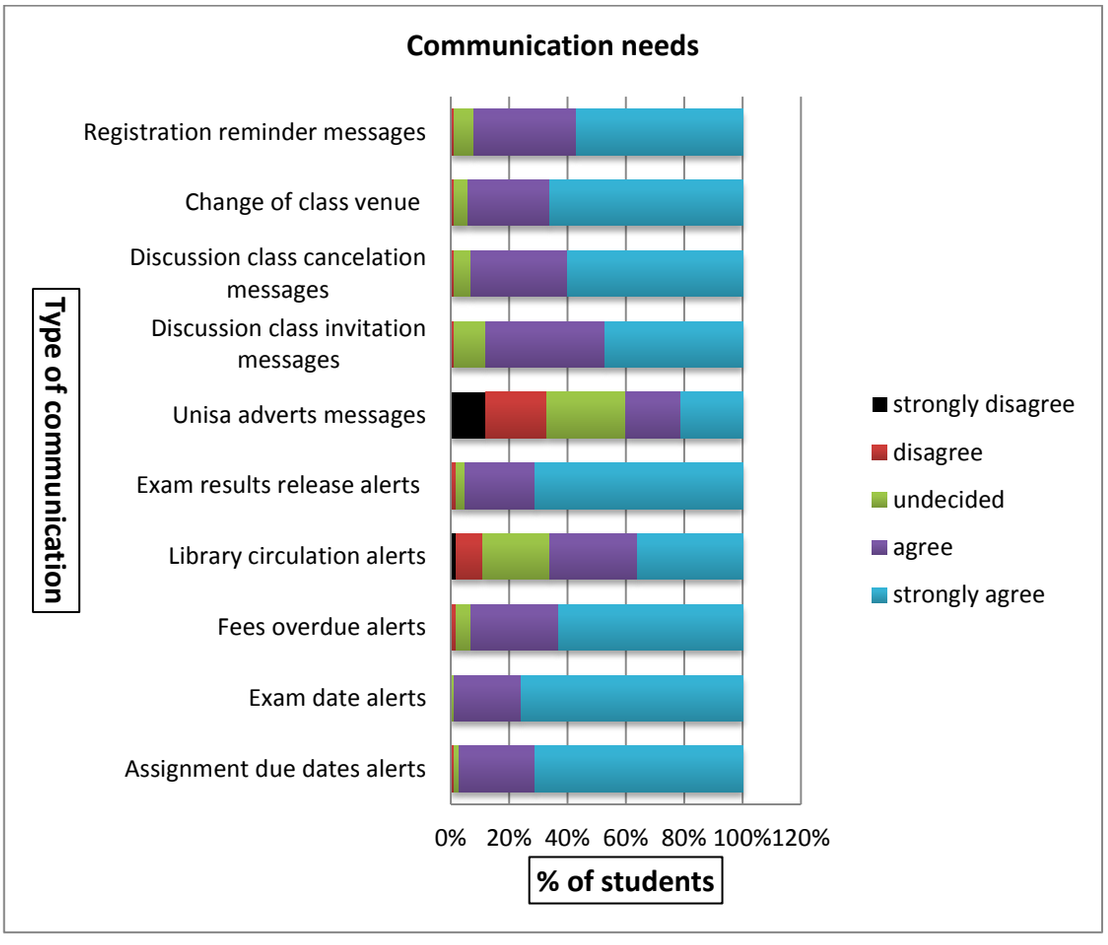


Figure 4-15: Communication messages frequency graph

The graph shows that over 90% of the students *Agree* and *Strongly agree* that 6 of the listed communication messages were important to receive on a mobile phone. The 6 communication messages were *Assignment due date alerts (97%), Exam date alerts (99%), Fees overdue alerts (93%), Exam results alerts (95%), Discussion class cancellation alerts (93%), Change of class venue (94%) and Registration reminder alerts (92%).* The results confirm that the students are prepared to receive communication messages through their mobile phones.

Notably, 33% of the students disagreed and strongly disagreed to receive *University adverts* through a mobile phone. 27% of the students who were undecided on whether the *University adverts* were important or not. Only 40% of the students agreed and strongly agreed that receiving *University adverts* messages was important. Further investigation to see if the variables cluster around certain factors was performed using Factor analysis.

i. Factor Analysis results for the Communication messages

Factor Analysis established that the *Communication messages* needs clustered around three factors. The three factors had the Kaiser's criterion above 1 after running the initial Eigenvalues analysis. The Eigenvalues and cumulative percentages of variance of the three factors were 4.5930 (45.930%) and 1.6229 (16.229%) and 1.0659 (10.659%). The total percentage variance of the three factors was 72, 8%, which is above the 60% threshold.

Table 4-12 shows the rotated factor loading clusters under Factors 1 (*Assessment messages)*, Factor 2 (*Class administrative messages)* and Factor 3 (*General administrative messages)*. The 3 factor clusters were tested for internal consistency using the Reliability test. The results of the Reliability test indicated that Factor 1 (α =0.8535) and Factor 2 (α = 0.8887) were reliable with Cronbach Alpha coefficient above 0.7. Factor 3 was unreliable with α = 0.297.

Table 4-12: Rotated factor loadings for communication messages

	Factor 1 Assessment messages	**Factor 2 Class administrative messages**	**Factor 3 General administrative messages**
15.1 Assignment due date alerts	**0.84**	0.22	0.14
15.2 Exam date alerts	**0.94**	0.18	0.19
15.3 Fees due alerts	0.48	0.08	**0.62**
15.4 Library book circulation alerts	0.12	0.30	**0.40**
15.5 Exam results release alerts	**0.65**	0.15	0.14
15.6 Unisa adverts messages	0.02	0.12	**0.43**
15.7 Discussion class invitation messages	0.17	**0.64**	0.35
15.8 Class cancellation messages	0.22	**0.96**	0.19
15.9 Change of class venue notices	0.19	**0.82**	0.21
15.10 Registration reminders	0.34	0.38	**0.57**
Eigenvalues	4.5930	1.6229	1.0659
% Variance	45.930%	16.229%	10.659%
Cronbach Alpha	0.8535	0.8887	0.297

ii. Effects of Age, Gender and Student funding on the Communication messages

MANOVA tests were performed to find the effects of *Age, Gender* and S*tudent funding* on how the students perceive the importance of mobile phone communication messages. The *Age, Gender* and S*tudent funding* factors were tested against the three factors. The MANOVA test results showed

that *Age, Gender* and S*tudent funding* seemed not to have a significant effect on how students perceive the mobile phone communication messages.

Factor analysis established that the communication messages that the students would like to receive could be categorised into *Assessment messages, Class administrative messages and General administrative messages.*

4.6.10 Mobile phone constraints

Question 16 of Student survey 3 investigated constraints that could be encountered by students when accessing and interacting with information through mobile phones. The question reads, *"Which mobile phone limitations have you encountered when interacting with your mobile phone?"* The question listed 12 constraints and required students to rate how the constraints could affect them based on a Likert scale. The Likert scale values were from 1 to 5, where 1 depicts *Strongly disagree* and 5 depicts *Strongly agree*. The descriptive data analysis results for Question 16 are presented in a frequency count graph in Figure 4-16.

Over 70% of the students strongly agreed and agreed that they encountered some limitations due to *Poor network connectivity (72%), Unreliable battery life (70%), Make mistakes when typing on the keyboard (72%) and Experience slow data exchange (e.g. when uploading photos) (76%).* However, there were some constraints on which less than 50% of the students neither *Strongly agreed* or *Agreed* nor *Strongly disagreed* or *Disagreed*. The constraints are now listed showing the sum of frequencies of *Strongly agree* and *Agree* against *Strongly disagree* and *Disagree* in brackets. The difference between the two frequencies is the percentage of the undecided students. The constraints were: *I can afford to call other students (40% vs 44%), I can afford to SMS other students (35% vs 47%), I can afford to call the lecturer (41% vs 49%) and I can afford to download school material from my phone (41% vs 48%).*

Further investigation to see if the variables cluster around certain factors was carried out using Factor analysis. The results of Factor analysis are now presented.

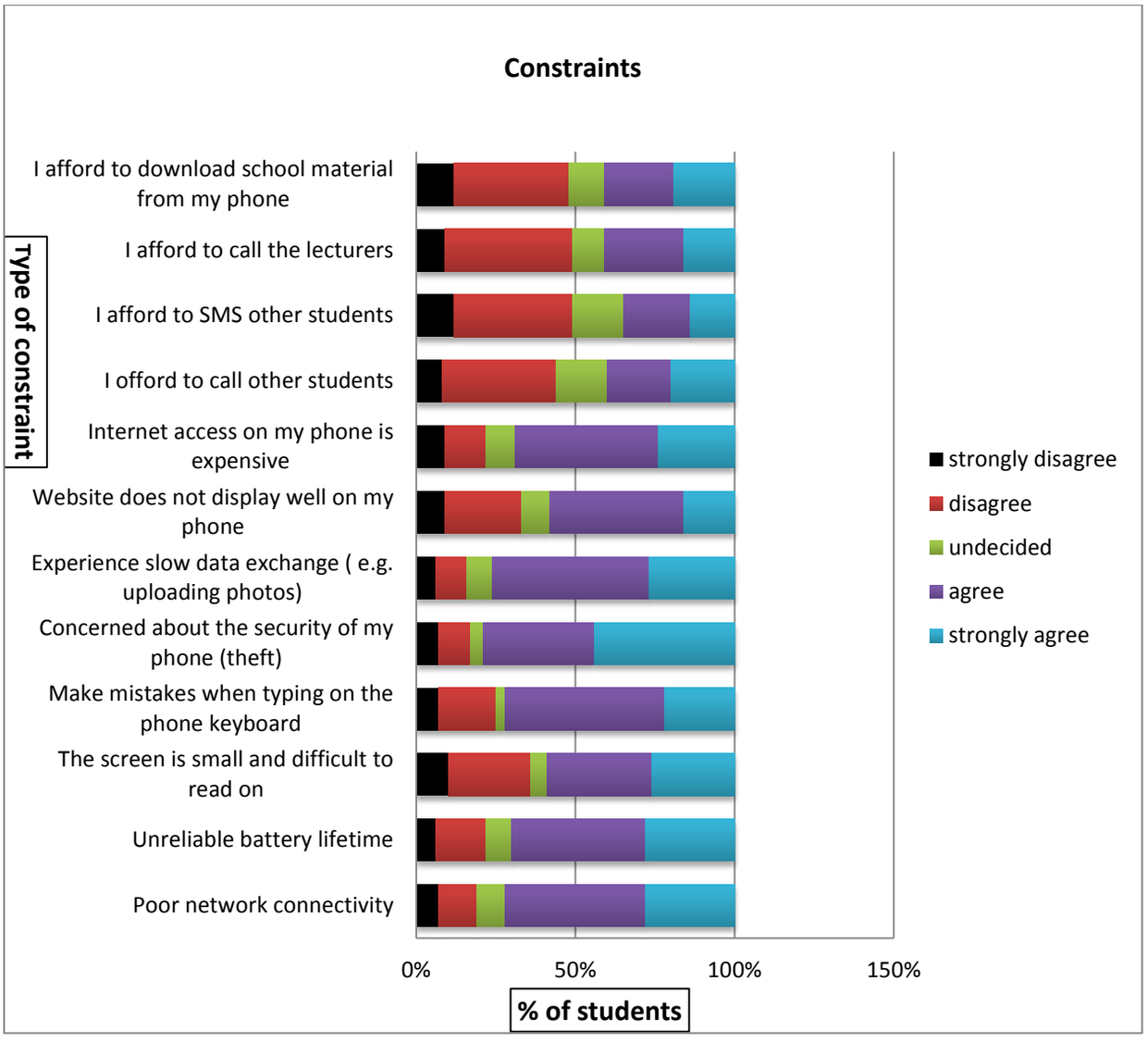


Figure 4-16: Mobile phone constraints frequency graph

i. Factor analysis results for mobile phone constraints

Factor analysis results established that the constraints clustered around two factors. The two factors had the Kaiser's criterion above 1 after running the initial Eigenvalues analysis. The Eigenvalues and cumulative frequencies of the two factors were 4.8379 (40.32%) and 2.2833 (19.03%). The total percentage variance of the three factors was 59.35%.

The results of the rotated factor loading for Factor 1 (*Technical constraints*) and Factor 2 (*Financial constraints*) are presented in Table 4-13. The 2 factor clusters were reliable with acceptable Cronbach Alpha coefficients scores of $\alpha = 0.7884$ for Factor 1 (*Technical constraints*) and $\alpha = 0.9043$ for Factor 2 (*Financial constraints*).

Table 4-13: Rotated factor loadings for mobile phone constraints

	Factor 1 Technical constraints	**Factor 2 Financial constraints**
16.1 Poor network connectivity	**0.58**	0.10
16.2 Unreliable battery lifetime	**0.73**	-0.0
16.3 Small screen that is difficult to read on	**0.50**	0.27
16.4 Make typing mistakes on the keyboard	**0.82**	0.14
16.5 Concerned about data security	**0.64**	0.11
16.6 Slow data exchange e.g. uploading photos	**0.75**	0.13
16.7 Websites display well on my phone	**0.48**	0.29
16.8 Slow internet connection on my phone	**0.40**	0.31
16.9 I afford to call other students	0.08	**0.93**
16.10 I afford to SMS other students	0.16	**0.69**
16.11 I afford to call the lecturers	0.13	**0.91**
16.12 I afford to download school material from phone	0.24	**0.78**
Eigenvalues	4.8379	2.2833
% Variance	40.32%	19.03%
Cronbach Alpha	0.7884	0.9043

Responses to Question 16 were descriptively analysed and identified the constraints that could affect students when using mobile phones to access information. The results of Factor analysis established that the constraints fall into two categories and they are *Technical constraints* and *Financial constraints*.

4.6.11 Summary of Student survey 3 results

Student survey 3 gathered student reflections with respect to the components for the *Conceptual Framework for providing mobile centric services at HEIs* and Table 4-14 summarises the findings.

Table 4-14: Summary of student survey 3 results

Readiness	Needs	Context of use	Constraints
1. Mobile infrastructure ownership (*presented in Table 4-9*) 100% of the students owned a mobile phone	1. Access to resources needs (*discussed in Section 4.6.7, depicted in Figure 4-12 and presented in Table 4-11*) Factor analysis identified 3 groups of needs as access to: • Administrative resources • Learning resources • Informational resources	1. Students always carry their phones; use them at any time and at any place (*depicted in Figure 4-11)* Hence, context that affect students are: • Physical environment context • User context • Social context	Factor analysis identified that students are affected by technical constraints and financial constraints (*presented in Table 4-14*)
2. Knowledge of brands and features (*depicted in Figure 4-6 and Figure 4-7*) • 100% students know their mobile phone brands • 100% of the students identified common features such as SMS, clock and calendar • Some students fail to identify if their phones had Apps download, voice recorder and document reader • Some mobile phones had no functions such as Internet connection, email, voice recorder etc.	2. Interaction activities needs (*discussed in Section 4.6.8, depicted in Figure 4-12 and presented Table 4-12*) Factor analysis identified 3 groups of needs as: • Learning interaction activities • Administrative interaction activities • Assessment interaction activities		
3.Sources of internet access (*depicted in Figure 4.8*) • 78% of the students access internet from a mobile phone • Students depend on other sources for internet access such as Computer at home, office, Internet Cafe	3. Communication needs (*discussed in Section 4.6.9, depicted in Figure 4-14 and presented in Table 4-13*) Factor analysis identified 3 groups of needs as: • Class administrative communication • Assessment based communication • General university administrative communication		
4. Mobile phone internet activities (*depicted in Figure 4-9*)Factor analysis identified three groups of activities as: • Information gathering activities • Communication activities • Social connection activities			
5. Cost (*depicted in Figure 4-10*) The affordability of students is not homogenous. Students spend different amounts of money on their mobile phones per week.			

4.7 Chapter summary

This Chapter presented data analysis results of Policy document analysis, Tool observation analysis, and Students surveys. The objective of the data analysis was to enhance the components of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The results for policy document analysis were presented in Section 4.2.7, Tool observation analysis in Section 4.3.5, Student survey 1 in Section 4.4.4, Student survey 2 in Section 4.5.3 and Student survey 3 in Section 4.6.12. The following Chapter presents the second part of data collection and analysis in this study.

Chapter 5: Data analysis results (Part 2: Lecturer interviews)

5. 1 Introduction

This Chapter presents the second part of the data analysis results that answer sub research question 2, which reads *"To what extent does practice in HEIs reflect the components for providing students with mobile centric information access and interaction at HEIs?"* The data analysis results are for the qualitative lecturer interviews. The results provide the knowledge base for developing the *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa (presented in Section 6.3).* Figure 5.1 gives an overview of this Chapter.

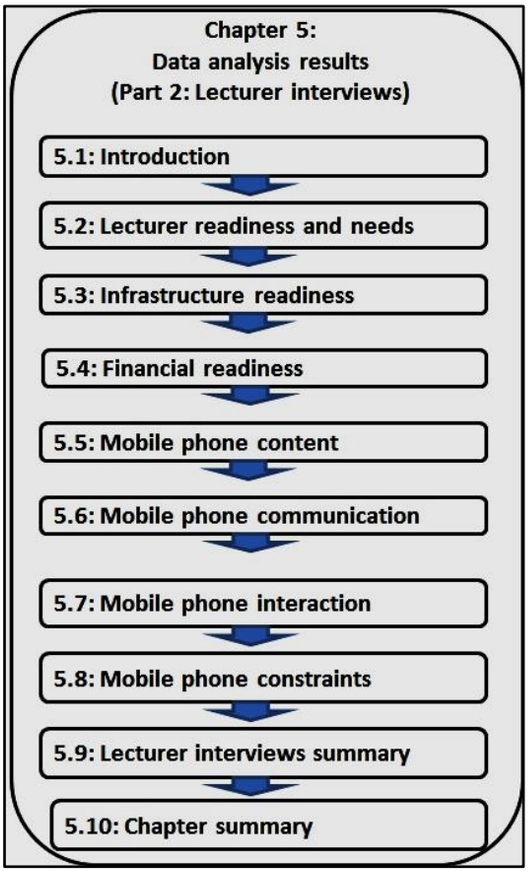


Figure 5-1: Overview of Chapter 5

The discussion continues as follows: Section 5.2 discusses lecturer readiness and needs results, Section 5.3 discusses infrastructure readiness results, Section 5.4 discusses financial readiness results, Section 5.5 discusses mobile phone content results, Section 5.6 discusses mobile phone communication results, Section 5.7 discusses mobile phone interaction results, Section 5.8 discusses mobile phone constraints results, Section 5.9 presents the lecturer interview summary and Section 5.10 presents the Chapter summary.

