A framework for the User Experience of teachers using mobile technology in resource constrained environments

By

Nonzwelo Rollen Makama

Submitted in accordance with the requirements for
the degree of

Master of Science

In the subject of
Computing

At the
University of South Africa

Supervisor: Dr Corne van Staden
Co-Supervisor: Prof Adele Botha

April 2021

DECLARATION

Name: Nonzwelo Rollen Makama

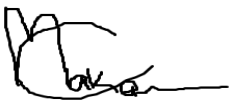
Student number: 55022146

Degree: Masters in Computing

I declare that **A framework for the User Experience of teachers using mobile technology in resource constrained environments** 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.

I further declare that I submitted the thesis/dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.



14 April 2021

_____ _____

SIGNATURE DATE

Abstract

The use of mobile technology at schools is no longer a dialogue in the boardroom, it has become a reality in South Africa. Various projects are taking place in the education sector that involve implementing the use of technology at schools in teaching and learning. Amongst these projects is the ICT4E project that resumed in 2016. The CSIR was assigned to lead the project, which aims to incorporate the use of mobile technology in teaching and learning in resource constrained environments. A resource constrained environment can be described as an environment with specific conditions, such as limited access to electricity, low levels of literacy within the population, a lack of infrastructure, and technology and technical constraints.

In the project, teachers were trained to use mobile technologies (tablets) in teaching and learning. After teachers had completed their training, they were provided with mobile technologies to use at schools with learners. After using the technologies, it was important to ensure that teachers were comfortable with using mobile technologies and that the User Experience (UX) of teachers using mobile technologies was enhanced. The study focussed on identifying the components and factors that may have an influence on the UX of teachers using mobile technologies in resource constrained environments, and aimed to develop a framework that can be used as a guideline in implementing and using mobile technologies at schools for teaching and learning. The framework informs the project implementers, researchers and other stakeholders to focus on the identified components.

The study used the explorative qualitative methodology to collect data, and utilised a questionnaire that was developed from a conceptual framework derived from the literature review. The study revealed that most of the components (subcomponents) and the factors that were identified do have an influence on the UX of teachers, and only a few were removed from the final framework. Additional factors that were identified or suggested by the participants (teachers) were included in the final framework. The final product of this study is the User Experience of Teachers using Mobile Technologies in Resource Constrained Environments (UXFTMTR) framework.

Key words: User Experience, Mobile technologies, resource constrained environment, ICT4E

Acknowledgements

I would like to thank the University of South Africa and the CSIR for granting me the opportunity to conduct the research. If it was not for the UNISA bursary I received I would not have been able to complete this degree. I greatly appreciate the assistance that I received from the CSIR, without their cooperation I would not have be able to reach all of the participants and I would not have had full access to the ICT4E project.

I would also like to thank my supervisors, Dr Corne Van Staden and Prof Adele Botha, for their guidance and for being patient with me.

To my daughter, Owethu, thank you for being understanding when I could not spend time with you, your love and support is incredible. To my family and friends thank you for your support and prayers. To my mother, Joana Ntuli, who made it part of her routine to call and check on me during this process — this one is for you, my dearest mom.

And where would I be if it wasn't for the Almighty Lord! Dear Lord, I thank you.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Description
CSIR	Council for Scientific and Industrial Research
ICT	Information and Communications Technology
ICT4E	Information and Communications Technology for Education
ICT4RED	Information Communication and Technology for Rural Education Development
DBE	Department of Basic Education
DST	Department of Science and Technology
DRDLR	Department of Rural Development and Land Reform
DoE	Department of Education
HCI	Human Computer Interaction
PDA	Personal Digital Assistant
TECH4RED	Technology for Rural Education Development
TPD	Teacher Professional Development
UX	User Experience
UXFTMTR	User Experience of Teachers using Mobile Technology in Resource Constrained Environments

KEYWORDS

Keyword	Description
Components	Components is the term used to refer to elements, aspects, dimension, factors or facets.
Context	Refers to the physical environment where the user interacts with the system (Schools).
Factors	Refers to the subcomponent of the components, the characteristics of the system that affect components.

Framework	A real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful (TechTarget, 2015).
Mobile technologies	Refers to mobile devices such as tablets, PDAs, smartphones and portable computers.
Resource constrained environments	Refers to rural environments, environments with many limitations including access to technology.
System	System is sometimes considered as a product or as the services it provides (ISO 9241-11:2018, 2018). This study used the term "system" to refer to mobile technologies.
Usability	The extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11:2018, 2018).
User Experience	A person's perception and responses resulting from the use and/or anticipated use of a product, system or service (ISO 9241-11:2018, 2018).

1. CHAPTER ONE: INTRODUCTION

1.1 Introduction

Towards the end of the twentieth century the use of technology started to change globally. These changes are classified as the redevelopment of the information society and the emergence of Information and Communication Technology (ICT) is believed to have influenced the development of the society (Bornman, 2015). According to Mbebe (2017), ICT refers to various technologies, including the Internet and mobile technologies that make it possible to process information. Huang and Tsai (2011) describe mobile technologies as mobile devices that enable a user to move around with their devices, the mobile devices includes tablets, PDAs, smartphones, portable computers, iPads. Technologies enable communication and access to information; they also make it possible to grant schools access to e-education using mobile technologies allowing teaching and learning to happen anywhere anytime (Chinapah & Odero, 2016).

South Africa's Department of Education (DoE) has embraced the significance of technology use in education and has suggested that all learners should be computer literate in order to use the technologies at schools (Nkula & Krauss, 2014). *The Dakar 2000 demanding education for all by 2015* framework, adopted by the World Education Forum (WEF) in Senegal, was based on the argument that everyone deserves an opportunity to have access to education to better their lives and to transform their societies (Simuja, Krauss & Conger, 2016). Education has the potential to improve development in rural areas, hence the importance of education transformation in rural schools (Chinapah & Odero, 2016).

In 2012, the Department of Science and Technology (DST) together with the Department of Basic Education (DBE) and Information Communication and Technology for Rural Education Development (ICT4RED) initiated a project with the main objective of improving education in rural schools using technological innovation (Mabila, Herselman & Van Biljon, 2016). According to SAINFO (2013), South Africa's Council for Scientific and Industrial Research (CSIR) was appointed to provide technologies and training to teachers in the Eastern Cape with the aim of developing a mobile teaching model that could be utilised nationwide. The project was executed over a period of three years (2012-2015), with teachers being trained to use mobile technologies to support teaching and learning through the Teacher Professional Development (TPD) programme (Mabila, Van Biljon & Herselman, 2016). One of the project's objectives was to develop infrastructure that would support the use of ICT, and mobile

technologies were introduced to enhance rural teaching and learning (Botha, Herselman, Musgrave & Jaeschke, 2017). The "ICT4RED was very successful in implementing technology at a school level and in empowering the teachers to teach with technology, using 21st century teaching practises" (Dlamini, Meyer, Marais & Ford, 2017, p.1).

The ICT4RED project was successfully implemented in 26 rural schools in the Cofimvaba district, in the Eastern Cape Province, where ICT was integrated and teachers were trained to use the mobile technologies in the classroom for teaching and learning (Dlamini et al., 2017). A project specific agreement between the Department of Rural Development and Land Reform (DRDLR) and the CSIR was signed in 2016 for the implementation of the Information Communication and Technology for Education (ICT4E) project in rural schools, with the aim of incorporating the use of mobile technology in teaching and learning (Herselman, Botha, Dlamini, Marais & Mahwai, 2019). The CSIR team was expected to implement the ICT4E project in 24 rural schools in seven of the nine provinces in South Africa (Herselman, Botha, Mayindi & Reid, 2018). The provinces included Limpopo, Gauteng and North West. Each school selected ten teachers to participate, and approximately 240 teachers from the seven provinces participated in the project (Herselman, Botha & Maremi, 2019).

Part of the project involved the training of teachers through a short learning programme known as the Teacher Professional Development (TPD) course, which was facilitated by The IDEA lab at the University of the Free State (Botha et al., 2017). The TPD course included skills, knowledge and strategy improvement in ICT, where teachers were trained to use the mobile technologies (tablets) in teaching and learning, and were awarded certificates for completing the course (Mabila, Herselman & Van Biljon, 2016). However, not all teachers were successful in completing the course, therefore the certificates were awarded on successful completion.

It is "without a doubt [that] teachers are essential in the integration of ICTs and as they are the ones who decide how to use ICTs in the classroom it is essential that they are trained and well equipped to integrate ICTs" (Nkula & Krauss, 2014, p.248). Various studies argue that most teachers do not have enough confidence and lack the experience to conduct teaching using mobile technologies (Chinapah & Odero, 2016; Nkula & Krauss, 2014). The successful use of technology in teaching and learning relies on the experience, attitude, teachers' beliefs, skills, resources, policies, culture and the environment where mobile technologies are used for learning and teaching (Mabila, 2017). Consequently, this research explored the user experience of teachers using mobile technologies in resource constrained environments. This study

focussed on Gauteng, North West and Limpopo where the ICT4E project was implemented in rural schools.

Rural schools are based in rural environments. Rural environments are considered to be resource constrained environments because they often lack proper road infrastructure, have low tele-connectivity, market growth is very low and have a low income (Herselman, Botha, Maremi, Dlamini & Marais, 2020; Mamba & Isabirye, 2015). A resource constrained environment can be described as an environment with many limitations including limited access to electricity, low levels of literacy, lack of technology and technical constraints, all of which require people to be innovative (Anderson, Anderson, Borriello & Kolko, 2012).

1.2 Background

The TPD course that was used in the ICT4E project contained activities that helped teachers improve their knowledge, strategies and skills in using mobile technologies (Botha et al., 2017). TPD has been used as an element to transform classroom practices, use of technologies and technology integration in the classroom (Botha & Herselman, 2015a). It is understood that teachers find it easy when the training is related to or involves the actual teaching, and the activities are school based and integrated into their daily work or duties (Saavedra & Opfer, 2012). Teachers who participated in the training course (TPD) and passed the course were offered tablets and badges, and graduated after course completion (Botha & Herselman, 2015a; Herselman, Botha, Dlamini et al., 2019).

After completing the training, teachers were expected to share their training skills with learners by applying the content using mobile technologies in the classroom (Botha & Herselman, 2017). Herselman, Botha et al. (2019) argue that training teachers to use mobile technologies in the classroom is important, as teachers are expected to apply their skills in implementing and using the technology at schools. As the teachers apply their skills in using the technology in the classrooms one should also take into consideration the "beliefs, attitude and anxiety levels of teachers when integrating mobile technology into their classrooms" (Herselman, Botha, Dlamini et al., 2019, p.50), thus be done with an intention to measure the UX of the teacher.

It is advisable that teachers know how to use the mobile technologies in the classroom to support teaching and learning, and that they have the necessary experience (Herselman, Botha

et al., 2019). The experience of the teachers is significant because the assumption is that if the teachers are motivated and comfortable with using the technologies, it will have a positive influence on the performance of learners and improve the standard of learning and teaching using the mobile technologies (Langenhoven, 2016). Therefore, the use of mobile technologies was evaluated with the aim of exploring the user experience of the teachers who participated in the ICT4E project using the mobile technologies in teaching and learning at schools.