5.2 Lecturer readiness and needs

This section reflects on the Readiness component and the Needs component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The data analysis focuses on lecturers' readiness and needs in order to provide mobile centric services to students. The following questions were answered during the interviews (see Appendix 3),

- *To what degree do you consider mobile phone access when you design learning content for online access?*
- *How ready are you in providing students with mobile centric services that facilitate information access and interaction?*
- *What would you need in order to do that?*

None of the participants was ready to provide mobile centric services. Data analysis identified six needs that have to be satisfied in order for lecturers to provide mobile centric services. The needs are *training, technical support, workload, motivation, resources awareness and management support*, as illustrated in Figure 5-2 and discussed in the following sections.

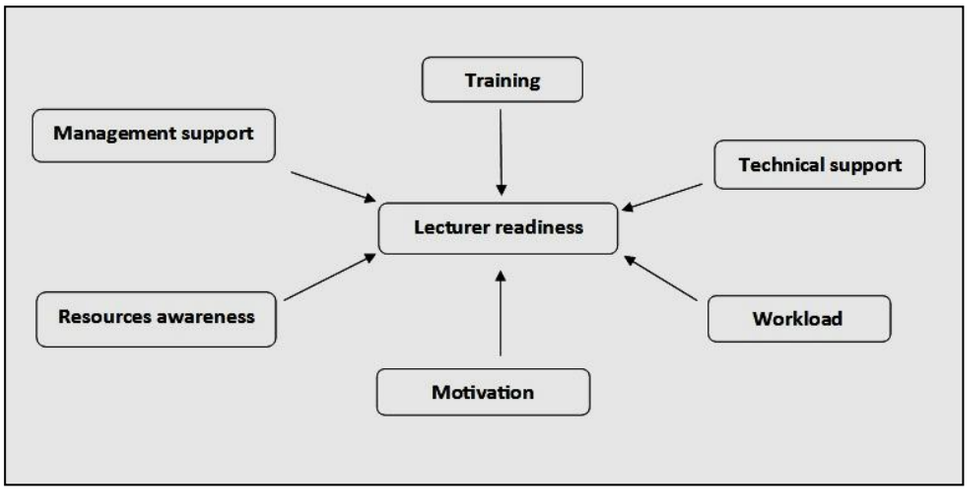


Figure 5-2: Factors that determine lecturer readiness

5.2.1 Training

The participants were not ready to provide students with mobile centric services and they required training. The participants required training on designing mobile phone content and learning activities. In this regard, participant P5 said,

"With things like simulation, you really need training. I know that there was once podcasting training, a few colleagues attended it, one of them is [lecturer's name], like how to pose, articulate and I am not sure if other lecturers had time for that."

Even though the participants required training, participants P1, P2, P3, P7, and P10 acknowledged that the university has the capacity to train lecturers to integrate mobile centric services in teaching and learning. They argued that even though the university does not currently focus its training on integrating mobile phones in pedagogy, the university provides training on online access design. Participant P6 said,

"*Yes, I have attended one, they mentioned it [mobile content design] as a by-the-way, it was not specially looked at. They just said online, and our traditional online is normal web based which is accessed through a PC, so they didn't specifically mention mobile phone online issues."*

Participants P1, P2, P3, P4, and P6 pointed out that it would be too early for the university to address the integration of mobile phones in pedagogy because the focus is on providing basic online access through computers. Participant P2 said,

"*Yah-a-a-a, well, the university provides a lot of training and my assumption is that, that kind of training would probably be on its way, they are usually good at providing training, even if the training may not be effective."*

Participant P4 said

"*... I would not assume that there is no training because this is something that is still under development. I hope that we will get some training though at the moment there is nothing."*

Apart from the formal trainings offered by the university, participant P6 indicated that some lecturers were empowering themselves with some skills for providing mobile phone content and services through focus groups. This provides evidence that some of the lecturers at the university are putting effort in providing mobile phone information access and interaction. Participant P6 said,

"…..*That is the only thing that I attended where people specifically discussed how they used tablet PCs and some even demonstrated how they use them for teaching. I was excited by that. Otherwise, from the formal university trainings that I attended nothing of that sort was discussed."*

In trying to determine the knowledge and skills that the participants had, it emerged that some of the participants were already providing students with basic mobile phone resources. Participants P5, P7 and P10 confirmed that they provide students with podcast/vodcasts that they either create themselves or access from Open Access Resources. The participants also used discussion forums for interaction and SMS for communication. Participant P5 said,

"I incorporate mobile tools, not in the design stage of my learning study material but in the process of delivering learning content. I use mobile phones as a notice board; making students aware of what is on e-learning portal, or on discussion forums. It helps with quick interactions because it alerts students even when in a club that they have new learning material on the learning

portal, for example lecture slides."

Since all the participants were lecturers, they confirmed that they were competent in curriculum and instructional design. They indicated that they would not have difficulties in designing mobile content and services if they receive some training. Lecturer participant P1 said,

"*Lecturers would not have troubles in designing for mobile information access and interaction because they will still develop study material the same way they are doing for online learning."*

The implications for the lack of technical skills in providing mobile centric services are that the opportunities presented by mobile phones as tools for information access and interaction in education could be derailed. The results imply that the university needs to come up with strategies for training lecturers in providing mobile centric services.

5.2.2 Technical support

The participants needed technical support in order to provide mobile centric services to students. The participants indicated that they would want to approach the provision of mobile phone services as a team because they do not have the required skills. Lecturer participants P5 and P6 argued that the team should include specialists such as educational technologists and mobile applications designers. In this regard, participant P11 pointed out that the university has Open Educational Resources (OER) specialists who can help with identifying resources that can help in providing mobile phone content and services. Participant P11 said,

"There are OER experts who are helping people to design for online learning, I think they can help with designing for mobile access."

5.2.3 Workload

The participants were not ready to provide mobile centric services because they are overloaded with work-related responsibilities. The workload does not give the lecturers time to pursue and experiment with new technologies. Participants P1, P2, P3, P5, P6, P9, P10, P11 and 12 reported that apart from tuition duties, lecturers perform other duties such as community engagement and academic citizenship. In this regard, participant P1 said,

"*It would be a problem if the university expects the lecturers to do everything; we do not have time on our side. Other than tuition, lecturers are expected to do research, community engagements and academic citizenship. They cannot do everything - they can't."*

The results established that teaching large classes at the university further increases the workload of the lecturers. As a result, lecturers end up doing minimum work in teaching and learning. Participant P7 said,

"I am totally alone for 1500 students, I am lecturing, and designing for next year and I am on my own. I have to keep up with technology; there is something that I have to give up."

This section established that if the lecturers have unmanageable workloads and big job descriptions, in the end they end up doing minimum work in everything. The lecturers' above normal workloads discourage them from being innovative in their teaching, especially, experimenting with new technologies. The results of this study suggest that lecturers need a manageable workload in order for them to have capacity to plan, design and implement mobile centric services.

5.2.4 Motivation

Two factors that motivate lecturers in providing mobile centric services to students were observed. Firstly, participants P6, P9, P11 and P14 were motivated by their interest in researching on mobile technology in teaching and learning. Participant P6 reported that some lecturers formed a focus group that researches on mobile learning,

"Lecturers who are interested in mobile phone information access and interaction formed an informal group to look into that and I attended one of them and found it interesting. I was excited by that."

Secondly, participants P5 and P10 indicated that their motivation for providing students with mobile centric services was due to being sympathetic with students who primarily access information through mobile phones.

Participants, P3, P6, and P8 were reluctant to provide mobile centric services to students. Two factors that demotivated the participants from providing mobile centric services to students were observed. The first factor was that some participants did not want to do extra tuition work. Participant P3 said,

" *Before you go ahead, let me say that I am not interested because I have something else do as well, I am not just sitting the whole day, you know that, so if I say I don't have interest, it's because I don't think the time is right."*

The second factor was that some participants were of the opinion that the university has no policies that support the provision of mobile centric services and felt that they were not protected. Participant P6 said,

"If you do something beyond the given standards at the university, you must make sure that every student should have access to that, otherwise you will be accused of unfair practice. I stick to the

given standards; there is nothing that specifically says design for mobile phones' access and interaction."

This section established that some participants were motivated and ready to provide mobile centric services to students. Motivating factors were identified as the desire to research on mobile technology in teaching and learning and providing learning resources to students who primarily access information through mobile phones. Demotivating factors were identified as hesitance to do extra work and fear of not being protected by policy.

5.2.5 Management support

The participants required university's management to support them when providing students with mobile centric services. The participants expect the university's management to show interest and to have knowledge of the merits of providing mobile centric services. In addition, the participants expect the university's management to provide support by motivating lecturers, managing lecturers' workload, providing infrastructure, policies and strategy. Lecturer participant P11 said,
"*Lecturers should get incentives for using a mobile phone platform and also give them resources to be on a mobile platform. Right now I can't be using my own cell phone and data, which is very expensive to get hold of students."*

5.2.6 Resource awareness

Some participants were not aware that the university had any resources that could assist them in providing mobile centric services to students. Participants P5 and P9 admitted that they were not aware of any resources that could assist with designing mobile phone content and services. The participants indicated that it is difficult to know all the functionalities of the Learning Management System (LMS) used at the university but were interested in exploring it further. In contrast, lecturer participant P3 expressed no interest in providing mobile phone services.

Participants P1, P2, P6, P10, and P11 were aware of the SMS service and had used the service for communicating with students more than once. Lecturer participants P10 and P11 observed that it would be difficult for the lecturers to know some of the available mobile phone resources because the university does not market them. Participant P11 said,
" I am not sure of their name. I know there is a department that is in the fourth floor of TVW building, which gives such services, but the only problem is that these people are not really out there to market themselves so that they can give such services. You have to look for such services yourself."
The university needs to market mobile centric resources to the lecturers. Lack of awareness among the participants could be due to ignorance of technological advancements, negative attitude or the

university not marketing the resources. If the lecturers are not aware of the resources, it follows that they would not use the resources in their teaching.

5.3 Infrastructure readiness

This Section examines the Readiness component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (2.8) and focuses on how the participants perceived the readiness of the university's infrastructure in providing mobile centric services. The participants responded to the following questions during the interviews,

- *"Which resources are provided by the university that support the provision of mobile phone services?"*
- *Which resources would you expect the university to provide you with?*

The participants were of the view that the university does not have any special hardware resources dedicated for providing mobile phone services. Participant P1 pointed out that even though the university does not currently provide lecturers with any special hardware, it has the capacity to do so. Participants P10 and P11 expect the university to provide lecturers with internet-connected devices such as tablet computers or mobile phones that enable lecturers to interact with students when they are out of office. Participant P11 said,

"...the lecturers must also be connected and be online and have resources. Let's say we are given an application that is based on a computer only, I would not be seen responding to a student on a laptop whilst doing shopping with my family. If I have access through a mobile phone and data is sponsored by the university, I would do that."

Even though the consensus among the participants was that the university does not provide lecturers with hardware for providing mobile centric services, it emerged that it is putting some efforts towards providing students with computing hardware. Participants P4, P5, P6, P8, P10, and P11 indicated that the university negotiated with some computer companies to provide students with special prices when buying devices such as desktop computers, laptops and tablet PCs. The university also negotiated for a similar deal with some local mobile cellular companies to provide students with special prices for broadband. The negotiations were in line with the university's obligation of going online fully. Participants P10 and P11 indicated that such deals were good for students and they expected the same deals for the lecturers. Participant P10 said,

"The university has made some deals for students to receive cheap laptops or tablet PCs and broadband. This could also be extended to lecturers. Lecturers need those resources."

With respect to software infrastructure, all the participants viewed the LMS as an important infrastructure that facilitates content creation, distribution, access to resources, communication, and interaction. Participant P4 indicated that the Sakai based LMS that the university uses has a small

bandwidth footprint and is strategic for mobile phone access and interaction. Participant P2 indicated that the university provides some mobile phone apps on the LMS system such as the MCQ assignment application, study material downloading apps, results checking apps and podcast/vodcast apps. Therefore, the university has some readily available software infrastructure for providing mobile phone content and services.

5.4 Financial readiness

Finance is a critical factor that affects the readiness of an institution in its provision of mobile centric services. Data analysis results established that the participants did not explicitly discuss the financial aspect for the provision of mobile centric services. The only aspect of finance that the participants discussed was the cost of broadband. Participants P3, P5, P6, P9, and P11 indicated that the university does not fund or subsidise broadband utilisation by lecturers when they are out of the university premises. The reasons for not showing interest in discussing the financial implication may be that they do not have control over the finances of the university.

5.5 Mobile phone content

This section examines the Resources component and the Needs component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (2.8). The examination focuses on how the lecturers at the university design and provide mobile phone content. This extends to resources that the lecturers would need in order to design and provide mobile content as a service. Data analysis in this section focuses on responses to the following interview questions,

Do you prepare any learning content specifically for mobile phone access and interaction?

- *Which other content formats would you want to consider?*
- *Which resources do you need in order to achieve that?*

The participants were not providing students with content designed for mobile phone access. The participants wish they can provide mobile phone content in the form of text documents and multimedia content. In this regard, participant P8 said,

“I am considering using podcast, but not yet. I haven’t done it yet. I guess they should be helpful if they are accessible through mobile phones. They should be, because I think the students will be able to access them from anywhere, making them learn from anywhere any time.”

The participants required access to mobile phone content design tools. Participants P1, P2, P4, and P9 indicated that, due to time limitation, lecturers would fail to design content for both desktop PC’s and for mobile phone access separately. The participants expected the university to provide a system that automatically adapts content for any platform. In that respect, participant P2 saw lack

of content adaptation resources as an obstacle to the provision of mobile phone content. Participant P2 said,

"The other approach that would make it possible for cell phones to use these things is for the applications to actually facilitate this, because most applications have a mobile version, like browsers have mobile version that do not have all the richness of the desktop version. I would say, it is the tools that can be used to develop teaching material for mobile applications that are a limitation."

Participants P2, P7, and P10, recommended that content in the form of podcasts is good for mobile phone access. Participants P2 and P10 suggested podcasts as good for creating demonstrations. Instead of creating new podcasts, participants P7 suggested that lecturers could consider making use of podcasts that are available on platforms such as YouTube.

This section established that the participants are not currently providing students with content designed for mobile phone access and interaction. Even though the participants are not currently providing students with learning content, they indicated that they would want to provide students with downloadable documents, multimedia content, open access resources, and content on social media. In order for participants to do this, they need to have access to mobile content authoring tools.

5.6 Mobile phone communication

This section examines the Resources component of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The focus is on how lecturers communicate with students through their mobile phones. The participants responded to the following interview questions,

"How do you communicate with students through mobile cellular phones?

- *Which other ways would you want to consider?*
- *Which resources do lecturers need in order to achieve this?"*

Data analysis results established that the participants communicated with students through emails (discussed in Section 5.6.1), SMS (discussed in section 5.6.2), telephone (discussed in Section 5.6.3), social media (discussed in Section 5.6.4), discussion forums (discussed in Section 5.6.5), and blogs (discussed in section 5.6.6).

5.6.1 Email

All the 14 participants agreed that they send emails to students but could not confirm whether the students access the emails through mobile phones or not. The participants gave different views on

whether it is appropriate to send emails targeted at mobile phones. Five participants P1, P2, P4, P13 and P14 would want to send emails targeting mobile phones because they assumed that many students have smartphones and can view emails. In contrast, participants P3 and P6 argued that sending emails targeted at mobile phone access would segregate students without smartphones. Participant P10 reasoned that lecturers could use an array of communication channels so that students can access the information through any resource that is at their disposal. This was consistent with participant P1 who acknowledged that lecturers communicate with students through emails but they were not concerned with how the students would access the emails. Participant P2 observed that it could be a challenge for lecturers to receive and respond to emails through a mobile phone due to large volumes of emails received per day. In this regard, participant P2 said,

"For the asynchronous, the most popular way is email, but email can be a problem to the tutors because going through 1000 emails from students and so forth can be a problem, but that's the burden that you have to deal with when you are dealing with ODeL."

Therefore, the participants showed that they communicate with students through email even though they may be having different perspectives on whether the email should be targeted for mobile phone access.

5.6.2 SMS

All the participants were aware of the SMS service that the university provides. Despite knowing about the service, three participants P6, P8, and P14 confirmed that they were not yet using the service but were considering using it in future. Participant P1 said,

"I am aware that communication can be made easier by sending SMSs to students, which they would receive on their mobile phones. The university has an SMS application that all lecturers can use to communicate with students."

Participants P3, P4, P5, and P10 had used the SMS service for communicating important announcements to students, for example, class cancellation alerts, and registration dates alerts. Participant P3 said,

"They want to use cell phones to receive SMS; you passed, you failed, and you owe us money- that's what the students want to hear."

Other participants P3, P4, P5, and P10 had used the SMS service for sending instructions about new resources that had been added on the LMS. Participant P4 said,

"*We make a lot of announcements and I always send announcements to the students' myLife account as well, and then I backup by sending an SMS that says go to your myLife account to check this*"

Participant P11 observed that the SMS system was a unidirectional channel, only for sending messages to students and students could not in turn reply through the same channel. Hence, the students would have to respond to the SMS message through other communication channels such as email or phone calls. At the end of the day, this introduces parallel communication channels between lecturers and students. Participant P11 said,

"*So we must be aware of our platforms, where we talk with our students. If I send an SMS, they should be able to respond in SMS, the SMS-email thing is not efficient."*

This section established that all the participants were aware that the university provides an SMS service. Some participants had already started using the service whilst others intended to do so in future. The issue of unidirectional sending of SMS messages to students was identified as a drawback.

5.6.3 Discussion forums

The participants used discussion forums as a communication and interaction channel. For communication, participants P1, P2, P9, P10, P12, and P13 had used discussion forums as notice boards for sending class announcements. Participants P1 said,

"I also use the discussion forums for giving updates to students. If students make some queries on the announcement, I would follow up and it would be good if they can use their mobile phones to access the discussion forums."

Participants P2 and P4 argued that discussion forums make communication with students easy in ODeL. That is, the students would first check for new communication on the discussion forums and if they have queries, they would then ask through the same platform.

Participants P1 and P10 would want to have access to social media tools such as instant messages, voice, and video because they facilitate interaction with students. Participant P10 expected the university to provide lecturers with access to Skype and related applications so that lecturers could have real time interaction with students. Additionally, participant P1 suggested MXit as a social media platform for communicating with students. Participant P1 said,

"I have heard that there are some lecturers that make use of social media applications such as Mxit, which is their own effort. The university policy does not say that such applications should be used."