User Experience (UX) is described by the International Organisation for Standardisation's current ISO standard 9241-11 on ergonomics of human-system interaction as "a person's perception and responses resulting from the use and/or anticipated use of a product, system or service" (ISO 9241-11:2018, 2018). User experience consist of factors that are used to determine the UX of the user, factors such as emotions, attitude, perceptions and the user's expectations (Alhussayen, Alrashed & Mansor, 2015; Kuusinen, Väätäjä, Mikkonen & Väänänen 2016). The primary reason for evaluating UX is to make improvements to the product or system, thus evaluation assists with identifying the gap in the field of UX and determining what needs to be improved (Tullis & Albert, 2013). "A system is sometimes considered as a product or as the services it provides" (ISO 9241-11:2018, 2018). This study used the terms "system" and "product" interchangeably.

The UX is used to examine the qualities of a system, and to improve efficiency, usability, user's satisfaction and experiences (Tullis & Albert, 2013). According to Roto (2006), user experience can be achieved through system evaluation, which identifies the UX components that affect the evaluation and can be used as a starting point for the system evaluation, design and system improvement. For the purposes of this study, the researcher referred to the system as the mobile technologies and the user as the teacher. The teachers' interaction with mobile technologies was not limited to teaching and learning, but also included activities such as doing research to develop learning and using the mobile technologies to do administration. It was, therefore, important to facilitate and enhance the user experience of the teachers using mobile technologies. This research focussed on developing a UX framework of teachers using mobile technologies in resource constrained environments (UXFTMTR) that will help improve the experience of using mobile technologies in learning and teaching in these environments.

1.3 Problem statement and research questions

This section focuses on the problem statement of the research and the research questions that were developed to address the objective of the research.

1.3.1 Problem statement

The use of mobile technologies such as smartphones, tablets and iPads not for telephonic use, but for other social interactions including learning and teaching in the classroom has become prominent (Harpur, 2013). In the context of education, teachers use the mobile technologies to deliver lessons to learners, but these are not only limited to learning and teaching. Mobile technologies can also be used by teachers to do research, for administration, and personal development (Becta, 2010). The transmission model acknowledges that teachers are influential in transferring knowledge to learners and in implementing the changes of the curriculum in the classroom (Saavedra & Opfer, 2012). The adoption and use of mobile technologies have been viewed as a challenge in many parts of the world including the African continent, mostly the sub-Saharan region where South Africa is also located (Isaacs, 2012). The challenges facing technology adoption at schools are compounded by a lack of infrastructure at schools, teachers being technophobic, a shortage of qualified teachers trained to teach using technology, and a lack of experience in using these technologies to teach (Mabila, 2017).

For mobile technology to be effectively implemented in schools, it is advisable to consider the fundamental elements required such as ICT infrastructure and teacher training so that they can adopt and deliver teaching and learning in the classrooms (Botha & Herselman, 2015b). "Teachers' adoption of technology plays a significant role in providing children with a technology-supported learning environment" (ChanLin, 2017, p.1936). The ICT4E project is one of the projects that was initiated to implement and improve ICT infrastructure in rural schools, and aimed to deliver tablets to these schools and train teachers to use the tablets (mobile technologies) for teaching and learning (Botha et al., 2017).

As mobile technology becomes progressively used in schools, and teachers are expected to conduct teaching and learning in the classrooms using mobile technologies, it is important to ensure that teachers are comfortable with using mobile technologies, the UX of teachers is evaluated and that the UX of teachers using mobile technologies is enhanced. This study used feedback from teachers to improve the UX of the teachers using mobile technologies for learning and teaching in resource constrained environments. According to Miao, West, So and Toh (2017, p.7), "[t]o improve the quality of education and make it more equitable and

inclusive, countries will need to accelerate efforts to ensure effective and well-qualified teachers for learners". Hence the importance of developing frameworks to ensure that technologies are used as expected at schools, and that the teachers' use of mobile technologies is improved.

Negative user experiences have been reported and have led to limited participation and engagement, resulting in the ineffective utilisation of the expected pedagogical gains and organisational benefits. A comprehensive survey of 1000 users found that poor UX translated to the abandonment of data services (WDSglobal, 2010). As a result, it is suggested that the UX of the teachers be acknowledged in order to provide an optimal learning environment (Davis & Wong, 2007).

Different UX frameworks and related frameworks were identified and discussed in this study. However, no specific UX framework for teachers using mobile technologies in resource constrained environments was identified. The aim of this study was to explore components and factors that are relevant to teachers using mobile technologies in resource constrained environments and develop a framework that can be used as a guideline to implementing and using mobile technologies for teaching and learning in rural schools.

1.3.2 Research question

The main research question is:

MRQ: How can the components of a framework for the user experience of teachers using mobile technologies enhance their classroom practice in resource constrained environments?

1.3.3 Research sub-questions

The following sub-questions assisted with achieving the research objectives and answering the main question

- RSQ1: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments?
- RSQ2: How is the user experience of the teacher reflected in the use of mobile technology for teaching in resource constrained environments?

1.3.4 Research Objectives

The main objective of the study:

To design a framework for the user experience of teachers using mobile technology in resource constrained environments.

The secondary objectives of the study:

- To identify the components and factors of user experience relevant to teachers using mobile technologies in resource constrained environment. — RSQ 1
- To evaluate the perception and expectations of the teachers when using mobile technologies in resource constrained environments.
- To evaluate the constraints affecting the provision of mobile technologies in resource constrained environments. — RSQ 2
- To assess the experience of the teachers using mobile technology in resource constrained environments.