Participant P9 argued against the use of social media tools for academic purposes for the reason that lecturers would not have control over the students. Moreover, participant P2 argued that providing pedagogy through social media platforms would leave lecturers with a lot of work in terms of content preparation and planning. Participant P2 said,

"… most social media would have instant messaging which is more like a discussion forum except that it is managed differently. It requires a lot of preparation and activity on the lecturer or tutor's side."

This section established that lecturers use discussion forums for communicating and interacting with students. The participants would want to have access to social media tools to facilitate interaction with students. The implications of using social media were identified as lack of student control, extra work overload in terms of planning and content preparation.

5.6.4 Telephone calls

The participants used fixed telephone to communicate with students but they discouraged students from calling them. The participants indicated that telephoning students ought to be taken as the last resort after all other communication channels would have been exhausted. The participants had different views on conditions under which they could telephone students. The conditions of participants P2 and P10 were that they do not call students but the students could call them. The conditions for participants P8 and P9 were that students could call them and they could call students if and only if they need to communicate something important to individual students. Participant P2 recommended that lecturers should avoid phone calls because they would become unmanageable due to large class sizes at the university. Lecturer participant P2 said,

"*I would not recommend phone calls or conference calls, it's not manageable within ODeL, but those are other means that cell phones can be used for."*

Lecturer participant P8 said,

"*Sometimes some students may need special attention, for example F1 concession students. These kinds of students would need special help to pass their exams. So, you may need to call these students to give them extra assignments and guidance."*

The data analysis found that the participants would only have telephone conversations with students under strict conditions. The participants argued that telephone conversations in ODeL were unmanageable due to large numbers of students.

5.7 Mobile phone interaction

This section examines the Resources component of the Conceptual framework for providing mobile centric services at HEIs (depicted in Figure 2-6). The focus is on how lecturers provide students with mobile phone interaction services. The participants responded to the following interview questions:

"Which learning interactions do you provide to students through mobile cellular phone?"

- *Which other interactions would you want to consider?*
- *Which resources do lecturers need in order to achieve this?"*

The data analysis results established that the lecturer participants provided students with mobile phone services that facilitates peer-mentoring (discussed in Section 5.7.1), group work (discussed in Section 5.7.2), and assessment (discussed in Section 5.7.3).

5.7.1 Peer mentoring

The participants provided students with learning activities that required students to interact with each other or with a tutor. The activities were designed for desktop computer access but not for mobile phone access. Participant P4 said,

"Technically speaking I don't know how possible it is but if the facility is available on myUnisa [LMS], a student could do discussion forums on a mobile phone, because many of these mobile phones have discussion platforms."

Participant P7 said,

"Nothing directly says mobile phones, but I am available, so I have emails coming in, we have tutors now for the module, they phone and most students come and see them"

The participants indicated that they would consider providing students with mobile phone peer mentoring activities in future. The participants identified mobile centric services that could facilitate peer mentoring as telephone calls, mobile apps, and SMS/MMS. Participant P2 grouped interactions into synchronous and asynchronous. Synchronous interactions included real time interactive communication services such as instant messaging and Voice over IP (VoIP) services. Participant P2 said,

"You can also have something called chat rooms, they would be live, which means that this is synchronous. So you can tell who is available and who is not."

The participants would want to design peer-mentoring activities that take advantage of social networking services that run on mobile devices. Participant P1 claimed that exploiting social media capabilities would bridge the distance between the students in ODeL. Participant P1 said,

"Social media applications such as Skype can provide students with real time interaction with other students or their lecturers. There are several activities that can be done by ODeL students in bridging the distance between themselves and the university."

Participants P1, P2, P4, P5, P9, and P11 were ready to provide resources through discussion forums on either the LMS or social media. On social media, participant P10 indicated that she was in the process of creating a social media facility to encourage peer tutoring. Participant P10 said,
"*I am trying to have our own Facebook page where our students can help each other and do peer tutoring. It is actually a good idea because Facebook is easily accessible through mobile phones."*

The participants had different perspectives on the use of social media in pedagogy. Participant P9 argued that it would be difficult to monitor students' activities on social media. Participants P2 and P10 argued that the added advantage of social media platforms is that students are already present.

This section established that the participants had not yet started designing and providing peer mentoring learning material for mobile phone access and interaction. All the participants had interest in learning how to design learning activities for mobile phone access and interaction.

5.7.2 Group work

The participants were not designing group work learning activities for mobile phone access and interaction. The participants were not concerned with the devices that the students used to interact with each other but would appreciate it if mobile phones were used. The participants commended mobile phones as tools that could facilitate group work interactions because they can provide voice/video real time interaction, instant messaging, emails and sharing of resources. Participant P2 said, "
Yes, I actually believe in the use of social media for teaching and the advantage is that most students would actually belong to one of those…. … I have used Twitter, for example, and it worked very well and have also used something called DIIGO, a social media tool that is good for teaching, you can put anything there, students just need to subscribe and you create a group, and everyone joins the group."

The participants were of the view that students could easily utilise social networks in forming study groups because they were already doing so informally. Participant P9 said,
"*Informally students are doing most of those things, because when you go to the discussion forum you see students asking, sending messages to other students, to their fellow students asking if they are in a certain area so that they can form a study group. They most probably organise themselves and form study groups maybe virtually through social media."*
The participants indicated that students could participate in discussion groups under two modes of interaction, which are synchronous and asynchronous. Participants P1 and P7 indicated that students could have real time synchronous interactions through tools such as Skype. Participant P8 said,

"I have volunteered to work on Chromebook, kind of a prototype or project, whatever, which is coming to the university now; it is like the Google discussion groups or Google docs, kind of a more interactive way of doing it."

In asynchronous discussion groups, students would visit the discussion platform, go through the discussion, and make their contribution. Participant P4 argued that it is a challenge to make students participate in asynchronous discussion groups but students could be enticed to do so. Participant P4 said,

"*Using social media you can post a question, especially towards exams, everybody would be anxious at that time, when you put a key word exam, everybody wakes up and starts participating on discussion forums"*

This section established that even though the lecturer participants were not designing group work learning activities for mobile phone access and interaction, they commended mobile phones as essential tools that can potentially facilitate that.

5.7.3 Assessment

The participants were not providing mobile phone assessments to students but some were interested. Participants P1, P4, P5, and P11 were interested in providing mobile phone based multiple choice questions (MCQ) assessment. In particular, participant P1 would want to have access to a mobile phone based self-assessment system. Participants P1 said,

"Resources that provide interaction that would be good for mobile phone access and interaction would be MCQ assessment apps … This would give students an interface to submit assignments and receive immediate feedback. The assessment system would evaluate the submitted assignment and return the scored mark and the solutions to the students immediately."

Participant P4 said,*"*

Technically speaking one of the four assignments that the students do in myIT lab is an MCQ. So we could probably set up that to be done through a mobile phone interface"

Participants P5 suggested that mobile phones could provide an interface for collecting assessment evidence. That is, the students could use mobile phones to take pictures or record videos, and submit as evidence. Participant P5 said, "

Creative use of mobile phones would be used for collecting evidence where students can create a portfolio of evidence, with specific outcomes. They can take pictures of processes as they happen in front of a computer, they can put that together and send it to the lecturer as some kind of a mini portfolio of evidence."

This section established that the participants were not providing students with any assessment that is mobile phone based but would like to have access to services such as mobile-based MCQ and self-assessment applications.

5.7.4 Summary of services provided to students

This section discussed the mobile centric services that the lecturers are providing to students. The mobile centric services could be categorised into services that facilitate access to resources, those that facilitate communication and those that enable interaction. With respect to providing students with services that facilitate mobile centric access, the participants indicated that it was the responsibility of the university's ICT department to provide such services. In terms of communication, the participants communicate with students through the following channels, emails, SMS, telephone, social media, discussion forums, and blogs. With respect to mobile phone interaction, the participants provide students with mobile centric services that enable them to take part in peer mentoring, group work and assessment.

5.8 Mobile phone constraints

This section examines the Constraints component of the *Conceptual framework for providing mobile centric services at HEIs* (depicted in Figure 2-6) and focuses on the constraints that lecturers encounter when providing mobile centric services. The participants responded to the following question during the interviews, "*What are the challenges encountered by lecturers when providing mobile centric services to students?"*

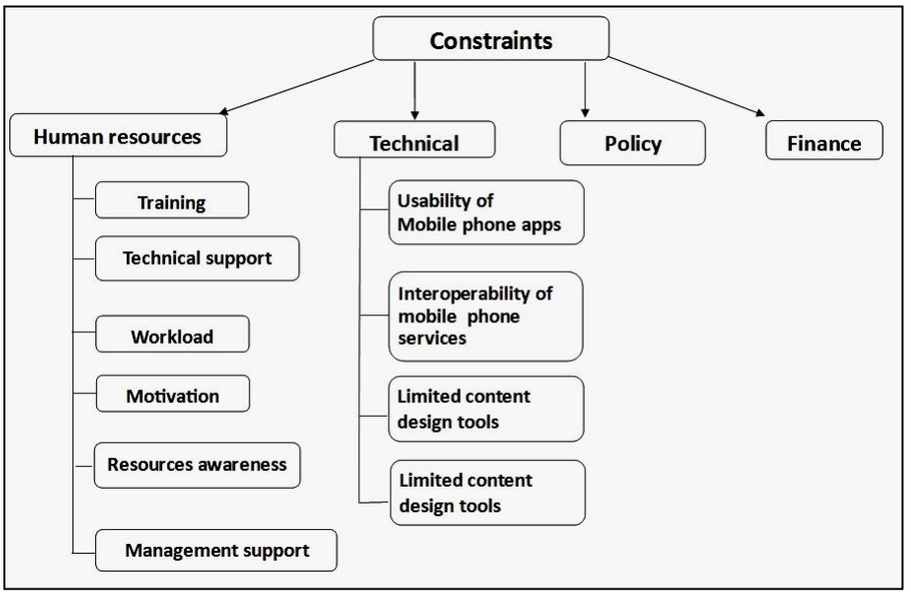


Figure 5-3: Constraints that affect the provision of mobile centric services

The data analysis results identified the following themes of constraints: human resource constraints (discussed in Section 5.7.1), technical constraints (discussed in Section 5.7.2), policy constraints (discussed in Section 5.7.3) and financial constraints (discussed in Section 5.6.4) as depicted in Figure 5-3 and discussed in the following sections.

5.8.1 Human resource constraints

The human resource constraints that could affect lecturers when providing mobile centric services are training, technical support, workload, motivation, resource awareness and management support as depicted in Figure 5-3. The constraints are similar to the factors that affect the readiness of the lecturers (discussed in Section 5.2). Hence, the human resource constraints are not discussed any further in this section.

5.8.2 Technical constraints

The technical constraints that affect the provision of mobile centric services were identified as usability of mobile phone apps (discussed in Section 5.8.2.1), interoperability of mobile phone services (discussed in Section 5.8.2.2), content design tools (discussed in Section 5.8.2.3), and parallel communication channels (discussed in Section 5.8.2.4).

5.8.2.1 Usability of mobile phone apps

The participants were concerned with the usability of mobile phone apps in teaching and learning. Participants P4, P5, P8, and P9 found it unpractical for students to engage in any meaningful Computer science learning on a mobile phone. In that regard, Participants P8 and P9 argued that it would be difficult for programming applications to run on a mobile phone due to limited memory, keyboard, and display screen. Participant P8 said,

"I wouldn't say that I consider mobile devices because as I am teaching a computer science course, in my mind I think students are using the same computer that I am using because to my understanding it's kind of nearly impossible to do a programming on a mobile phone."

Participant P5 said,

"In my subjects, most of what I teach is about modelling and is very difficult to do some kind of simulation on a cell phone or on mobile technology"

Participants P2, P5, P9, and P11 were concerned with the user experience gained from the display screen of a mobile phone. Display screens of some mobile phones have limited dimensions and that makes it difficult to interact with applications. In that regard, participant P11 pointed out that the user experience would be better on smartphones. Smartphones have bigger screens, which improves readability. Participant P2 said,

"Most cell phones would not show you much, when you connect to the internet, its only smartphones that would give you a reasonable access to internet and visibility. The other phones are just minimal, the images sometimes you can't even see, take for example a three year old blackberry."

This section established that the constraints of mobile phone devices could result in negative user experience when interacting with learning applications. The negative user experience could discourage students from using the devices.

5.8.2.2 Interoperability of mobile phone services

The interoperability of mobile phone apps could become an obstacle when providing mobile centric services. The participants were of the view that the university needs to provide mobile phone applications that are interoperable across a range of devices. The devices include desktop computers, tablets, mobile phone devices and other related devices. It is important to provide interoperable services because participants P2 and P9 indicated that they were not concerned about the devices through which the students access learning material. Participant P1 argued that interoperable and useable services needs to be provided in order to avoid information access discrimination since students have a variety of mobile phone handsets.

5.8.2.3 Limited content design tools

Limited content design tools at the university could affect the provision of mobile centric services. Participants P2 and P6 discussed the shortage of software for designing and providing mobile content at the university. Currently, tuition content design depends on the e-learning LMS, which the participants did not recognise as specialised for designing and providing mobile phone content. Participant P2 said.

"When you do instruction design you have to also consider the media that is going to be used for delivering that material and we do not have those many tools that are actually used for designing mobile application and it means that we are using the traditional development tools to actually develop that."

5.8.2.4 Parallel communication channels

The data analysis established that parallel communication channels could affect the provision of mobile centric services at the university. In this regard, participant P11 indicated that the university has an SMS server broadcasting important messages to students. The problem is that when students receive SMS messages they cannot respond to the message through the same channel but could respond through email or a telephone call. Hence, this creates parallel communication channels between the students and the lecturers. Participant 11 said,

"Most of the time after I send a message, I see emails, which is frustrating. If I sent an SMS, they respond through email. They get frustrated; there is no number to respond to, they resort back to the email thing."

Participant P11 recommended that the university should create SMS accounts for lecturers so that they can receive communications from students through SMS.

5.8.3 Policy constraints

Institutional policies could introduce bureaucratic limitations that restrain lecturers from providing mobile centric services. Nine participants found university policies not supporting the provision of mobile centric services. Participants P1 and P6 supposed that ICT policies were an obstruction because lecturers are required to get permission to send SMS messages. Participant P6 remarked,

"I have always wanted to do so but they always say if you want to send that out [SMSs], you must go and apply, I don't know if things have changed, but you know, when you have something that you want to communicate tomorrow you want it out, so I don't want to go through all those processes. Policies introduce some procedural obstacles."

Participants P5 and P11 expected the university to support policies with resources. They argued that the tuition policy requires lecturers to use IT technologies to provide students with learning resources but the university does not provide the lecturers with broadband when they are out of the university premises. They argued that if the university implements a mobile tuition policy, they expect the university to provide the requisite resources. Participants P5 emotionally remarked,

"They have a wish, aspirations of what they want us to do is not supported by resources that enable that. We are told to go this way, do this, but we do not have the enablers, we do not have things that support us, like this thing of time, we are told to do this and that and everything has added into our workload, but nothing is done to enable that. Policies should be supported by resources."

Participant P2 argued that mobile phones are private property and it would be difficult for the university to come up with a comprehensive policy that controls how students should use their mobile phones. Participant P2 said,

"I think that the use of mobile phones for teaching would be initially very difficult to implement as a policy because the universities are not going to come up with a deal where students register and get a subsidised phone or whatever. It means this would remain as students' expenses and they would choose whatever cell phone they can afford."

Moreover, participants P3, P6, and P8 contended that providing students with mobile phone content and services would break the rule of technological minimisation. The rule requires that if

you provide students with mobile phone resources, students with the minimum technology should be able to access the resources. Participant P3 remarked,

"It's unfair to other students and I think it is immoral, because you are providing students that have smartphones with better learning than those who do not have. There is a principle that we call principle of technological minimisation, that principle says that we take the lowest technology that the students have access to, if 99% of the students have smartphones and 1% doesn't, then you cannot use a smartphone"

Participants P8, P9, 10, 11 indicated that even if they wanted to provide students with mobile phone content and services, they are not clear about what procedures and guidelines exist within the tuition policy. They argued that if the guidelines existed, the university should market them as they are unknown. Lecturer participant P9 remarked,

"The current problem is that when designing for online access each lecturer does it their own way. We do not have guidelines; we do not have standards at least that I am aware of. So, I have to design the way I like, the way I think it would be good, and the lack of uniformity can be a problem and also the quality of teaching can be affected … Guidelines would be important for providing students with mobile phone access."

Therefore, policies would be a bottleneck in the provision of mobile centric services if it does not inform on resource allocation, tuition content design, device standardisation, communication, and interaction.

5.8.4 Financial constraints

The participants would want the university to provide them with mobile phone infrastructure and pay for broadband use. Participants P1, P2, P5, P9, and P11were concerned about the costs incurred on broadband when they provide students with learning resources during times when they are working from home. The participants perceived mobile cellular technology as strategic for improving their online presence in ODeL but the bottleneck would be the cost of broadband. Participant P5 emotionally remarked,

"There is a policy, I do not know to whom it applies, where certain individuals can claim the data bundles. Even professors that work from home are not part of this. I think it is for senior management because not everybody can use that facility. Our university does not support mobility. Even though they would say they do so, it does not show in anyway."

Lecturer participant P9 said,

"*I am paying Telkom each month about R700, the minimum is R500 including phone calls and internet connection and the university is not giving me anything back."*

Participants P1, P2, P10, and P11were of the view that broadband costs could be expensive for students if they are to access learning services through mobile phones. Participant P1 argued that given that the university does not pay for broadband needs of lecturers, it is highly unlikely it would subsidise students' mobile phone access in anyway. Participant P11 remarked,
"*Yah, but the thing that I can tell you is that the students do not have enough data to access the vodcasts/podcast."*

The participants expected the university to provide lecturers with mobile hardware resources. Participants P10 and P11 anticipate the university to provide them with mobile hardware such as Tablet PCs that would enable them to interact with students at anytime from anywhere. The participants indicated that they would be reluctant to provide mobile centric services if the university does not provide them with resources.

5.9 Summary of data analysis

The interviews gathered lecturer reflections with respect to the Readiness, Needs, Resources and Constraints components of the *Conceptual Framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). Table 5-1 summarises the reflections.