1.4 Overview of the research methodology

The research project used the interpretive paradigm (philosophy). According to Oates (2006), interpretivism does not focus on producing a hypothesis, but rather explores the phenomenon with the aim of creating an understanding of the real social problem. An inductive approach was selected, which is often used in interpretivism, and an explorative qualitative research strategy was selected for this research because it focusses on exploring the phenomenon with the aim of identifying the problem and gaining insight about a phenomenon. Explorative research is explored qualitatively using qualitative data collection methods (Malhotra, 2010; Swanson, 2015). The study utilised purposeful sampling, and data was collected using a questionnaire comprising open-ended and closed-ended questions. The research methodology is discussed in Chapter Four.

1.5 Ethical processes

Research ethics are an important aspect in any kind of research. This study followed the UNISA code of ethics and applied for and received ethical clearance for the study from UNISA's ethical clearance committee (Appendix B). The study applied the ethical principles put forward by Fouka and Mantzorou (2011) and took into consideration the following:

- Informed consent
- Beneficence
- Anonymity and confidentiality
- Privacy

Since the study involved teachers who had participated in the ICT4E project, the researcher had to obtain ethical clearance from the CSIR Meraka Institute that was directing the project (Appendix C). More information regarding ethical considerations in relation to the research are provided in section 4.7.

1.6 Research contribution

This study sought to contribute to the body of knowledge of UX as it relates to the use of mobile technologies in resource constrained schools for teaching and learning. The study provides suggestions about how mobile technologies might be utilised in schools. Research into the user experience of teachers should provide insight into the user experience of learners when required or expected to use the technologies at schools.

The User Experience of Teachers using Mobile Technologies in Resource Constrained Environments (UXFTMTR) framework constitutes a practical contribution. The framework provides a full understanding of what constitutes a positive user experience for teachers using mobile technologies in resource constrained environments. Since the ICT4E project will be implemented in other provinces, the framework could be used as a guideline in implementing and using mobile technologies at schools for teaching and learning purposes. The framework suggests that the project implementers, researchers and other stakeholders focus on three key components — user (teacher), system (mobile technologies), context (schools) — if the use of mobile technologies at schools is anticipated to be successful in South Africa. The mobile technologies could help both teachers and learners create a conducive environment that drives basic schooling and increases educational value by fast-tracking learners' time to value and driving better technology adoption.

The scope and the limitations of the study are discussed below:

- The scope of the study was limited to the public schools in resource constrained environments in Gauteng, Limpopo and North West where the ICT4E project was implemented.

- The study focussed on the UX of the teachers as they interacted with the mobile technology.
- Data collection was limited to teachers who participated in the ICT4E project.
- The study focussed on teachers who attended and finished the training course (TPD).

1.7 Dissertation structure

This research consist of seven chapters. The structure of the research is illustrated in Figure 1.1 and indicates how each chapter is structured.

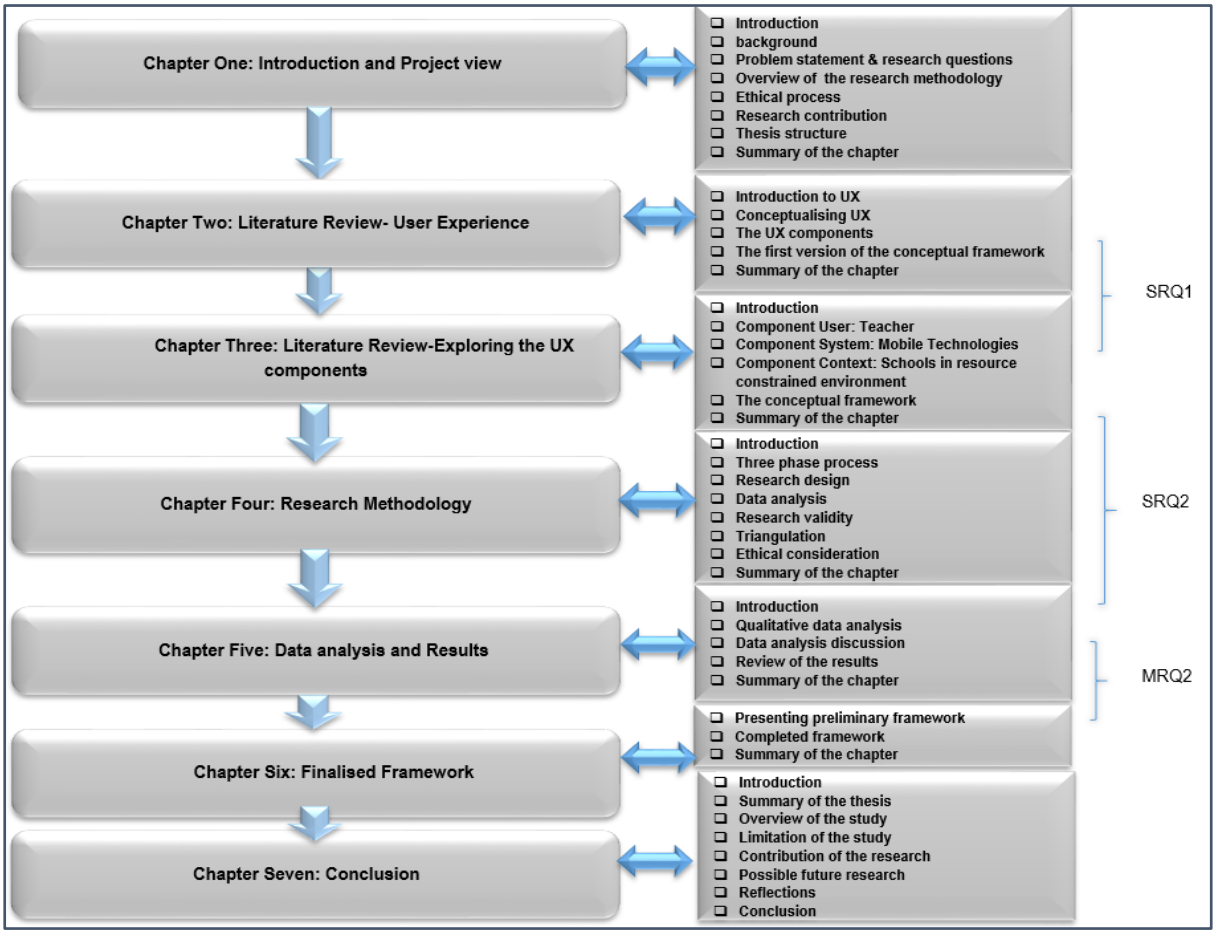


Figure 1.1: Dissertation structure

Chapter One — Introduction

- The introduction provides an overview of the research and what the reader should expect from the dissertation. This chapter includes the problem