Table 5-1: Summary of lecturer reflections

Factors affecting readiness	**Needs**	**Resources provided to students**	**Constraints**
1. Training	1. Required training for designing content, interacting and communicating with students	1. Communication resources • Email • SMS • Discussion forums • telephone	1. Usability of mobile services
2. Workload	2. Required access to resources for providing mobile services	2. Interaction resources • Peer mentoring o Discussion forum o Email • Group work o Discussion forum o Email o Social media • Assessment o MCQ apps	2. Interoperability of mobile apps
3. Resources awareness	3. Needed a reduced workload	3. Learning content format not targeted for mobile phone access	3. Limited content design tools
4. Motivation	4. Needed incentives		4. Parallel communication between students and lecturers
5. Technical support	5. Needed technical support when providing mobile		5. Hardware cost

	services		
6. Leadership support	6. Needed management support		6. Broadband cost
7. Finance	7. Needed policy support		7. No technical skills
8. Infrastructure	8. Needed real time VoIP communication apps such as Skype		8. Unaware of mobile technology tools
			9. Lecturers' resistance

5.10 Chapter summary

The interviews examined how lecturers provide mobile centric services at the university with respect to the components of the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). With reference to the components of conceptual framework, Table 5-1 summarises the results of the interviews.

Chapter 6: Discussion

6.1. Introduction

This chapter discusses the results of the Policy document analysis (discussed in Section 4.2), Tool observation analysis (discussed in Section 4.3), Student surveys (discussed in Section 4.4) and Lecturer interviews (discussed in Chapter 5) with the view of developing a *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*. The discussion in this Chapter focuses on triangulating the results obtained from different sources of data with the aim of answering the main research question of this study, namely:

What are the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa?

The two sub research questions are:

1. *What are the components for providing mobile centric services that facilitate student information access and interaction at HEIs?*
2. *To what extent does practice in HEIs reflect the components for providing mobile centric services that facilitate students' information access and interaction?*

In order to answer sub research question 2, seven research questions developed from the *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6) guided the research. The seven research questions are:

2.1 What is the status of the university policy on the provision of mobile centric services?

2.2 Which mobile cellular technology tools are provided by the university that facilitate student information access and interaction?

2.3 Which services do students want to access and interact with through mobile cellular technology?

2.4 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?

2.5 Which mobile centric resources do lecturers provide to students that facilitate information access and interaction?

2.6 How ready are the students in accessing and interacting with mobile centric services at the university?

2.7 Which constraints affect the provision of mobile centric services at the university?

The above listed questions guided this research in four phases. The first phase of the study was a literature analysis, which identified the components for providing mobile centric services at HEIs. The identified components were theorised as a *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6). The conceptual framework was instrumental in selecting the units of analysis, research strategy, philosophy and design of data collection instruments as discussed in Chapter 3. Data collection included policy document analysis (Section 4.2), Tool observation analysis (Section 4.3), Students surveys (Sections 4.4 - 4.6) and lecturer interviews (Sections 5.2 - 5.8). The discussion in this section is based on the findings of each of the research questions of this study. Figure 6.1 gives an overview of this Chapter.

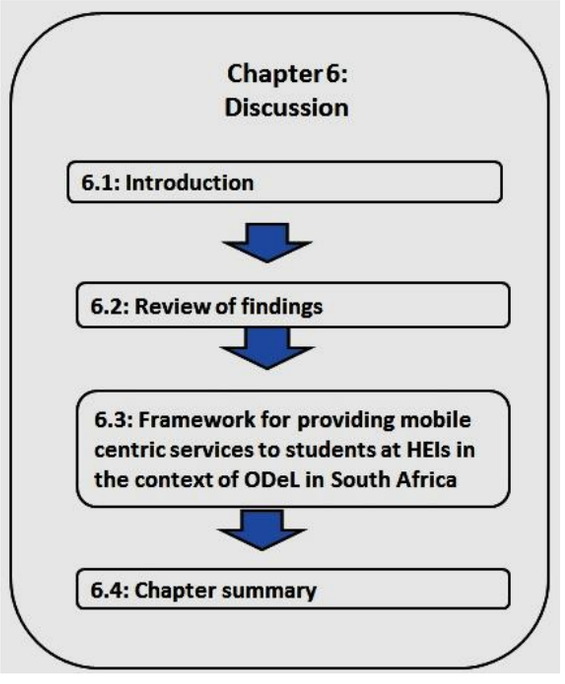


Figure 6 -1: Overview of Chapter 6

The discussion continues as follows: Section 6.2 reviews the findings, Section 6.3 proposes the framework for providing mobile centric services at HEIs in ODeL context in South Africa, and Section 6.4 summarises the chapter.

6.2 Review of the findings

This section reviews the findings of sub research questions 1 and 2 as listed in Section 6.1. The findings from both sub research questions were analysed and triangulated, and informed the identification of components for the *Framework for Providing Mobile Centric Services to Students at HEIs in ODeL context in South Africa*. The findings of this research are discussed in the following order: Section 6.2.1 discusses the components that influence the provision of mobile centric services at HEIs. Section 6.2.2 reflects on the extent to which practice in HEIs reflects the components identified in Section 6.2.1.

6.2.1 What are the components for providing mobile centric services that facilitates students' information access and interaction at HEIs?

Chapter 2 carried a literature analysis and identified the components for providing mobile centric services that facilitate student information access and interaction at HEIs. The components were theorised as a *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). The conceptual framework had five components and they are R*eadiness, Needs, Resources, Context of use, and Constraints.* The description of each of these components was presented in Section 2.8.1.

6.2.2 To what extent does practice in HEI reflect the components for providing mobile centric services that facilitate student information access and interaction?

In order to answer this question, seven research questions were employed to explore the phenomena within a single case study with embedded units of analysis. The University of South Africa (UNISA) was selected as the case study. The findings for each of the research questions are now discussed.

6.2.2.1 What is the status of the university policy on the provision of mobile centric services?

The university has eight policies that reference the use and the provision of mobile centric services at the university (discussed in Section 4.2). The policies fall into two categories, ICT policies, and Teaching and Learning policies. Three of the ICT policies regulate mobile cellular technology information access and interaction. The policies focus on the provision of mobile infrastructure, security measures, ethical behaviour, communication and interaction on the university network.

The Teaching and Learning policies support the provision of mobile centric services in terms of integrating innovative technology in teaching and learning. Even though this provides evidence that the university has responded to the use of mobile technology at the university, policy document analysis could not find concrete frameworks or models that guide lecturers in providing mobile centric services.

The results of policy document analysis are now discussed in terms of the support they provide to lecturers and students. The discussion focuses on training, infrastructure, communication, interaction, and content design support.

i. Training

Three of the Teaching and Learning policies support the training of lecturers in providing mobile centric services (discussed in Section 4.2.2). The policies specified that the university provide lecturers with training that enables them to develop, implement and experience e-learning or m-learning. The university policies support the UNESCO 2013 mobile learning policy guidelines (Kraut, 2013), which recommended that educators receive training on how to provide learning resources, communicate, and interact through mobile technology.

ii. Infrastructure

The university regulates the provision of infrastructure through the ICT policies. Three ICT policies addressed the provision of infrastructure to lecturers and students (discussed in Section 4.2.3). Three models through which mobile phone infrastructure can be owned and used at the university are bring your own devices (BYOD), purchase a mobile device through a research funding, or own a university funded mobile device. The implication of the BYOD to lecturers and students is that they can be reluctant to use their mobile phones for communicating and interacting in teaching and learning. Furthermore, students have a variety of mobile phones, with some having better functionalities than others, for example smartphones compared with feature phones. As established in this study, some students indicated that their mobile phones had no multimedia capabilities (Section 4.6.2). Such mobile devices would be difficult to use as information access and interaction tools in learning. Hence, there is a risk of introducing information access divide based on mobile phone functionality. Even though BYOD has some advantages, this study recommends institutional policies to recognise and provide students from lower income families with financial assistance so that they can purchase mobile phones with multimedia capabilities.

iii. Communication and interaction

The university policies regulate mobile phone communication and interaction through the ICT policies (discussed in Section 4.2.4). The policies stipulate that lecturers can only use the university communication resources for the purposes of university business during working hours. Lecturers are obliged to use their office landline telephones for calling students. With respect to sending SMS and email, the policies provide a code of conduct on how lecturers should communicate with students. The policy on SMS requires that line managers approve SMS messages before they are sent to students. As established in this study, some lecturers were reluctant to follow such bureaucratic conditions and they did not communicate with students through SMS (discussed in Section 5.2.4). In this regard, the UNESCO policy guideline on mobile learning advised that policies should strive to provide access for all (Kraut, 2013). Even though the ICT policies encourage lecturers to use communication technologies innovatively to enhance teaching and

learning in ODeL, it is explicitly stated that the use of video-based telephone applications such as SKYPE is not permitted due to limited bandwidth.

iv. Content design

The university polices regulate content design through the Teaching and Learning policies. Policy document analysis established that the policies addressed the issue in a broad way, not specifically focusing on designing content for mobile phone access (discussed in Section 4.2.6). The policies require lecturers to design content that is accessible through the web and takes advantage of interactive technologies. Even though the policies encourage lecturers to design for interactive technologies, they categorically specify that tuition content developed for registered students should not be distributed through social media. Therefore, the institution supports the design of content that is accessible through mobile devices in a broad way, but it does not provide guidelines on how it could be accomplished.

This section established that policy readiness is an important aspect of institutional readiness in providing mobile centric services. Furthermore, policy document analysis could not find concrete frameworks or models for providing lecturers with best practices or guidelines that support the provision of mobile centric services. Hence, institutions need to support policies with implementation frameworks.

6.2.2.2 Which mobile cellular technology tools are provided by the university that facilitate student information access and interaction?

The university provides electronic tools that are accessible through a mobile phone to both lecturers and students. Tool observation analysis (discussed in Section 4.3) categorised mobile centric tools into *communication tools, interactions tools and access to resources tools* (presented in Table 4.2). The identified tools per category are as follows:

- Communication tools: SMS, email, telephone, and discussion forums.
- Interactions tools: Multiple Choice Questions (MCQ) assignment submission tool, Interactive Voice Response (IVR) tool, SMS parcel tracking tool and discussion forums.
- Access to resources tools: The LMS mobi site provided tools that facilitate access to resources. The lecturers can provide learning units, reading material, self-assessment, podcasts and share resources through the drop box. Students can access the resources provided by lecturers.

Therefore, when providing mobile centric tools, a university is recommended to provide tools that facilitate communication, interaction and access to resources.

6.2.2.3 Which services do students want to access and interact with through mobile cellular technology?

Student mobile centric needs were captured through Students survey 1 and discussed in Section 4.4. The identified student mobile centric needs were presented in Table 4-5. The list of mobile centric needs captured in Student survey 1 was prioritised in Student survey 2 in Section 4.5. The prioritised needs were used to design Student survey 3. Results of statistical Factor analysis on Student survey 3 data identified three categories of student needs and they are A*ccess to resources needs, Interaction needs and Communication needs*, (discussed in Sections 4.6.7 - 4.6.9). The access to resources needs included access to administrative, learning and informational resources. The interaction needs category included the desire of the students to be able to have synchronous and asynchronous interactions with other students and the lecturers. The interactions which the students would like to have included the ability to do group work and practical learning irrespective time and context.

6.2.2.4 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?

The data analysis results of lecturer interviews identified challenges that showed that the lecturers were not ready to provide students with mobile centric services that facilitate information access and interaction (discussed in Section 5.2). The factors included lack of technical expertise, motivation, leadership, resources awareness, infrastructure, finance.

i. Technical expertise

Technically, all the lecturer participants required training on content design, communication and interacting with students. Matching the needs of the participants with the contents of the policies (discussed in Section 4.2.2), it was established that the policies categorically supported professional development of lecturers with respect to integrating technology in teaching and learning. Hence, lack of lecturer technical expertise readiness could be due to other factors such as motivation, awareness or workload.

ii. Motivation

The data analysis results established that some lecturers were motivationally ready and others were not (discussed in Section 5.2.4). Two aspects motivated lecturers and they are prospects to establish a research niche in mobile technology and being sympathetic with students whose primary source of information access is a mobile phone. The findings support Davis et al., (1992) who argued that lecturers could be motivated in providing a technological intervention if it is enjoyable, valuable and if they could associate the activity with their teaching goals. For the lecturers who were not motivated in

providing mobile centric services, their cause of concern was lack of institutional support in terms infrastructure, workload and awareness.

iii. Infrastructure

The provision of mobile technology infrastructure was found to have an effect on the motivation of lecturers. The policy document analysis established that lecturers are encouraged to bring and use their own mobile devices (BYOD) at work (discussed in Section 4.2.3). The policies require lecturers to be responsible for the security, insurance and funding of their mobile devices. The conditions are unfavourable and could explain the lack of lecturer motivation. In this respect, the policies are viewed as not motivating lecturers in providing mobile centric services in teaching and learning.

iv. Workload

The workload of lecturers came out as a factor that affects the motivation of lecturers in providing mobile centric services (discussed in Section 5.2.3). The lecturers expressed that their workload was huge due to their wide job requirements that included research, tuition, academic citizenship and community engagement. Such a huge workload could be time intensive and not spare lecturers with time to experiment with new teaching technologies. The findings lend considerable support to studies that reported that lecturers could resist m-learning if they see it as an extra workload (Mohamad, 2012; Sridharan, 2013). However, the lecturers would consider providing mobile centric services if they are provided with technical support.

v. Awareness

Experiences gained from this case study have shown that even though the university has some resources for providing mobile phone services there, were lecturers who were not aware of their existence. Lack of awareness could be due to ignorance of technological advancement, negative attitude or lack of interest by the lecturers. In this respect, a policy document analysis could not find where the policies promoted and provided strategies for promoting mobile centric awareness among lecturers.

This study found that the factors that affect the readiness of lecturers in providing mobile centric services to students are technical expertise, motivation, infrastructure, workload and awareness.

6.2.2.5 Which mobile centric resources do lecturers provide to students that facilitate student information access and interaction?"

The mobile centric resources provided by the lecturers to students could be categorised into learning resources, communication resources and interaction resources.

i. Learning resources

The lecturer participants were not providing students with resources targeted for mobile phone access. The participants were not concerned with how the students access learning resources because they designed the resources for internet access. Hence, it was seen as the responsibility of the university's ICT department to provide tools that automatically adapt resources for mobile phone access. The perceptions of the participants contradict the view that resources designed for desktop computers may provide negative user experience when accessed through mobile phones (Traxler, Vosloo 2014; Botha et al., 2012; Peters, 2007). Botha et al., (2012) explained that due to the differences between the way desktop computers and mobile devices are used, m-learning pedagogy should be different from E-learning. Therefore, the university is recommended to provide lecturers with resources that facilitate the design of resources for mobile access.

ii. Communication resources

The lecturer participants communicated with their students through email, SMS, discussion forum and telephone. Concerning email (discussed in Section 5.6.1), lecturers perceived it as a universal channel that is accessible through any internet-enabled device. Hence, the lecturers argued that even though there are students who have mobile phones that are not email compatible, they are not disadvantaged because they could access email through any internet-enabled device. The participants claimed that it was impracticable for lecturers to receive and respond to students' emails through a mobile phone especially in ODeL. In ODeL, lecturers receive many emails per day and that would become unmanageable on a mobile phone.

Concerning SMS (discussed in Section 5.6.2), the participants used SMS for sending class administrative messages such as reminders, alerts and directives. The use of SMS was only one way, from the lecturers to the students. When lecturers broadcast SMS messages to the students, the system does not allow the students to respond to the messages through SMS. The students had to respond to the SMS messages through other channels such as email or telephone call. The findings highlight the existence of parallel communication between the lecturers and the students.

The participants used discussion forums as notice boards for posting announcements (discussed in Section 5.6.3). Discussion forums were considered an efficient way for managing large classes in ODeL since all the students could access the announcements. The advantage of communicating through a discussion forum is that announcements could remain there throughout the period of a course and the students can ask questions through the same platform.

Regarding telephone calls (discussed in Section 5.6.4), the participants discouraged students from calling lecturers. Telephoning students was taken as the last resort after all other communication channels have been exhausted. Some of the participants would not call students under any circumstances but they would receive calls from students. On the other hand, some participants would only call students if and only if they have an important issue that needed to be addressed with an individual student.

iii. Interaction resources

This study established that the participants provided students with learning activities that required students to interact with each other in groups. The activities were designed for desktop computer access and not for mobile phone access. Not providing students with learning activities designed for mobile phone access and interaction is against the notion that mobile phones provide students with a platform for collaboration and knowledge creation (Koole, 2009; Park, 2011; Peters, 2007). Even though the learning activities were not designed for mobile phone access and interaction, the lecturers encouraged the students to use any resources at their disposal to access learning activities. Lecturers would want to design activities that take advantage of social networking services that run on mobile devices. The perspectives of lecturers support Timmis (2012) who argued that group work practices are already visible in students' daily lives and universities should build their student support models on existing practices of students. With respect to providing learning content through social media, policy document analysis (discussed in Section 4.2.6) established that the content intended for registered students should not be published through social media. In addition, the policy stipulated that real time VoIP services such as Skype could not be used on the university network due to bandwidth limitation (discussed in section 4.2.4). Therefore, lecturers would be limited on the services that support group work that they can provide through social media.

The lecturers were not providing students with mobile phone based assessments (discussed in section 5.7.3), either formative or summative. For formative assessment, the lecturers requested services for self-assessment, portfolio of evidence, and peer evaluation. For summative assessments, the lecturers indicated that they would like to have access to a system that enables students to respond to multiple choice questions, and short question assignments. With reference to Tool observation analysis (discussed in Section 4.3), it was observed that the university already provides some of the resources being requested by the lecturers. For example, the university has a mobile MCQ assignment tool, which students can use to do and submit assignments. This finding indicates that the lecturers were not aware of the mobile resources that are provided by the university (discussed in Section 5.2.7). Therefore, the university is recommended to advertise the resources that are available to lecturers.