statement, research questions and the objectives of the research. An overview of the methodology is also provided in this chapter, as are the ethical processes, the research contribution, as well as the scope and limitations of the study.

Chapter Two — Literature Review (User Experience)

- Chapter Two provides an overview of the literature review of the User Experience. The chapter first introduces UX and how UX is conceptualised, then discusses the UX components and the factors identified in different UX frameworks. The first version of the conceptual framework is provided in this chapter.

Chapter Three — Literature Review (Exploring the Components)

- The three identified components — user, system and context — are explored and discussed in the context of the study. The subcomponents (factors) of UX that are relevant to teachers using mobile technologies in resource constrained environments are identified and the final conceptual version is discussed in this chapter.

Chapter Four — Research Methodology

- This chapter outlines the overall research methodology of the thesis and discusses the selected paradigm, research approach, research strategy, research method, data collection and the source of the data. Ethical considerations are also discussed in-depth, including research validity and data analysis.

Chapter Five — Data Analysis and Results

- This chapter outlines how the data was analysed and presents the information collected from the questionnaire.

Chapter Six — Finalised Framework

- In this chapter the preliminary framework and the final framework are presented.

Chapter Seven — Conclusion

- This chapter concludes the research and includes a reflection on the study and provides recommendations for future research.

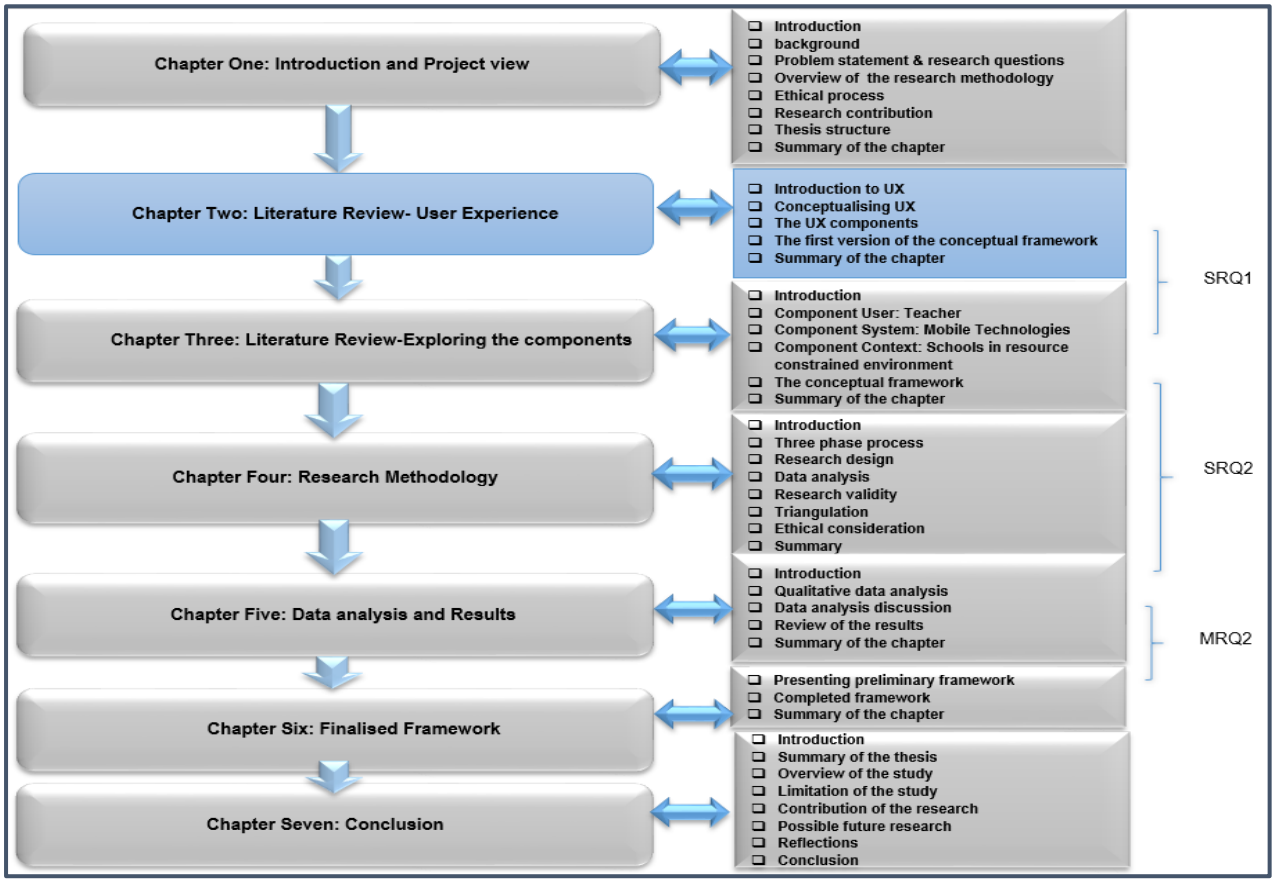
1.8 Summary

The use of mobile technologies in schools for teaching and learning is an emerging practice in South Africa. There is an assumption that the integration and use of mobile technologies at school has been slow due to the lack of professional development amongst teachers, teachers' beliefs about the use of technology, a lack of policies and a lack of experienced teachers to help integrate technology into schools. This research aimed to explore components and factors that are relevant to teachers using mobile technologies in resource constrained environments and developed a framework that can be used as a guideline to implementing and using mobile technologies for teaching and learning in rural schools.

The study was limited to teachers who participated in the ICT4E project, teachers who attended the TPD course and successfully completed it, and teachers who were using the technologies in rural schools in Limpopo, Gauteng and North West.

The problem statement, research questions, research objectives and contribution of the study have been outlined in this chapter. Chapters Two and Three constitute the literature review, Chapter Two focusses on the User Experience and Chapter Three focusses on exploring the UX components. The research used an explorative qualitative research method, with the intention of gaining insight into the phenomenon and addressing the research problem.

2. CHAPTER TWO: LITERATURE REVIEW — USER EXPERIENCE



2.1 Introduction

The literature review offers a summary of the available information relevant to this area of research. The purpose of conducting a literature review is to substantiate the proposed study or research (Cronin, Ryan & Coughlan, 2008). This chapter seeks to partly answer research sub-question one:

> **RSQ1: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments?**

The literature that was reviewed included academic journals, conference papers, online magazines and news, books, and internet sources. The sources were retrieved through the MyUnisa Library, Google search engine, and journal publishing databases. Databases such as Scopus, Research Gate, Elsevier, SAGE, ACM Digital, Science Direct and Google Scholar were used to find data sources for the literature review. The study adopted the APA referencing

style, following the APA guidelines throughout the research paper, and used Mendeley as the citation manager tool.

This study reviewed some of the published work concerned with User Experience, Mobile technology and ICT at schools in resource constrained environments, focussing on the components of UX related to the study. The literature review assisted with building a theoretical framework and identifying a gap in the body of knowledge. Focussing on the ideal cases helped formulate, explain and understand the phenomena that were used to build a conceptual framework. The keywords applied in the search used to generate the literature review are shown in Table 2.1.

Table 2.1: The search criteria used in the literature review

	Chapter Two: **User Experience**	**Chapter Three:** **Exploring the Components**
Keywords	User experience, Usability, UX frameworks, UX components	Mobile technology, ICT skills, Resource constrained environments, Context
Keyword searches	User experience in mobile technology, Factors of User experience, Definition of UX, Components of User Experience, UX components, Usability, UX product design frameworks, UX evaluation frameworks, Difference between UX and usability, Human Computer Interaction, Factors influencing UX.	Mobile technologies at schools, the use of technologies in schools, 21st century mobile technology skills, ICT challenges, ICT policy, Education policies, Mobile technologies factors affecting UX, Factors affecting mobile technologies at school, Mobile learning, ICT4E project, Different mobile technologies + mobile devices, Context in UX, Context of use.
Inclusion and exclusion principles	Studies focussing on the components of UX were considered. Articles focussing on UX frameworks were considered.	Studies focussing on mobile technologies were considered. Studies focusing on ICT at schools were considered. The pedagogy using mobile technologies was excluded.

The literature review is divided into two chapters: Chapter Two and Chapter Three. Chapter Two (Part I) concentrates on the User Experience and explores the components of user

experience with the purpose of uncovering which of the available components are relevant when using mobile technologies in resource constrained schools.

Chapter Three (Part II) focusses on the three components: user, system and context. The outcome of the literature review chapters is the conceptual framework. Figure 2.1 illustrates the structure of the literature review. The literature review contributed to answering the research problem and assisted with addressing the following objectives of the research:

- Identifying the components of user experience that are relevant to teachers using mobile technologies.
- Evaluating the perception and attitudes of the teachers using mobile technologies.
- Assessing the current practice of using mobile technology at schools.
- Evaluating what shapes the user experience in a teaching and learning environment.