6.2.2.6 How ready are the students in accessing and interacting with mobile centric services at the university?

Students were found to be ready to access and interact with mobile centric services. The students were evaluated based on the following parameters: *ICT infrastructure ownership, Knowledge of mobile phone features, Sources of internet access, Mobile phone internet activities and Context of use* (discussed in Section 4.6).

i. ICT Infrastructure ownership

Mobile phones were the only IT devices owned by all the students if compared to other devices. Infrastructure ownership is one of the factors that determine if a group of people is ready to use a technology (Darab & Montazer, 2011; Machado, 2007). By comparing mobile phone ownership (100%) with iPad/tablet computer ownership (20%), fewer students owned iPad/tablet computers (discussed in Section 4.6.1). Therefore, mobile phones are accessible to most students and present a readily available channel for information access and interaction. Matching students' mobile phone ownership with the contents of policies, the policies did not address issues of providing students with mobile phone devices. The policies encourage students to bring their own devices (BYOD) and use them to access the university network. Section 6.2.2.1 discussed the implications of BYOD on student infrastructure ownership and use in learning.

ii. Knowledge of mobile phone features

The results confirmed that students had knowledge of their mobile phone functionality (discussed in Section 4.6.2).The majority of the students (over 90%) identified the features on their mobile phones and knew how to use them. However, there were some students who did not use (or know how to use) all the features on their mobile phones. Some students did not know whether their mobile phones had features such as a voice recorder, Twitter, Skype, Apps download, Instant messenger, or Maps (depicted in Figure 4.8). The findings of this study support Donner and Gitau (2009) who found that many people with mobile phones would not know if their mobile phones had internet or not. Therefore, students who were not aware of all the features on their mobile phones were assumed not to be fully ready to use their mobile phones. Considering that these were Computer Science students, it can be concluded that most other students could face similar challenges at the university. Therefore, technical support needs to be provided on how to fully use the necessary functions of mobile phones. With respect to student training, the results of the policy analysis established that the policies did not refer to providing students with technical training on using the mobile phones at the university. While the policies did not refer to student training in using mobile phones, they supported professional development of lecturers with respect to

integrating technology in teaching and learning. This study recommends that institutional policies include mobile training for students.

iii. Sources of internet access

Mobile phone internet access dominated the students' daily internet access compared to other information access resources such as desktop computers (discussed in Section 4.6.3). This reflected the readiness of students in utilising mobile phones as internet access tools. Even though mobile phones dominated internet access, the students also depended on desktop computer access especially when they are at their homes or at their work places. This finding is in line with Donner and Walton (2013) who found that even though students use their mobile phones to access the internet they often visit public internet access venues. Inversely, the results established that some students had never accessed the internet from a computer at home or computer at the work place (depicted in Figure 4.9). The results reveal that there are students who do not have desktop computer access at home and they do not have jobs where they can access internet from a desktop computer. Such students would most likely access internet from mobile phones as confirmed by the results of this study.

iv. Mobile phone internet activities

Factor analysis results established the categories of mobile internet activities of students as information gathering activities, communication activities, and social connection activities (discussed in Section 4.6.4 and presented in Table 4-9).

This study considered information gathering as a characteristic of mobile centric readiness. The results confirmed that the students have some mobile phone information gathering skills, for example searching the internet. This suggests that if the university provides students with mobile phone services that enable them to gather information, the students could be ready to use the services. Matching the students' information gathering activities with the institutional policy support, the results of policy document analysis established that lecturers are required to design content that is accessible on the web and utilises interactive technologies. This finding confirms that the institutional policies are ready to provide students with mobile centric information resources.

The communication activities that the students were familiar with included SMS texting, telephone calling, chatting or checking email. The results confirm that students have some mobile phone communication experience, which implies that they are ready to communicate with other students and their lecturers. Matching the communication readiness of students with institutional policy

support, policy document analysis established that the university supports mobile phone communication with students. Mobile phone communication is supported by the policies under the pretext of providing equitable communication to students. The university has specific policies that govern communication through telephone, SMS, email and Voice over Internet Protocol (VoIP) services such as Skype. The policies also enforce aspects of ethics and code of conduct when communicating with students. The results confirm that institutional policies are ready to govern mobile communication at the university.

The social connection activities that the students were familiar with included visiting social networking sites, chatting with friends, uploading and viewing pictures. The experiences gained when interacting on social media platforms is important in that they improve students' communication and interaction, sharing of content and knowledge, collaboration and virtual presence. Additionally, technologies that are available on social media platforms could enable students to have synchronous peer tutoring and group work. Therefore, the findings of this study provide evidence that students are ready to use their mobile phones for information access, interaction and sharing resources. Matching social media readiness of students with institutional policies support, the results established that the university has some guidelines on how social media should be used in pedagogy. The policies encourage academic and non-academic departments to utilise social media for marketing purposes only. Academic departments are discouraged from distributing copyrighted content on social media as only registered students could have that access privilege. Hence, the results confirm that the institutional policies are adequate to govern the utilisation of social media in pedagogy.

v. Context of use

The statistical results (Section 4.6.6) established that students always carry their mobile phones and use them at any given time and at any place. The students use their mobile phones either at public places such as stations or private places such as their homes. Hence, if students can access and interact with mobile phones in any context then in theory they can access and interact with learning resources in similar contexts. In reality, there are factors that may stop students from accessing and interacting with learning material such as noise levels that may disturb reading concentration. If mobile services are to be provided for accessing learning material in any context, the services should be designed in ways that take into consideration that both the device and the student are mobile.

6.2.2.7 Which constraints affect the provision of mobile centric services at the university?

The results of this study have shown that the constraints that affect the provision of mobile centric services could affect the institution, the lecturers and the students. The constraints that could affect the institutions were found to be related to the funding of the mobile centric projects (discussed in Sections 4.6.10 and 5.8.4). The institution would need funds to purchase hardware, software, develop policies, training and managing the project. The lecturers and students could be affected by the technical constraints of the mobile devices when accessing and interacting with information (discussed in Section 4.6.10). The technical constraints included networking connection problems, battery life span, small display screen and theft of devices. The lecturers were constrained by work overload, attitude towards provision of mobile centric services, lack of technical expertise to design learning content and unfavourable provision of infrastructure models employed by the university (discussed in Section 5.8.1).

6.3 Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa

At this juncture, the findings from different sources of data have been presented by answering sub research question 1 and 2 (presented in Section 6.2). The sources of data for answering the sub research questions included Policy document analysis (discussed in Section 4.2), Tool observation analysis (discussed in Section 4.3), Student survey (discussed in Sections 4.4 - 4.6), and Lecturer interviews (discussed in Sections 5.2 - 5.8). The findings from these different sources are now integrated with the findings of the literature analysis presented as a *Conceptual framework for providing mobile centric services to students at HEIs* (depicted in Figure 2-6) in answering the main research question of this study. The main research question reads,

What are the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa?

The answer to the main research question is now presented as a *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*. The framework has five components, which are Readiness, Needs, Resources, Context of use and Constraints. Figure 6-2 presents the components, their characteristics and their relationships.

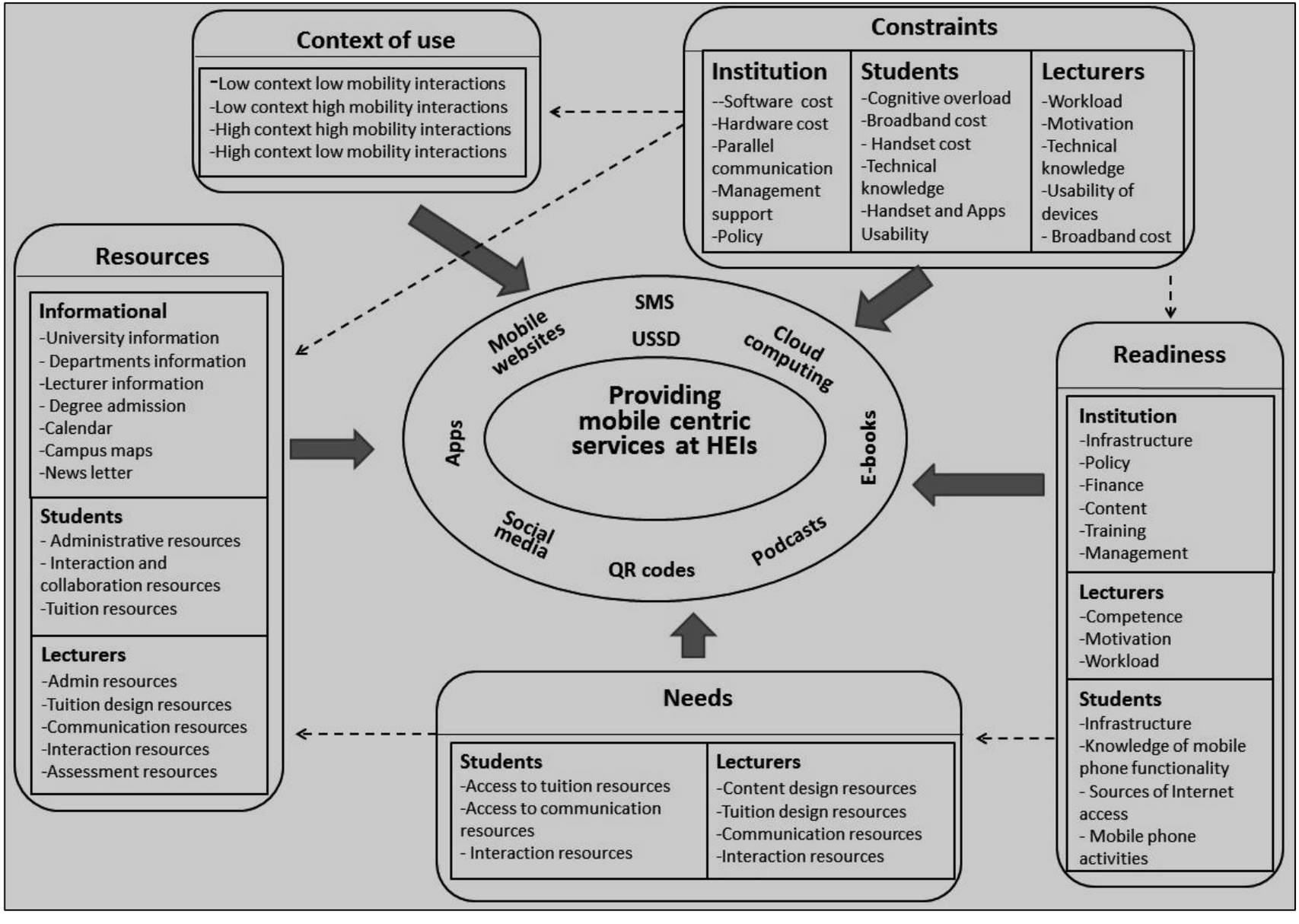


Figure 6-2: Framework for Providing Mobile Centric Services to Students at HEIs in ODeL context in South Africa

6.3.1 Readiness

Readiness is the preparedness of a higher educational institution and the interested stakeholders in providing mobile centric services. As illustrated in Figure 6-2, the major stakeholders that have to be ready when providing mobile centric services at a university are lecturers, students and the institution itself. Table 6-1 denotes stakeholder readiness in terms of the basic readiness requirements that need to be satisfied and the supporting evidence for including the requirement in this framework. The evidence is from the literature analysis (Chapter 2) and research results of this study (Chapters 4 and 5). From the literature analysis (Chapter 2), Table 2-6 provided the evidence for including components in the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs* (depicted in Figure 2-6). Hence supporting evidence from literature analysis refers back to Table 2-6 (Chapter 2).

Table 6-1: Stakeholder readiness

Stakeholder	Requirement	Evidence for inclusion from research results and literature analysis
Institution	Infrastructure	• Policy analysis (discussed in Section 4.2.3) • Tool observation (discussed in Section 4.3) • Lecturer interviews (discussed in Section 5.3) • Literature analysis reference (discussed in Section 2.8 and presented in Table 2-6)
	Finance	• Student survey 1 (discussed in Section 4.6.11) • Lecturer interviews (discussed in Section 5.4) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Policy	• Policy document analysis (discussed in Section 4.2.7) • Lecturer interviews (discussed in Section 5.7.3) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Content	• Policy document analysis (discussed in Section 4.2.6) • Student survey 3(discussed in Section 4.6.7) • Lecturer interviews (discussed in Section 5.5) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Management	• Lecturer interviews (discussed in Section 5.2.5)
	Training readiness	• Lecturer interviews (discussed in Section 5.2.1) • Literature analysis (discussed in Section 2.8, Table 2-6)
Lecturer	Competence	• Lecturer interviews (discussed in Section 5.2.2) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Motivation	• Lecturer interviews (discussed in Section 5.2.4) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Workload	• Lecturer interviews (discussed in Section 5.2.3)
Students	Infrastructure ownership	• Students survey3 (discussed in Section 4.6.1) • Literature analysis (discussed in Section 2.8 and presented in Table

Stakeholder	Requirement	Evidence for inclusion from research results and literature analysis
		2-6)
	Knowledge of mobile phone functionality	• Student survey 3 (discussed in Section 4.6.2) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Sources of internet access	• Student survey 3 (discussed in Section 4.6.3)
	Mobile phone activities	• Student survey 3 (discussed in Section 4.6.4)

6.3.1.1 Institution readiness

An institution is ready to provide mobile centric services if it satisfies the following requirements as presented in Table 6-1: *infrastructure, finance, policy, learning content, management support and training*. The following sections discuss each of these requirements.

i. Infrastructure readiness

In order for an institution to provide mobile centric services, it needs to have the necessary infrastructure. The infrastructure includes reliable mobile cellular network within the reach of the students, lecturers and the institution. The institution is required to have hardware and software infrastructure. Hardware infrastructure constitutes computer servers and the network backbone for connecting to the GSM mobile cellular network. Software infrastructure constitutes the services that enable the students to access and interact with the information repositories on the institution network.

ii. Financial readiness

An institution needs funds to support the provision of mobile centric services. The funds are required to support the budget for sourcing hardware, software, content development, human resources training and operational costs.

iii. Policy readiness

An institution needs a policy that regulates its provision of mobile centric services. The policy is required to guide content design for mobile phone access, lecturers' workload, network security, training, resources awareness, and provision of infrastructure.

iv. Content readiness

An institution can provide learning resources in two ways. Lecturers can develop new content or adapt existing content for mobile phone access. If lecturers create new content, the content should

be fluid so that it is usable on a variety of devices. Techniques for designing fluid content include Responsive Web Design (Marcotte, 2010) and Smart Framework for Web Content and Resources Adaptation in Mobile Devices (Guirguis & Hassan, 2010). If the option for adapting existing content is followed, the server side adaptation techniques that could be used include the Webpage Filtering Technique (Bickmore, Girgensohn & Sullivan, 1999), Server Side Architecture for Re-authoring Existing Websites (Nichols, Hua & Barton, 2008). The adaptation techniques have the advantage of taking away the responsibility of formatting content or services from the lecturer.

v. Management readiness

This is the preparedness of the managers in supporting the provision of mobile centric services at the university. Managers are ready to support the provision of mobile centric services if they can provide and implement a mobile centric strategy. Strategy implementation includes capacity building, sourcing funds, drafting of new policies and managing employees workload to support the provision of mobile centric services.

vi. Training readiness

This entails the capacity of the institution to organise, provide and evaluate a mobile centric training program. Curriculum for mobile centric training has to address content design, interaction, communication and mobile functionality.

6.3.1.2 Lecturer readiness

Lecturer readiness is concerned with the preparedness of lecturers in providing and supporting students with mobile centric services. The study found that lecturers can only be ready to provide mobile centric services if they are competent, motivated, aware of the technology and have a manageable workload.

i. Competence

Lecturer competence is concerned with the knowledge and technical skills that enable the lecturers to provide students with mobile centric services at the university. The study found that lecturers are competent to provide mobile centric services if they can design content and learning activities optimised for mobile phone access as well as communicate and interact with students through mobile phones.

ii. Motivation

Motivation is concerned with factors that stimulate the desire and energy of lecturers to commit to provide mobile centric services. Lecturers would be motivated in providing mobile centric services if it is enjoyable, valuable (Davis et al., 1992) and can associate the activity with their teaching goals (Chiu, Wang, 2008). The study found that motivated lecturers have the will to go the extra mile, are innovative, goal oriented and problem solvers. On the other hand, a university can motivate lecturers by providing training, technical support and incentives for good work.

iii. Workload

Workload is concerned with the amount of work that the lecturers are expected to do. The study found that lecturers with above normal workload could resist providing mobile centric services because they saw it as extra work. A manageable workload that provides lecturers with time to attend training, research and experiment with mobile technology would motivate lecturers to embrace the technology.

6.3.1.3 Student readiness

The preparedness of students in communicating, accessing and interacting with services through mobile phones determines their readiness. The study found factors that affect students' readiness to include infrastructure ownership, knowledge of mobile phone functionality and mobile phone activities (depicted in Figure 6-2 and presented in Table 6-1).

i. Infrastructure ownership

Students are mobile centric ready if they have the mobile phone infrastructure to access and interact with services. In order for a university to provide students with mobile centric services, all the students are expected to have access to a mobile phone handset. If some students do not have handsets or their handsets cannot access the mobile centric services, the university needs a strategy for providing those students with mobile phone handsets.

ii. Knowledge of mobile phone functionality

Students are mobile centric ready if they are familiar and know how to use the functionalities of their mobile phones. If students are familiar with using the functions, they would readily use the services; otherwise they would need training on how to use the various functions.

iii. Mobile phone activities

Mobile phone activities are concerned with how students use mobile phones as tools for information gathering, communication, and social connection.

- Student information gathering activities included searching for facts to win an argument, sports results and medical information, just to mention a few (discussed in Section 4.6.4 and presented in Table 4-9). Therefore, students are ready to interact with similar information gathering activities for their learning.
- Students' communication activities included texting, telephoning, emailing, just to mention a few (discussed in Section 4.6.4 and presented in Table 4-9). Therefore, students are ready to interact with similar communication activities in learning.
- Students' social connection activities included chatting with friends, promoting their images, uploading and viewing pictures (discussed in Section 4.6.4 and presented in Table 4-9). The activities improve students' communication, interaction, sharing of knowledge and collaboration. Therefore, students are ready to interact with similar activities in learning.

6.3.2 Needs

Needs are the perceived requirements that lead a student or a lecturer to use a mobile phone as an information access and interaction tool. Table 6-2 denotes the lecturers and students needs in terms of mobile centric requirements as supported by evidence from literature analysis and empirical results of this study. From literature analysis (Chapter 2), Table 2-6 provided the evidence for including the components in the *Conceptual Framework for Providing Mobile Centric Services to Students at HEIs*. Hence, supporting evidence from literature analysis refers to Table 2-6.