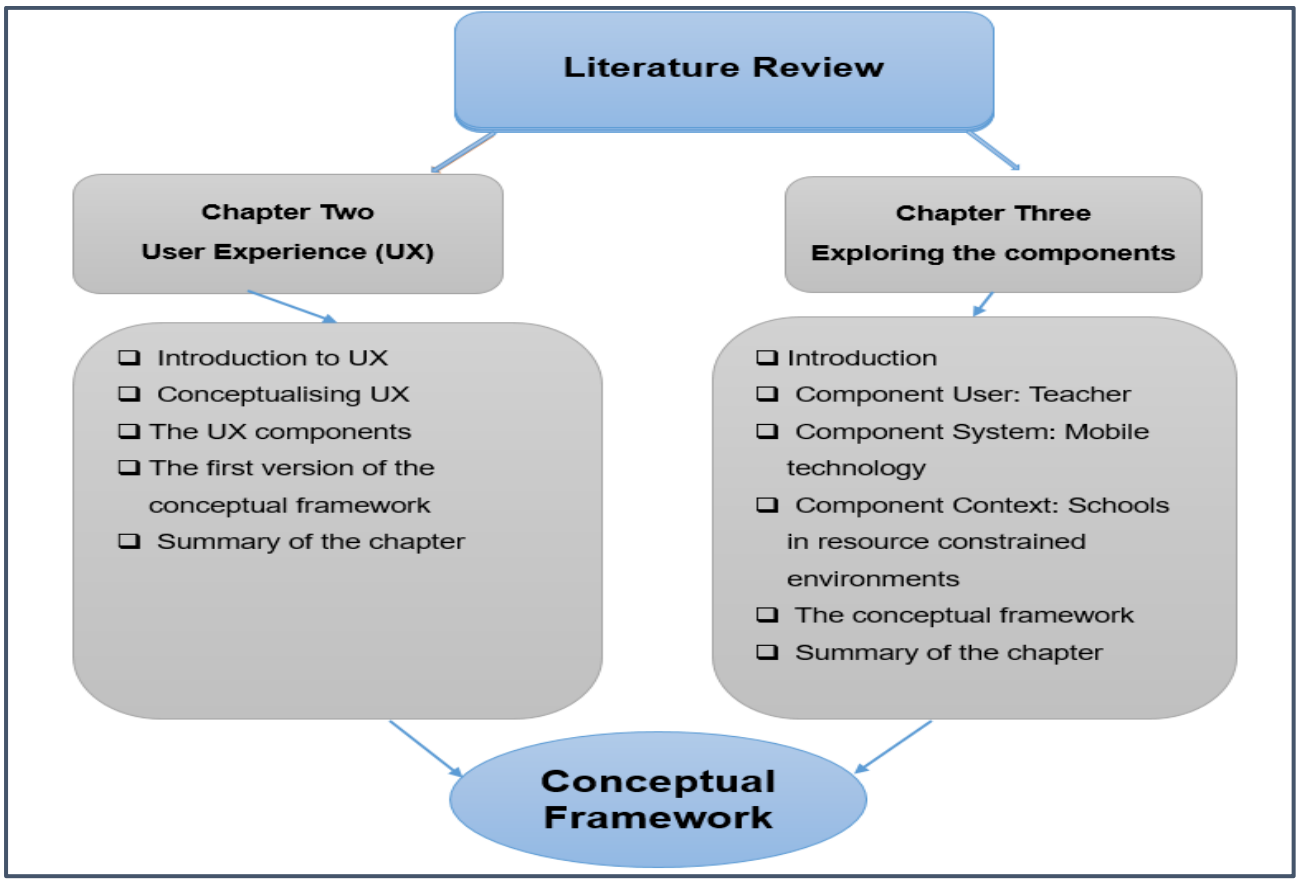


Figure 2.1: Structure of literature review

This section focusses on the existing literature concerned with User Experience.

2.2 Literature Review: Part I – User Experience

The following topics are covered in this section: Introduction to UX, the conceptualisation of UX, and the components of UX. These components were used to develop the theoretical framework that was used to create a UX framework for teachers using mobile technologies in resource constrained environments.

2.2.1 Introduction to UX

UX is a unique concept that can be viewed as a phenomenon, a field of study or a practice, depending on what the researcher wants to focus on (Kaasinen et al., 2015; Roto, Law, Vermeeren and Hoonhout, 2011). According to Scapin, Senach, Trousse and Pallot (2012), UX has been popular for some time, even during World War II. In the 1990s it was associated with User-centred design, however, in the job market the scope of UX was very limited. Over the past few years UX has shown potential for becoming independent, which has resulted in UX becoming a subfield of Human-Computer Interaction (HCI) (Glanznig, 2012; Toko, 2017).

According to Roto (2006), UX is used to evaluate the effectiveness and efficiency of a system through the user's feedback by way of emotions, behaviour, attitude, expectations and perception of the system. Portugal (2014) argues that the concept of UX includes "all emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and realization of the user" (p.232) during and after interaction with the system. As discussed in Chapter One, the terms "system" and "product" are used interchangeably in this study, and refer to the mobile technologies.

Tan's (2009) study emphasises that users are bound to declare that the system is user-friendly if it conforms to the standard of the user's expectation, meeting both functional and non-functional requirements, otherwise the system will not be user-friendly. With the improvement in the user requirements when designing a product or system, experience is important in the design of the product (Wan, Zhu & Hou, 2013, p.107). UX is viewed as the key element that should be taken into consideration when designing a product or system (Gentner, Bouchard & Favart, 2013). However, this study is based on the user experience of the teachers using the mobile technologies rather than on the design of the system. Alhussayen et al. (2015) confirm that users have expectations about the system when using the system (technologies) and their expectations are factors which may affect their experience of the

system. In general, UX is about the experience the user had when using the system, through the feedback from the user when interacting or after interacting with the system. In this study the system that is of interest is the mobile technology.

Figure 2.2 illustrates the product-user interaction UX where the ***user*** interacts with the product ***(system)*** in a specific ***context***, and each of the components has different factors that play a role in influencing the UX (Arhippainen, 2003). The framework was developed to show the interaction between the user and the mobile technology (iPad) in different contexts.