Table 6-2: Mobile centric needs of lecturers and students

Stakeholder	Requirements	Evidence for inclusion from research results and literature analysis
Lecturer needs	Content design and authoring resources	• Lecturer interviews (discussed in Section 5.5 and presented in Table 5-1) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Communication resources	• Lecturer interviews (discussed in Section 5.6 and presented in Table 5-1) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Interaction resources	• Lecturer interviews (discussed in Section 5.7 and presented in Table 5-1) • Literature analysis (discussed in Section 2.8 and

Stakeholder	Requirements	Evidence for inclusion from research results and literature analysis
		presented in Table 2-6)
Student needs	Access to tuition resources	• Students survey 3 (discussed in Section 4.6.7, depicted in Figure 4-13 and presented in Table 4-10) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Interaction resources	• Students survey 3 (discussed in Section 4.6.8, depicted in Figure 4-14 and presented in Table 4-11) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)
	Communication resources	• Students survey 3 (discussed in Section 4.6.9, depicted in Figure 4-15 and presented in Table 4-12) • Literature analysis (discussed in Section 2.8 and presented in Table 2-6)

6.3.2.1 Lecturer needs

As illustrated in Table 6-2, the needs of the lecturers were found to be *content design and authoring resources*, *communication resources, and interaction resources*.

i. Content design and authoring resources

Lecturers require access to mobile content design and authoring tools. Examples of content design and authoring resources are intelligent LMS systems that automatically adapt content for mobile phone access, podcast/vodcasts recorders, software for creating simulations and games (presented in Table 5-1).

ii. Communication resources

Lecturers require access to resources that enable them to communicate with students. Communication resources include hardware devices, communication services and financial support. Mobile communication services include email, SMS, discussion forums, telephone calls and social media. Hardware devices include mobile phone handsets such as Smartphones. Financial support to sustain the mobile communication cost between the students and the lecturers (presented in Table 5-1).

iii. Interaction resources

Lecturers require access to resources that enable them to interact with students. Interaction resources include discussion forums, real time VoIP apps, and Instant Messaging apps (presented

in Table 5-1). An example of interactions that lecturers can embark on with students is real time teleconferencing.

6.3.2.2 Student needs

As illustrated in Table 6-2, student mobile centric needs were found to fall into the following categories: a*ccess to tuition resources, communication resources and interaction resources.*

i. Access to tuition resources

Students need to access administrative resources, learning resources and informational resources.

- Administrative resources are resources that help students to manage their learning on a daily basis. The administrative resources comprise of tools for accessing assignment and examination results, registration, accessing examination timetables, library books management, and school fees management (presented in Table 4-10).
- Learning resources are pedagogical tools that help students when they are learning. The learning resources comprise of tools that facilitate access to tuition content, podcast/vodcasts, practice examination questions and quizzes (presented in Table 4-10).
- Informational resources are online tools that enable students to access or request for information on the information systems repository. The informational resources comprise of campus maps and directions, bulletin boards, informational podcasts, news, advertisements or upcoming events (presented in Table 4-10).

ii. Interaction resources

Students need to access resources that facilitate learning interactions and learning administrative interactions.

- Learning interaction resources are online mobile centric resources that enable students to engage in pedagogic interactions. Examples of pedagogic interactions comprise of group work, peer tutoring, simulations, and assessments (discussed in Section 4.6.8). Examples of mobile centric resources include discussion forums, instant messaging and real time VoIP services such as Skype (presented in Table 4-11).
- Administrative interaction resources are mobile centric resources that enable students to manage their learning on a daily basis. Examples of administrative interactions comprise of registration, parcel tracking, assignment submission, checking results, borrowing books from the library, downloading study material and paying schools (presented in Table 4-11).

iii. Communication

Students need to access resources that facilitate communication with other students and lecturers. The communication resources comprises of hardware devices, communication services and support. Mobile communication services include email, SMS, discussion forums, telephone calls and social media (presented in Table 4-12). Hardware devices include mobile phone handsets such as Smartphones. Financial support is required to sustain the mobile communication cost between the students and the lecturers (presented in Table 2-6).

6.3.3 Resources

Mobile centric resources are applications that run on mobile phone devices that enable lecturers and students to do their work. The categories of mobile centric resources are informational resources and transactional resources, as depicted in Table 6-3.

Table 6-3: Mobile centric resources

Category	Examples of resources	Evidence for inclusion from research results
Informational resources	**Institutional resources** • General university information • Study information • Department information • Lecturer information • Admission information • Newsletter • Timetables • Student careers	• Search Hierarchy Framework (Rose & Levinson, 2004) • User Activities on the Mobile Web Taxonomy (Cui & Roto, 2008) • Matrix of Information Needs (Tate & Russell-Rose, 2012)
Transactional resources	**Student administrative resources** • Registration • Fees payment • Library book management • Parcel tracking • Accessing exam and assignment results • Learning flow management	• Tool observation analysis (discussed in Section 4.3 and presented in Table 4-1) • Students survey 1(discussed in Section 4.4 and presented in Table 4-5) • Students survey 3 (discussed in Sections 4.6.7, presented in Table 4-10, Table 4-11 and Table 4-12)
	Student interaction/collaboration resources • Communication • Group work • Peer mentoring • Assessments	• Tool observation analysis (discussed in Section 4.3 and presented in Table 4-1) • Students survey 1(discussed in Section 4.4 and presented in Table 4-5) • Students survey 3 (discussed in Section 4.6.8 and presented in Table 4-11 and Table 4-12)

Category	Examples of resources	Evidence for inclusion from research results

	Student tuition resources
	• Learning Management System (LMS)
	  o Podcast/vodcasts
	  o Lecture summarised content
	  o Links to learning resources
		• Tool observation analysis (discussed in Section 4.3 and presented in Table 4-1)
		• Students survey 1(discussed in Section 4.4 and presented in Table 4-5)
		• Students survey 3 (discussed in Section 4.6.9 and presented in Table 4-10)

	Lecturer administrative resources • Mobile content authoring tools • Assessment creation, and evaluation tools • Provision of learning resources tools • Provision of learning interaction/collaboration activities tools • Communication tools	• Lecturer interviews (discussed in sections 5.5 - 5.7 and presented in Table 5-1)

6.3.3.1 Informational resources

The goal of using an informational service is to obtain information on request. The mobile centric informational resources enable students and lecturers to obtain factual data upon making a query. Table 6-3 provides examples of informational services.

6.3.3.2 Transactional resources

Mobile centric transactional resources provide users with increased convenience of accessing secured services. Mobile centric transactional resources provide access to administrative services, interaction/collaboration services and access to learning content. The following sections discuss services.

i. Administrative services

Enable students or lecturers to carry out transactional administrative activities on a university system. Lecturer administrative services comprise of activities such as learning content design, uploading learning content, assessment, interaction and communication (presented in Table 6-3). On the other hand, student administrative services comprise of services such as registration, fees payment, and parcel tracking just to mention a few (presented in Table 6-3).

ii. Interaction/collaboration services

Enable students or lecturers to carry transactional interactive/collaborative activities. The students and the lecturers would have access to the same interactive functionalities except that lecturers would have administrative powers. Student mobile centric interactive/collaborative services facilitate interactions such as group work, peer mentoring, communication and assessment (presented Table 6-3).

iii. Access to learning content services

Enable students to access learning content through mobile devices. Learning content includes lecture notes summaries, podcasts/vodcasts and references.

6.3.4 Context of use

The dimensions of context, which are the physical context, social context and user context affect the provision and use of mobile centric services at a university. The contextual dimensions do not act in isolation but have an overlapping effect. Taking cognisance of the dynamic contexts under which students would interact with mobile phones, the findings suggest that mobile centric services are required to meet the needs of students in varying contexts. The Mobility and Context in Mobile Human Computer Interaction model (Botha et al., 2010) explains the contexts in which students can interact with mobile phones in context and is adopted in this framework. The model is a classifying matrix for grouping mobile interactions against given contexts as discussed below.

6.3.4.1 Low Context Low Mobility Interactions

This represents students who interact with mobile phones in static positions. Mobile phones interactions that can be carried out in this scenario include general broadcasting of messages that may not require immediate response, access remote information, interactions with a system (USSD) or communicate with other students. In this scenario, mobile phones are the only information access and interaction tools at students' disposal.

6.3.4.2 Low Context High Mobility Interactions

This represents interactions in a context where the mobility of the user and the device are important. Interactions that happen in this context are exposed to the forces of the physical, social and user context. For example, a student completing a multiple choice question (MCQ) assignment in a bus would be exposed to the physical motion of the bus, noisy social environment and would

need to disembark from the bus. Therefore, the designer of mobile centric services should take into consideration the physical context and social context factors that affect students.

6.3.4.3 High Context Low Mobility Interactions

This represents interactions that are dependent on the context in which they take place and the mobility of the student and the device is static. Interactions are personalised to student learning and require concentration on the task. The interactions are performed to achieve the expected goal. Examples of such interactions are: a student accessing the library catalogue, a student collecting data from the field, or a student participating in a discussion forum.

6.3.4.4 High Context High Mobility Interactions

This represents interactions in a context where the mobility of the student and the mobile phone is essential in mediating the interaction. These are high-level interactions that require HEIs to provide technological services that facilitate ubiquitous interaction with the environment. The technologies include augmented reality and virtual reality, which employ technologies such as GPRS, Remote Sensing, and Object Recognition.

6.3.5 Managing constraints

Constraints that need to be managed were found to affect students, lecturers and the institutions. Table 6-4 presents the constraints and how they can be managed.

Table 6-4: Constraints that affect the provision of mobile centric services

Stakeholder	Constraint	Managing the constraint
Students	Mobile phones demand attention from students all the time and this causes stress and anxiety.	• Limit the number of broadcasted messages • Put a policy to control broadcasting of messages. • Provide students with mobile apps that enable them to retrieve information on demand.
	HEIs do not train students how to use mobile apps.	• Provide training sessions on how to use mobile apps • Provide online tutorial sessions on how to use mobile apps.
	Cost for buying handsets and paying for tariffs.	• Negotiate with telecom companies for lower handsets and tariff prices.
	Mobile content is not compatible across a variety of mobile phone operating systems.	• Provide mobile content that is compatible to a variety of mobile phone platforms • This ensures that all students can access content from their mobile phones.
Lecturers	Overloaded workload causes	• Provide lecturers with manageable

Stakeholder	Constraint	Managing the constraint
	lecturers not to provide mobile centric services.	workloads that give them room to attend training, research and experiment with the technology.
	Without the technical expertise lecturers would not know how to provide mobile centric services.	• Provide training on content design and learning activities. • Provide training on mobile phone communication. • Provide training in mobile phone lecturer to student interactions.
	Resistance.	• Make the lecturers aware of the value of providing mobile centric services. • Associate the provision of mobile centric services with teaching goals. • Provide lecturers with training so that they can enjoy providing the services. • Provide lecturers with incentives for providing mobile centric services.
Institution	Lack of content design tools hinders the provision of mobile centric services.	• Make use of MOOCs that are formatted for mobile phone access. • Provide lecturers with the content design tools.
	Lack of software infrastructure for providing mobile centric services.	• Make use of Open source software (OPS) to provide mobile centric services, for example Moodle and Sakai LMS. • Make use of Social media platforms such as Facebook, Mxit, WhatsApp and Skype.
	Hardware infrastructure.	• Hardware for providing e-learning can be used for providing mobile centric services at the university. • Employ BYOD.

6.4 Chapter summary

This Chapter presented the answer to the main research question of the thesis, "*What are the components of a framework for providing mobile centric services at HEIs in ODeL context in South Africa?*" The answer to the main research question was presented as the *Framework providing mobile centric services at HEIs in ODeL context in South Africa* (depicted in Figure 6-1). The main components of the framework were identified as: Readiness, Needs, Resources, Context of use and Managing constraints. The following Chapter concludes the study.

Chapter 7: Conclusion

7.1 Introduction

This Chapter concludes the write up of this thesis. The aim of the research was to investigate the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa. This chapter reviews the research questions, the research methods, contributions of the study, limitations of the study and future research. Figure 7.1 gives an overview of this Chapter.

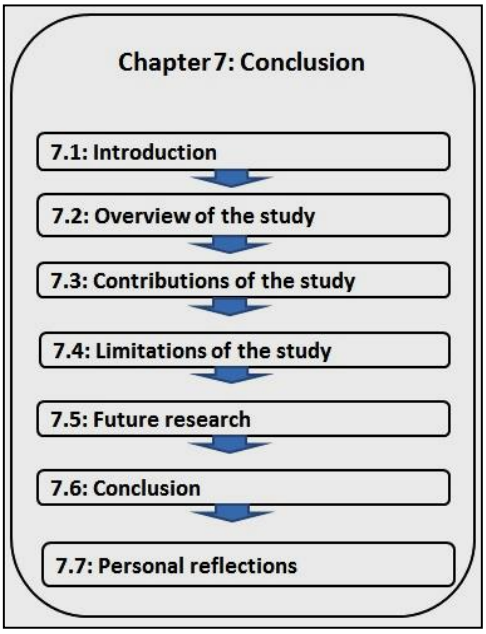


Figure 7-1: Overview of Chapter 7

The discussion in this chapter is as follows, Section 7.2 gives the overview of the research, Section 7.3 reflects on the research methodology, Section 7.4 discusses the contribution of the study, Section 7.5 discusses the limitation of the study, Section 7.6 discusses future research and Section 7.7 concludes the study.

7.2 Overview of the study

This thesis investigated the components of a framework for providing mobile centric services to students at HEIs in the context of ODeL in South Africa. The field of this study is Information Systems and the investigation was undertaken as a single embedded case study with embedded units of analysis (Yin 2009) at the University of South Africa (UNISA). The contribution of the

research is a *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*. The research question that guided this study was:

What are the components of a framework for providing mobile centric services to students at HEIs in ODeL context in South Africa?

The study had two sub research questions and they are:

1. *What are the components for providing mobile centric services that facilitate students' information access and interaction at HEIs?*
2. *To what extent does practice in HEIs reflect the components for providing mobile centric services that facilitate students' information access and interaction?*

The objective of the sub research question 1 was to identify the components that influence the provision of mobile centric services that facilitate students' information access and interaction at HEIs. Sub research question 1was answered by conducting a literature analysis. The literature analysis was presented in Chapter 2 and the outcome was a *Conceptual framework for providing mobile centric services to students at HEIs.* The conceptual framework had five categories and they are *Readiness, Needs, Resources, Context of use, and Constraints.* The components of the conceptual framework served as a blueprint for directing the search for evidence and organising the results in this study. The search for evidence was informed by sub research question 2. Sub research question 2 required the investigation to be undertaken as a case study reflecting HEIs' practice relative to the identified categories of the conceptual framework. To collect data, seven research questions were formulated to support sub research question 2. The research questions were:

- *2.1 What is the status of the university policy on the provision of mobile centric services?*
- *2.2 Which mobile cellular technology tools are provided by the university that facilitate student information access and interaction?*
- *2.3 Which services do students want to access and interact with through mobile cellular technology?*
- *2.4 How ready are the lecturers in providing students with mobile centric services that facilitate information access and interaction?*
- *2.5 Which mobile centric resources do lecturers provide to students that facilitate information access and interaction?*

2.6 How ready are the students in accessing and interacting with mobile centric services at the university?

2.7 Which constraints affect the provision of mobile centric services at the university?

The research questions guided data collection within the context of a single and embedded case study. Mixed methods data collection design was employed to collect data through Policy document analysis, Tool observation, Students surveys, and Lecturer interviews as presented in Chapter 3. The collected data was analysed qualitatively and quantitatively. Qualitative analysis was carried out on Policy document analysis, Tool observation analysis, Student survey1 and Lecturer interviews. Quantitative analysis was carried on Student survey 2 and Student survey 3. The results were triangulated in Chapter 6 leading to the formulation of the *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa*.

7.3 Limitations of the study

The research was undertaken as a single case study at only one ODeL higher educational institution. The institution was chosen because it is the largest ODeL University in Africa and the only one in South Africa. The research was also limited by purposefully selecting students and lecturers from the School of Computing as respondents. The relatively small number of 129 student participants and 15 lecturer participants is a limitation and affects the generalisability of the results. The technical aptitude and mobile devices owned by the respondents could be different from the rest of the student and lecturer population at the university. The selection means that the ICT challenges experienced by the students and the lecturers would likely apply to all other students and other lecturers in general. This researcher had also planned to have access to a student survey result collected by the University's Bureau of Market Research. The surveys collected information about student technological ownership from the wider student population but despite several requests, no access to the data could be secured.

The policies analysed and tools observed in this study were from the same ODeL University. However, the findings on matching student and lecturer readiness with policies are generalizable. Despite the identified limitations, the study contributed to the understanding of mobile centric readiness of students, lecturers and institutional policies.

An unexpected limitation was that ICT personnel were not available to be interviewed or to respond to a questionnaire during the study. ICT personnel's insights would have been of help in revealing the university's strategy on providing mobile centric services. Even though the ICT

personnel could not be reached, this study carried out tool observation analysis and policy document analysis to understand how the university provides mobile centric services.

Irrespective of the variety of mobile devices on the market, this study limited the investigation to mobile phone devices. Even though some students owned other devices such as PDAs and Tablet PCs, the results of data analysis established that the ownership was lower than that of mobile phones. Nevertheless, the components of the framework are equally applicable in guiding the provision of teaching and learning services through other mobile devices on the market.

The provision of mobile centric services in teaching and learning is time sensitive. This is due to the fast pace at which mobile phone technology is developing and evolving. New mobile phones with new technologies are produced within a short time period and this presents challenges in capturing data that correctly reflects the dynamic needs of the stakeholders. This research was conducted from 2011 to 2015. Therefore, data collection in this study is a snapshot of the current situation while acknowledging the dynamics of the ever changing mobile phone market. Despite the changing dynamics of mobile technology, the components of the framework remain relevant and are applicable to the provision of teaching and learning services through other technologies.

Despite the limitations as described in this study, the framework developed in this study was a true reflection of the data collected and analysed within the context of the case study. Mixed methods design was employed to gather and analyse data. The results of the data analysis were triangulated and informed the formulation of the components of the framework. The framework developed in this study has not been tested in the HEI environment and this opens room for future work.

7. 4 Contributions of the study

The following sections indicate the contributions of this research to the theoretical body of knowledge and its practical contribution to the field of Information Systems. The contributions are now discussed.

7.4.1 Theoretical contribution

Frameworks that inform the provision of mobile services in teaching and learning focused on mobile learning. The frameworks fall into the following groups: design of learning activities (Flores & Morteo, 2010; Koole, 2009; Muyinda et al., 2011; Shih & Mills, 2007), adapting learning material for mobile phone access and interaction (Khaddage & Zhou, 2009; Motiwalla, 2007;

Yang, 2007), classifying m-learning activities (Gay et al., 2002; Park, 2011; Taylor, Sharples, O'Malley & Vavoula, 2006), evaluation (Muyinda et al., 2011), and adoption (Baker, Krull, & Mallinson, 2005; Cheon et al., 2012). Nevertheless, the frameworks seemed to fall short of providing a holistic approach that informs the provision of mobile centric services at HEIs and that is the gap in the extant knowledge that this research addressed. Hence, a framework that informs the provision of mobile centric services was proposed.

The *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa* presented in this study makes a theoretical contribution to the body of Information Systems knowledge in the higher educational context. The contribution is incremental as the framework is a product of a conceptual framework developed from literature and empirically substantiated through a single case study with embedded units of analysis. Theoretically, the proposed framework provides an alternative lens through which the provision of mobile centric services at HEIs could be understood as a whole. It follows the logic that a complex whole could be understood from its parts and their interrelationships. The framework posits that successful provision of mobile centric services at HEIs depends on the successful resolution of tensions that could exist among the stakeholders' mobile centric needs and institution's standpoint in that respect. Therefore, the framework identifies the components for providing mobile centric services to students at HEIs in the context of ODeL in South Africa. The *Framework for providing mobile centric services to students at HEIs in ODeL context in South Africa* was presented and discussed in Chapter 6.

The rigour of the study is supported through evidence of triangulation and peer review. Mixed methods design was employed for data collection and multiple data sources were consulted, which include polices, tool observation, lecturers and students. The data collected from multi sources was triangulated for validating evidence.

The peer review was ensured by publishing the research in the Department of Higher Education and Technology accredited journals and conferences. The peer reviewed research publications included two journal papers and seven conference papers as presented in Table 7-1.

Table 7-1: Peer reviewed publications

Year	Paper	Stage of research
Journal papers		
2012	Chipangura B., Van Biljon J., & Botha A. (2012). Towards an ODL mobile centric model for inclusive sustainable interactions, *Progressio: South African journal for open and distance learning, 34(*3*),* 161-182.	Theoretical framework
2015	Chipangura B., Van Biljon J., & Botha A. (2015). Evaluating mobile centric readiness of higher educational institutions: The case of institutional policies and information systems students. *The African Journal of Information and Communication (AJIC), (*15*),* 4-13.	Data analysis and results
Conference papers		
2015	Chipangura, B., van Biljon, J., & Botha, A. (2015). An evaluation of the mobile centric readiness of students in HEIs. In E. Coleman (Ed.), *Renewing ICT teaching and learning: Building on the past to create new energies.* Proceedings of the 44th SACLAR 2015 Conference (pp 92-99). Johannesburg, South Africa.	Data analysis and results
2015	Chipangura, B., Botha, A., & Van Biljon, J. (2015). Support given to lecturers when providing mobile centric services in teaching and learning: A policy analysis perspective. In P. Cunningham & M. Cunningham (Eds), *IIMC International Information Management Corporation*. Proceedings of ISTAfrica 2015 Conference (pp 1-9). Lilongwe Malawi. DOI: 10.1109/ISTAFRICA.2015.7190537.	Data analysis and results
2014	Chipangura, B., van Biljon, J., & Botha, A. (2014). The provision of mobile centric services in Higher Educational Institutions: A case of lecturer readiness. In J. Steyn, J. & D. Van Greunen(Eds.), *ICTs for inclusive communities in developing societies.* Proceedings of the 8th International Development Informatics Association Conference (p 174-188). Port Elizabeth, South Africa. Retrieved from, http://www.developmentinformatics.org/conferences/2014/papers/16-Chipangura-VanBiljon-Botha.pdf	Data analysis and results
2013	Chipangura, B., van Biljon, J., & Botha, A. (2013). Prioritizing students' mobile centric information access needs: A case of postgraduate students. *Proceedings of the 2013 International Conference on Adaptive Science and Technology (ICAST)* (p 1-7). DOI: 10.1109/ICASTech.2013.6707519	Data analysis and results
2013	Chipangura, B. (2013). Categorizing the Provision of Mobile Centric Information Access and interaction for Higher Educational Institutions. *Proceedings of South African Institute for Computer Scientist and Information Technologies Conference, (p 101-1100).* East London, South Africa. DOI: 10.1145/2513456.2513460	Theoretical framework
2013	Chipangura, B., van Biljon, J., & Botha, A. (2013). Evaluating mobile centric information access and interaction compatibility for learning websites. *Proceedings of The Pan African International Conference on Information Science, Computing and Telecommunication (PACT 2013)* (pp 2018-222). Lusaka, Zambia. DOI: 10.1109/SCAT.2013.7055084	Data analysis and results
2012	Chipangura, B., van Biljon, J., & Botha, A. (2012). The digital difference between traditional information provision and students expectations in developing countries. In J. Steyn J & M Kirlidog (Eds.), *Alleviating Digital Poverty with ICT innovation in emerging economies. Will ICT Rights make a difference?* Proceedings of the 6th IDIA 2012 Conference (p 88-100). Beykent University,	Data analysis and results

	Istanbul, Turkey. Retrieved from http://www.developmentinformatics.org/conferences/2012/proceedings/IDIA2012-chipangura.pdf	

7.4.2 Practical contribution

Practically, the proposed framework can guide ODeL institutions or any other HEIs in providing mobile centric services to students. The framework informs HEIs' decision makers about the provision of mobile centric services. The decision makers include HEIs' managers, policy makers, IT managers and lecturers. In particular, the components of the frameworks guide HEIs in terms of institutional mobile centric readiness, identification of mobile centric needs of lecturers and students, identification of contexts in which students and lecturers use mobile centric services, identification of mobile centric resources that students and lecturers require, and managing the constraints (discussed in Section 6.3). This could inform the provision of mobile centric services at HEIs.

7.5 Future research

The framework provides a foundation for the provision of mobile centric services that facilitate information access and interaction at HEIs in the context of developing countries. One of the limitations of this study was that it was carried out at a single ODeL university and future research needs to focus on evaluating the framework at a residential university. The framework also needs to be evaluated based on technologies such as the Internet of Things and Cloud computing.

7.6 Conclusion

The framework adds new knowledge on understanding the provision of mobile centric information access and interaction at HEIs. The practical significance of the framework is that it can help HEIs with strategic planning around the rollout and implementation of mobile centric services to avoid pitfalls and make it sustainable. The components of the framework can help HEIs evaluate the readiness of various stakeholders in using mobile centric services, gauge the readiness of institutional resources in providing mobile centric services, gather the mobile centric needs of the stakeholders, translate the needs of the stakeholders into mobile centric services and manage the constraints that could be encountered. As such, the framework could be a valuable tool for informing HEIs' ICT strategies in general and when structuring policies for mobile phone information access and interaction in teaching and learning.

7.7 Personal reflection

At this juncture, I would like to say this was a worthwhile journey. I have grown intellectually and this has enhanced my scientific approach in solving problems.

Appendices

Appendix 1: Ethical clearance certificate 1

UNISA University of South Africa

Mr 8 Chipangura
Schoolof Computing
Pretoria

To whomit may Concern

Permission to conduct a Qualitative Research Project for a PhD Proposal entitled m-Learning adoption in an ODL context

The request for ethical approval for your research project entitled: "m-learning adoption in an ODL context" refers.

The College of Science,Engineering and Technology's (CSET) Research and Ethics Committee (CREC) has considered the relevant parts of the study relating to the abovementioned research project and research methodology and is pleased to indicate that the research process poses no ethical problems.

Therefore involved parties may also consider ethics approval as granted. However, the permission granted must not be (mis) construed as constituting an instruction from the CSET Executive or CSET CREC that sampled participants are compelled to take part in the research project. All participants retain their individual right to decide whether to participate or not.

We trust that sampling will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:

http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Yourssincerely.

ProfSLubbe
Acting Chairperson: CREC

Prof M Setati
Executive Dean: CSET

University of South Africa
Preller Street Muckleneuk Ridge, Pretoria
PO Box 392 UNISA 0003
South Africa
Telephone. +27 12 429 31 11
Facsimile +27 12 429 41 50
www.unisa.ac.za

Appendix 2: Ethical clearance 2

PROF L LABUSCHAGNE
EXECUTIVE DIRECTOR: RESEARCH DEPARTMENT
***Tel**: +27 12 429 6368 / 2446*
***Email**: llabus@unisa.ac.za*
***Address**: Theo van Wijk Building, 10th Floor, Office no. 50 (TvW 10-50)*

15 December 2014

Mr. B. Chipangura

School of Computing

College of Science, Engineering and Technology

Unisa

Dear Mr. B. Chipangura

PERMISSION TO DO RESEARCH INVOLVING UNISA STAFF, STUDENTS AND DATA

A study into: "A mobile centric framework for inclusive sustainable interactions."

Your application regarding permission to conduct research involving Unisa staff, students and data in respect of the above study has been received by the Research Permission Subcommittee of the Senate Research and Innovation and Higher Degrees Committee (SRIHDC) on 8 December 2014. The application will not be considered for approval by the Research Permission Subcommittee based on the retrospective nature of the application (the ethics clearance certificate was issued in 2011).

However, given that the Policy for Conducting Research Involving Unisa staff, students and data was approved by the Council on 20 September 2013, this letter provides you with principle permission to use the previously collected Unisa staff and student data to complete the thesis in fulfilment of your Doctor of Philosophy in Information Systems study during the proposed R & D leave in 2015.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

Please note that the future involvement of Unisa staff, students and data in this research will be excluded from this principle permission.

We would like to wish you well in your research undertaking.

Kind regards

pp  Dr. Retha Visagie Manager: Research Integrity

PROF L LABUSCHAGNE
EXECUTIVE DIRECTOR: RESEARCH

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

Appendix 3: Lecturer interview guide questions

Lecturer interviews

Interviewer Name: **Baldreck Chipangura**
Interviewee Name **……. Post……**
Venue: **……**
Date : **……**
Time: **……**

Title: Sustainable Mobile Centric Information Access and Interactions at Higher Educational Institutions

Objective: To reflect on how HEIs provide content and services that facilitate students' access and interaction through mobile phones.

Section A: Introduction

Interviewer: My name is Baldreck Chipangura and I am a PHD student at UNISA. I would like to thank you for accepting to participate in this interview. The duration of the interview is about 30 minutes. I hope you have read and signed the consent form.

Section B: HEI readiness

1. When designing online study material, do you consider the delivery mechanism, i.e. student information access resources?
2. Do you think you are ready to provide students with mobile centric services that facilitate students with information access and interaction in learning?
3. To what degree do you consider mobile phone information access?
    a. What about tablet computers?
4. Which resources are provided by the university that support the provision of mobile centric services?
5. In your view, how do the university's policies support mobile phone information access and interaction?

Section C: Student interaction and communication

6. Which learning resources do you make accessible to students through mobile cellular phones?
7. Which learning interactions do you provide to students through mobile cellular phones?
    a. Which other interactions would you consider?
    b. Which resources would lecturers need in order to achieve that?
8. How do you communicate with students through mobile cellular phones?
    a. Which other ways would you want to consider?
    b. Which resources would lecturers need in order to achieve that?

Section D: Content format

9. Do you prepare any learning content specifically for mobile phone access and interaction?
    a. Which other content formats would you consider?
    b. Which resources would you need in order to achieve that?

Section E: Constraints

10. What do you think are the challenges that would be encountered by the lecturers in providing mobile cellular phone information access and interaction?

Section F: Conclusion

11. How can the university improve mobile cellular interactions with students?

The END Thank you for your time

Appendix 4: Lecture interview consent form

CONSENT TO PARTICIPATE IN INTERVIEW

Title: Mobile Centric Information Access and Interaction at Higher Educational Institutions

Objective: To reflect on how HEIs provide content and services that facilitate students' access and interaction through mobile phones.

You are invited to participate in a research study conducted by *Baldreck Chipangura* PHD students in the School of Computing at the University of South Africa. The results of this study will be included in Baldreck Chipangura's PHD thesis.

You were selected as a possible participant in this study because you are a lecturer in the School of Computing at UNISA and your experience as Computer Science lecturer is valuable in this study. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

1. Taking part in the interview is voluntary.
2. You have the right not to answer any question, and to stop the interview at any time or for any reason.
3. The interview will take about 15-40 minutes.
4. You will not be compensated for this interview.
5. Your name or surname will remain confidential in any discussions or publications resulting from the interview.
6. All interview recordings will be stored in a secure place until I finish writing my thesis in 2014 and the tapes will be destroyed.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Name of Subject _____

Signature of Subject _____Date _____
Signature of Investigator _____Date _____

The END Thank you for your time

Appendix 5: Student survey 1

Students' mobile centric information access and interaction needs survey

Thank you for agreeing to take part in this research by completing this survey and providing your feedback.

Note that anonymity will be preserved and this data will only be used for research purposes.

The purpose of this survey is to investigate mobile phone information access and interaction needs at institutions of higher learning in developing countries.

The results of this research will be valuable in informing institutions of higher learning on how to provide students with access to resources and services through mobile phones.

Please answer the questionnaire as honestly and fully as you can. There are no right answers to these questions – we value your opinion. All the answers obtained from this research will be used for the purposes of this research only.

Your participation is completely voluntary, and your responses will be completely anonymous. If you agree in taking part in this survey please sign below.

Participant signature ……. Date …….

Thank you

Respond to the following questions based on the given scenario.
Consider the following scenario. Given the maturity advantage of e-learning and the fact that many of the decision makers may be pc-centric, a total redesign of the information systems are needed to accommodate the mobile-centric learning needs of distance education students. Reflecting on your own experience answer the following questions towards constructing a model for providing students with mobile centric services at higher educational institutions.

1.1 What are the information needs of students (organisational material such as timetables, study material download, discussion forums etc)?
1.2 What kinds of information do students prefer to access and interact with on a mobile phone?
1.3 What kinds of learning activities do students prefer to do on a mobile phone?

Appendix 6: Student survey 2 questionnaire

Students' mobile centric needs rankings survey

Dear Participant

Thank you for agreeing to take part in this research by completing this survey and providing your feedback.

Note that anonymity will be preserved and this data will only be used for research purposes.

The purpose of this survey is to investigate mobile phone information access and interaction needs at institutions of higher learning in developing countries.

The results of this research will be valuable in informing institutions of higher learning on how to provide students with access to resources and services through mobile phones.

Please answer the questionnaire as honestly and fully as you can. There are no right answers to these questions – we value your opinion. All the answers obtained from this research will be used for the purposes of this research only.

Your participation is completely voluntary, and your responses will be completely anonymous. If you agree in taking part in this survey please sign below.

Participant signature ……. Date …….

Thank you

Question 1
Consider the following information needs of distance education students as depicted in the table below. How would you rank the importance of each of the needs on a scale of 1 to 5, where 1 = not important and 5 = very important, for the implementation of a mobile information access in the ODL environment. Also indicate how often you would access the system. Your response should be in the format depicted below. Use an X to indicate your selection as in the example.

	Information need	**How important is the need?** 1= not important and 5 = very important				
		1	2	3	4	5
	Example				x	
1	Assignment feedback					
2	Assignment results					
3	Exam results					
4	Lecture summaries					
5	Tutorial and exam venues					
6	Due date reminders					
7	Student fees enquiry					
8	Exam timetable					

9	Announcements						
10	Study material						
11	Registration dates						
12	Discussion forums						
13	Self-assessment						
14	Campus maps and directions						
15	Course podcasts						
16	Library access						

Question 2:

	Information need	**How often would you access the need on a mobile phone system?** 1= not often and 5 = very often				
		1	2	3	4	5
1	Assignment feedback					
2	Assignment results					
3	Exam results					
4	Lecture summaries					
5	Tutorial and exam venues					
6	Due date reminders					
7	Student fees enquiry					
8	Exam timetable					
9	Announcements					
10	Study material					
11	Registration dates					
12	Discussion forums					
13	Self-assessment					
14	Campus maps and directions					
15	Course podcasts					
16	Library access					

Appendix 7: Student survey 3 questionnaire

Mobile phone information access needs and expectations for students survey

Dear Participant

Thank you for agreeing to take part in this research by completing this survey and providing your feedback.

Note that anonymity will be preserved and this data will only be used for research purposes.

The purpose of this survey is to investigate mobile phone information access and interaction needs at institutions of higher learning in developing countries.

The results of this research will be valuable in informing institutions of higher learning on how to provide students with access to resources and services through mobile phones.

Please answer the questionnaire as honestly and fully as you can. There are no right answers to these questions – we value your opinion. All the answers obtained from this research will be used for the purposes of this research only.

Your participation is completely voluntary, and your responses will be completely anonymous. If you agree in taking part in this survey please answer the following questions and submit them.

Thank you

* Required

Section A: Biographical Information

Your personal Information

1. What is your gender? *

Please select the applicable.

- o Male
- o Female

2. How old are you?*

Please select the applicable.

- o 19-24 years
- o 25-29 years
- o 30-35 years
- o more than 35 years

3. At which level of education are you at?*

Please select the applicable educational level.

- o First year
- o Second year
- o Third year
- o Fourth Year (Honours)
- o Post Graduate (MSc or PHD)

4. How are your studies funded?*

Please select the applicable.

- o Family
- o Bursary
- o Self funding
- o Other:

Section B: General ICT Infrastructure Ownership

Your access to ICT infrastructure

5. Which of the following electronic communication devices do you own?*

Please select all that apply to you.

- o Desktop Computer
- o Printer
- o Laptop
- o iPhone/iPad
- o Mobile Cellular Phone
- o Other:

6. Specify the brand and model of your mobile cellular phone*

Please tell us the brand of your phone for example: Nokia, Model: X2

7. Which of the following features are available on your mobile phone? [SMS]*

Please select all that apply to you.

	Yes	No	Do not know
SMS	⬬	⬬	⬬
Internet access	⬬	⬬	⬬
Camera	⬬	⬬	⬬
Video player	⬬	⬬	⬬
Calender	⬬	⬬	⬬
Emails	⬬	⬬	⬬
MP3 player	⬬	⬬	⬬
Voice recorder	⬬	⬬	⬬
Games	⬬	⬬	⬬
Document reader	⬬	⬬	⬬
Twitter	⬬	⬬	⬬
Clock	⬬	⬬	⬬
Maps	⬬	⬬	⬬
Instant Messanger	⬬	⬬	⬬
Apps download	⬬	⬬	⬬

8. Where do you access the Internet (via a desktop computer and/ laptop) and how often do you do this per week? [Desktop computer/ laptop at home]*
Please select all that apply to you.

	Not applicable	Once	Twice	Three times	More than four times
Desktop computer/ laptop at home	⬬	⬬	⬬	⬬	⬬
Internet cafe	⬬	⬬	⬬	⬬	⬬
Someone else's house	⬬	⬬	⬬	⬬	⬬
Work place	⬬	⬬	⬬	⬬	⬬
Mobile cellular phone (any time and anywhere)	⬬	⬬	⬬	⬬	⬬

9. As part of your normal routine, to what extent do you engage in the following activities on your mobile phone? Tell us if you do this regularly, infrequently, never or whether this is not applicable to you [Search internet for news or information on current events]*
Please select all that apply to you.

	Very often	Often	Seldom	Never	Not applicable
Search internet for news or information on current events	⬬	⬬	⬬	⬬	⬬
Search internet for particular facts to win an argument	⬬	⬬	⬬	⬬	⬬
Search internet for health or medical information	⬬	⬬	⬬	⬬	⬬
Use internet to access sports results	⬬	⬬	⬬	⬬	⬬
Go to TV websites to search for movies or films	⬬	⬬	⬬	⬬	⬬
Watch a video online	⬬	⬬	⬬	⬬	⬬
Download videos to watch later	⬬	⬬	⬬	⬬	⬬
Visit social networking sites to	⬬	⬬	⬬	⬬	⬬

check for updates and to update your status					
Check emails	●	●	●	●	●
Reply to your emails	●	●	●	●	●
View pictures received via mobile phone	●	●	●	●	●
Download songs for later use	●	●	●	●	●
Take pictures	●	●	●	●	●
Download documents	●	●	●	●	●
Surf the web for no particular reason, just to browse	●	●	●	●	●
Chat with your friends	●	●	●	●	●

10. How do you pay for your cellphone bills?
Please select one that applies to you.

- o ● "Pay as-you- go"
- o ● Cellular contract subscription

11. Please indicate the amount spent on airtime per week (if you have a monthly contract, please divide monthly contract amount by four to convert to weeks)?*
Please select one that is applicable to you.

- o ● Less than R20
- o ● R21 - R50
- o ● R51 - R100
- o ● R101 - R150
- o ● More than R150
- o ● I don't spend any money on air time
- o ● only receive calls
- o ● Only use free SMS

Section C: Context of Use

12. Please select from the statements below those that best describe your mobile phone use? [I always carry my phone]*
Please select a Yes if applicable to you or a No if not

	Yes	No
I always carry my phone	●	●
I use my Phone at a station (bus or train etc..)	●	●
I use my phone when travelling	●	●
I use my phone to capture situated interesting events	●	●
I use my phone at the same time doing other things	●	●

Section D: Mobile phone and Higher Education Institution access to resources, services and Interaction

13. Which of the following resources are important for mobile phone access? [Assignment feedback]*

Please indicate the importance on the five point Likert agreement scale as indicated in the table below.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Assignment feedback	⬬	⬬	⬬	⬬	⬬
Assignment results	⬬	⬬	⬬	⬬	⬬
Exam results	⬬	⬬	⬬	⬬	⬬
Lecture summaries	⬬	⬬	⬬	⬬	⬬
Tutorial and exam venues	⬬	⬬	⬬	⬬	⬬
Due date reminders	⬬	⬬	⬬	⬬	⬬
Exam timetable	⬬	⬬	⬬	⬬	⬬
Announcements	⬬	⬬	⬬	⬬	⬬
Study material	⬬	⬬	⬬	⬬	⬬
Registration dates	⬬	⬬	⬬	⬬	⬬
Discussion forums	⬬	⬬	⬬	⬬	⬬
Campus maps and directions	⬬	⬬	⬬	⬬	⬬
Course podcasts	⬬	⬬	⬬	⬬	⬬
Library access	⬬	⬬	⬬	⬬	⬬
Self assessment	⬬	⬬	⬬	⬬	⬬
Online registration	⬬	⬬	⬬	⬬	⬬

14. Which of the following activities are important for mobile phone interaction? [Order books from the library]*

Please indicate the importance as indicated on the agreement Likert scale in the table below.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Order books from the library	⬬	⬬	⬬	⬬	⬬
Submit assignments	⬬	⬬	⬬	⬬	⬬
Do multiple choice assignment	⬬	⬬	⬬	⬬	⬬
Capture learning evidence e.g photos and videos	⬬	⬬	⬬	⬬	⬬
Communicate and work together with other students when studying	⬬	⬬	⬬	⬬	⬬
Participate in discussion forums	⬬	⬬	⬬	⬬	⬬
Do online registration	⬬	⬬	⬬	⬬	⬬
Listen to podcasts	⬬	⬬	⬬	⬬	⬬
Track the courier of my Study material	⬬	⬬	⬬	⬬	⬬
Search online dictionary	⬬	⬬	⬬	⬬	⬬
Access E-learning portal (myUnisa)	⬬	⬬	⬬	⬬	⬬
Download study material	⬬	⬬	⬬	⬬	⬬
Share resources with my colleagues	⬬	⬬	⬬	⬬	⬬
Check book availability from the	⬬	⬬	⬬	⬬	⬬

library					
Pay school fees	⬬	⬬	⬬	⬬	⬬
Check the status of fees account	⬬	⬬	⬬	⬬	⬬

15. Which of the following communication messages do you consider important to receive on your mobile phone? [Assignment due date alerts]*
Please indicate the importance as indicated on the agreement Likert scale in the table below.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Assignment due date alerts	⬬	⬬	⬬	⬬	⬬
Exam date alerts	⬬	⬬	⬬	⬬	⬬
Fees due alerts	⬬	⬬	⬬	⬬	⬬
Library book circulation alerts	⬬	⬬	⬬	⬬	⬬
Exam results release alerts	⬬	⬬	⬬	⬬	⬬
Unisa adverts messages	⬬	⬬	⬬	⬬	⬬
Discussion class invitation messages	⬬	⬬	⬬	⬬	⬬
Class cancellation messages	⬬	⬬	⬬	⬬	⬬
Change of class venue	⬬	⬬	⬬	⬬	⬬
Registration reminders	⬬	⬬	⬬	⬬	⬬

Section E: Higher Education Institution environment and mobile phone constraints

16. Which mobile phone limitations have you encountered when interacting with your mobile phone? [Poor network connectivity]*
Please select the limitations as indicated on the agreement scale in the table below.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Poor network connectivity	⬬	⬬	⬬	⬬	⬬
Unreliable battery lifetime	⬬	⬬	⬬	⬬	⬬
Small screen that is difficult to read on	⬬	⬬	⬬	⬬	⬬
Make typing mistakes on the keyboard	⬬	⬬	⬬	⬬	⬬
Concerned about security of my phone (theft)	⬬	⬬	⬬	⬬	⬬
Slow data exchange e.g uploading photos	⬬	⬬	⬬	⬬	⬬
websites display well on my phone	⬬	⬬	⬬	⬬	⬬
Internet access on my phone is expensive	⬬	⬬	⬬	⬬	⬬

I afford to call other students	●	●	●	●	●
I afford to SMS other students	●	●	●	●	●
I afford to call the lecturers	●	●	●	●	●
I afford to download school material from phone	●	●	●	●	●

Submit

Never submit passwords through Google Forms.

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Screen reader support enabled.

Edit this form

Appendix 8: Policy analysis protocol

Name of policy /date of publication	• What is the name of the policy and when was it approved?
Purpose	• What is the purpose of the policy?
Implications on training	• What does the policy say on the training of lecturers? • What does the policy say on the training of students?
Implications on provision of infrastructure	• What are the guidelines for providing lecturers and students with mobile phone infrastructure?
Implications on communication	• How are mobile phones supposed to be used when communicating?
Implications on provision of learning resources	• What are the guidelines for providing students with access to learning resources? • How does the policy support lecturers when providing learning resources
Implications on interacting with students	• What are the guidelines for lecturer to student interactions? • What are the guidelines for student-to-student interaction?

Appendix 9: Tool observation protocol

Investigated factor	Tools found	Tool platform	Lecturer activities	Student activities
Communication: • Which mobile phone tools are available for lecturers to communicate with students? • Which mobile phone tools are available for students to communicate with other students or the university?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers use these tools to communicate with the students?	How do students use these tools to communicate with other students, lecturers or the university?
Access to resources: • Which mobile phone tools are available for lecturers to provide students with learning resources? • Which mobile phone tools are available for students to access resources?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers/administrators use these tools to provide students with learning resources?	How do students use these resources to access the resources?
Interaction: • Which mobile phone tools are available that enables lecturers to provide interaction activities to students? • Which mobile phone tools are available that enables lecturers to interact with students? • Which mobile phone tools are available that enables students to interact with each other?	List the mobile phone tools that were found.	Where are these tools accessed from?	How do lecturers/administrators use these tools to provide students with learning resources?	How do students use these resources to access the resources?
Social media services: Does the university provide social media services to students?	List of services found.		Lecturer/ administrator activities.	Students activities.

Appendix 10: Tool observation analysis results

Factor investigated	Tools found	Source	Lecturer access	Students access
Communication	SMS	Staff web portal	Send announcements to students only.	Receive announcements. Send administrative text messages to the university.
	Email	LM Mobi portal	Send and receive email from students.	Send and receive email to other students. Send and receive email to lecturers.
	Telephone calls	Telephone	Call and receive calls from students.	Call and receive calls from lecturers. No telephone call to administration.
	Discussion forum	LM Mobi portal	Send announcements	Access announcements. Respond to announcements.
Access to resources	Drop box	LM Mobi portal	Share reading material with students Access students' assignments and portfolio of evidence.	Access reading material Submit assignments and portfolios.
	Official study material	LM Mobi portal	Provide students with learning material (assignments, question and answers …).	Students access study material.
	Self-assessments	LM Mobi portal	Provide students with question and answer.	Self-assessment.
	Podcasts/vodcasts	LM Mobi portal	Provide students with podcast/vodcasts.	Access podcast/vodcasts.
Interaction/collaboration	Discussion forums	LM Mob portal	Provide students with interaction activities. Monitor students' interactions. Provide guidelines on students' interaction.	Read through interaction. Participate on the interaction.
	Telephone calls	Telephone	Lecturers can call students.	Students can call lecturers for guidance.
	SMS	Mobile phone	-	Students can interact with each other through SMS.
Specialised tools	MCQ assignments submission tool	Mobi app	Provide students with multiple choice questions?	Capture answers to the assignment questions, submit answers, receive an immediate confirmation for a successful.

Factor investigated	Tools found	Source	Lecturer access	Students access
				submission, View the memorandum after submission.
	Interactive Voice Response tool	Mobi app	-	Students query the exam database and receive a voice response.
	Mobile library (catalogue, databases)	Library website	Search for reading material.	Search for reading material.
Social media services	Facebook, twitter, YouTube	All websites have links	Monitor, update and respond to students' queries.	Read through postings, and participate on interactions.

Appendix 11: Policy analysis results

	Purpose	Implications on students and lecturers	Mobile Infrastructure	Mobile Communication support	Supporting the provision of mobile phone services	Supporting the provision of mobile content	Mobile Interaction with students
Internet, electronic communication and web management policy Approved: 24:02:2009 Revised: None	The policy informs and educates users on the use of communication equipment and facilities, create rules for access, interception and disciplinary action.	The policy applies to all users.	Telephones, cell phones, electronic handheld devices.	Enhancement of distance learning with internet communication tools and resources. The use of Skype phones or webcams is not allowed due to bandwidth limitations. Email is official communication.	For providing services that facilitate students to access information and content through the Internet.	Students should be provided with resources that facilitate distance learning.	Students should be provided with communication tools and resources that facilitate interaction in distance learning.
ICT Mobile device policy Approved: 20:09:2013	The policy regulates the use of mobile devices on the university network and informs users of	The policy applies to all users who access the university network through mobile devices.	Mobile devices provided to university staff depending on their job responsibilities and needs.	Students have access to Eduroam resources through mobile phones.	Students have access to Eduroam resources through mobile phones. ICT is not	Not specified	Students have access to Eduroam resources through mobile phones.

	Purpose	Implications on students and lecturers	Mobile Infrastructure	Mobile Communication support	Supporting the provision of mobile phone services	Supporting the provision of mobile content	Mobile Interaction with students
Revised: None	their responsibilities in protecting university mobile devices and information.		Bring your own device rule applies (BYOD). Mobile devices can be university funded, own funded or research funded. BYODs are allowed on the network on condition that they are configured for security by ICT. Only university/research funded mobile devices will be maintained by the university. Students BYOD can access the eduroam network. Visitors BYOD have access to the network. ICT helps with BYOD connection		responsible for any specialised software licensing not supported by the university.		

	Purpose	Implications on students and lecturers	Mobile Infrastructure	Mobile Communication support	Supporting the provision of mobile phone services	Supporting the provision of mobile content	Mobile Interaction with students
			to network. BYOD users are responsible for the security of their devices.				
Telephone and cell phone policy Approved: 09:07:2005 Revised: 22:11:2013	The policy gives direction on the use of the university telephone landlines as well as the use of cell phones for work purposes.	The policy applies to all employees.	Cellphone, landline telephones. All cell phone contracts should be in the name of the user. The use of telephone services should be for university business purposes. Only senior management and professors working from home receive monthly telephone allowance.	Lecturers have unlimited access to landline telephones. Lecturers can call students on their cell phones.	Not specified	Not specified	Lecturers can call students on their cellphones and discuss teaching and learning matters.
Policy on sending SMS and emails to students Approved: 04:10:2011	The policy provides guidelines for the appropriate use of SMS and email communication between the university	The line manager should approve all SMS messages sent to students. Lecturers should quality control all SMS and email	Not specified	SMS should be used for communication urgent messages and where email will not suffice. Email is for communicating	- Orientation - Registration - Dispatch of study material - Assignment submission - Examination timetable and	Not specified	SMS system can give automated response to students. Employees respond to students email.

	Purpose	Implications on students and lecturers	Mobile Infrastructure	Mobile Communication support	Supporting the provision of mobile phone services	Supporting the provision of mobile content	Mobile Interaction with students
Revised: 23:11:2012	employees and students.	messages sent to students registered in their courses. SMSs and emails should be sent to relevant students only. Course related SMSs and emails are compulsory to all students. Students can opt out from receiving none teaching and learning messages.		academic and administrative messages. Policy specifies types of SMSs messages. Students can initiate SMS messages.	results - Library books request and tracking - Survey invitations and reminders - Fees payment and reminders - Counselling services - Tutorial classes		
Unisa social media guidelines Approved: 24:05:2011 Revised: None	The guideline provides direction on the use of social media for and between university employees and students. The guidelines protect the university's corporate data, information and privacy of employees and	The guideline applies to all employees. Employees, students and university partners are encouraged to use social media to stimulate conversation and discussion. Bloggers on social media should commit to monitoring their	Not specified	Not specified	Academic departments can market their subject matter and research output. The policy discourages the distribution of teaching and learning content on social media. Subject specific social media online presence	Not specified	University recognizes the right of students to associates with each other through social media. Students interaction on social media is not considered official.

	Purpose	Implications on students and lecturers	Mobile Infrastructure	Mobile Communication support	Supporting the provision of mobile phone services	Supporting the provision of mobile content	Mobile Interaction with students
	students.	blogs. Employees can provide services on social media in their capacity as university employees and in their personal capacity.			should be approved.		
Open and distance learning policy **Approved:** 03:10:2008 **Revised: None**	The policy positions the university as a leading provider of higher education opportunities through ODeL.	The policy provides resources for staff development in teaching and learning.	Not specified.	The policy encourages communication through telephony, video and audio conferencing, SMSs and MMSs via cell phones, e-mail and discussion forums/chat facilities on LMS.	The university will use the best possible mix of media to support its core functions.	Learning material will be delivered through: LMS, audio, video podcasting, wikis, blogs, and e-portfolios.	Students and lecturers can interact through telephony, video and audio conferencing, SMSs and MMSs via cell phones, e-mail and discussion forums/chat on the LMS.
Curriculum policy Approved: 19:11:2010 Revised: 23:11:2012	The policy provides guidance on curriculum design and quality assurance.	Applies to all lecturers. Provides resources for lecturer training in providing e-learning/m-learning resources.	Not specified	Embed e-learning, m-learning and a range of information and communications technologies (ICTs) to facilitate distance learning.	Not specified	Not specified	Not specified
Tuition policy Approved: 29-09-2005	The policy contains principles that guide	Empowers lecturers to meet international	Ability to use appropriate and sustainable	Promote students communication and articulation (*not*	Provide technologies to explore	Students are provided resources that enable	Promote student active learning through

	Purpose	**Implications on students and lecturers**	**Mobile Infrastructure**	**Mobile Communication support**	**Supporting the provision of mobile phone services**	**Supporting the provision of mobile content**	**Mobile Interaction with students**
Revised: 05-04-2013	teaching, learning and research at the university.	standards in teaching and research through professional development. Provides students with appropriate support in learning.	technologies (*not specific to mobile devices*).	*specific to mobile devices*).	knowledge, conduct investigation and produce products. (*not specific to mobile devices*).	communication, interaction, and research (*not specific to mobile devices*).	communication and interaction (*not specific to mobile devices*).

Appendix 12: Editors' certificates

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CERTIFICATE OF EDITING

To whom it may concern:

This letter confirms that the research thesis detailed below was edited by BetterResults Consulting's professional editor. It was edited for academic style and standards writing, including communicative strength, grammar, spelling expression, succinctness, consistency of style and referencing.

Thesis Topic:	*A Framework for Providing Mobile Centric Services to Students at Higher Education Institutions: The Case of Open Distance Learning*
Details:	Doctor of Philosophy in Information Systems, School of Computing, University of South Africa
Researcher:	Baldreck Chipangura
Promoter:	Prof Judy van Biljon
Co- promoter:	Dr Adele Botha
Dates:	December 2 – December 18, 2015

Signed:

Buhle Makamanzi, Professional Editor

Editing done by: Buhle Makamanzi (Mrs)
MComm M & E (UCT); MSc International Relations, Post Grad. Media & Comms; Dipl. Public Relations; BA

SPECIALIST IN: Monitoring & Evaluation | Project Management |Organisational Communications incl. Strategy Development; Media Relations; Social Media; C4D; Advocacy; Speech Writing; Content Development |Publications Development | Writing & Editing | Training & Mentoring
Johannesburg, South Africa. Mob: +27 71 890 5534 buhle.editor@gmail.com cc: buhle.mm@gmail.com

Felicityswordcafe

PO Box 905372, Garsfontein, 0042

12 February 2016

VIA E-MAIL
[chipab@unisa.ac.za]

To whom it may concern:

I hereby confirm that I proofread Mr Baldreck Chipangura's PhD Thesis titled: A Framework for Providing Mobile Centric Services to Students at Higher Education Institutions: The Case of Open Distance Learning, in January 2016.

Sincerely,

Felicity Erasmus
BA Languages – UNISA (1978)

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