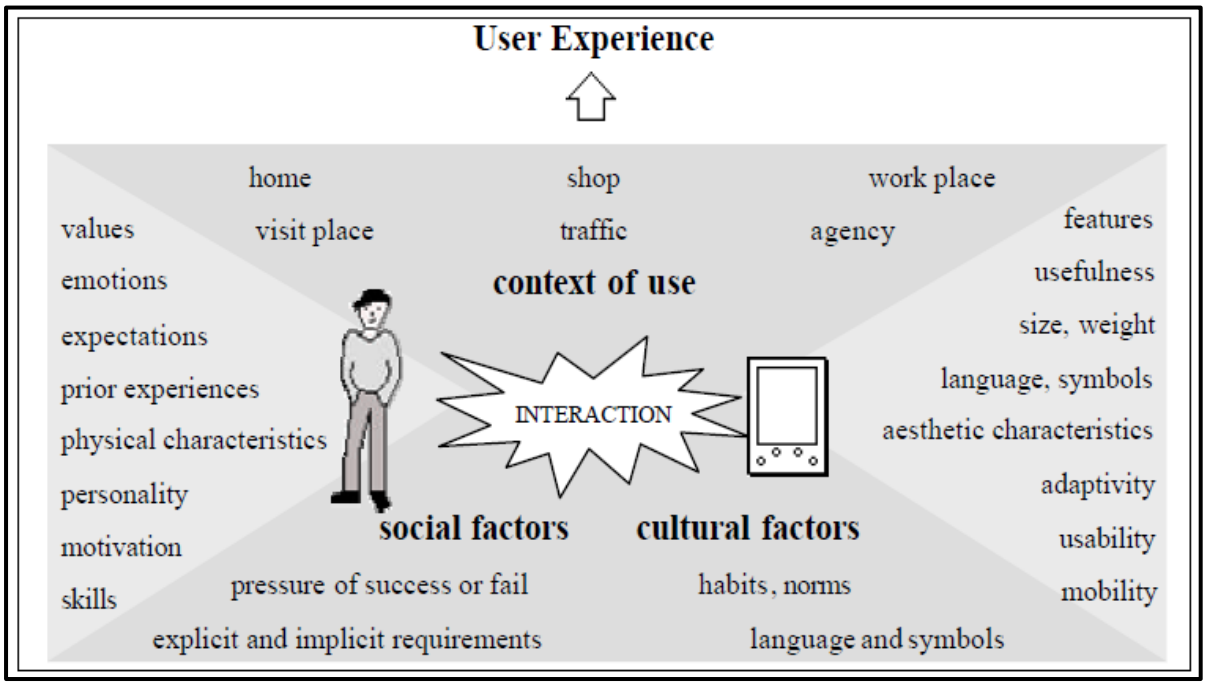


Figure 2.2: User Experience of product interaction in a specific context (Arhippainen, 2003)

There is, however, a difference between experience and user experience. "Experience" is aligned with people, and includes everything that a person has to go through, whereas "user experience" refers to an experience encountered when interacting with the system, such as mobile technologies (Roto et al., 2011). In brief, experience is what a person goes through in everyday life, and user experience is an experience that an individual has during an interaction, which means that there has to be an interaction for a user to have a user experience.

The user experience of the teacher is the focus of this study and not the experience that the user (teacher) has on a daily basis. The UX comes from an interaction with the mobile technologies.

2.2.2 Conceptualising UX

The concept of UX is broadly discussed in different types of research and has several different definitions; currently there is no agreement on the definition of UX (Hassenzahl & Tractinsky, 2006; Law, Van Schaik & Roto, 2013; Nakamura, De Oliveira & Conte, 2019). Most UX researchers do address the processes and the importance of good UX, yet only a limited number of researchers try to formulate a definition for UX (Nakamura et al., 2019; Roto, 2006). According to Roto and Rautava (2008), the concept of UX is ambiguous and is viewed from different perspectives because each product or system may have different goals for UX.

UX specialists (Law, Roto, Hassenzahl, Vermeeren and Kort, 2009) have outlined three reasons why it is challenging to have a single definition of UX:

- UX is affiliated with distinct concepts that involve emotions, expression, experience, hedonic and aesthetic variables. The inclusion or exclusion of each variable depends on the researcher's interest.
- Analysing UX comes with flexibility — from an individual point of view when interacting with the stand-alone system to different views of multiple users interacting with the company and its services from multiple disciplines.
- The aspect of UX is complicated with different theoretical models, such as emotional factors, pragmatism, values, pleasure and hedonic qualities.

To further explore the notion of UX it is appropriate for this study to define what UX is. The idea of UX is a growing field that is well described (Law et al., 2013; Nakamura et al., 2019; Van Schaik & Aranyi, 2014). A review demonstrated that it was challenging to put together a distinctive phrase for UX and to come up with unambiguous attributes of UX. As a result, the definition of UX depends on the view of the study (Harpur, 2013; Hassenzahl & Tractinsky, 2006; Law et al., 2009). Roto (2006) stated that "[a] fundamental question in User Experience definition is whether UX is a sensation, perception, emotions, mental state or an attitude?" (p.2).

There are many different definitions of UX, some of which have been discussed below.

Santosa (2016) defines User Experience as "the degree of positive or negative emotions that can be experienced by a specific user in a specific context during and after product use and that motivates for further usage" (p.340). According to Tullis and Albert (2013), UX concentrates

or focusses on someone's interaction with a system, and user experience ought to be measured to make improvements to the system.

Kuniavsky (2010) defines User Experience as:

> The totality of end users' perceptions as they interact with a product or service. These perceptions include effectiveness (how good is the result?), efficiency (how fast or cheap is it?), emotional satisfaction (how good does it feel?), and the quality of the relationship with the entity that created the product or service (what expectations does it create for subsequent interactions?). (p.14)

In his research Hassenzahl (2008) defines UX as "a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service" (p.12). Additionally, Hassenzahl (2008) states that "[g]ood UX is the consequence of fulfilling the human needs for autonomy, competency, stimulation (self-oriented), relatedness, and popularity (others-oriented) through interacting with the product or service (i.e. hedonic quality). Pragmatic quality facilitates the potential fulfilment of be-goals" (p.12).

The explanatory notes found in Scapin et al. (2012) interpret the definition of UX in the following way:

> User experience includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use" and "User experience is a consequence of brand image, presentation, functionality, system performance, interactive behaviour and assistive capabilities of the interactive system, the user's internal and physical state resulting from prior experiences, attitudes, skills and personality, and the context of use. (p.337)

User Experience (UX) is described by the International Organisation for Standardisation's current ISO standard 9241-11 on ergonomics of human-system interaction as "a person's perception and responses resulting from the use and/or anticipated use of a product, system or service" (ISO 9241-11:2018, 2018).

The definitions discussed imply that in UX, the user and the product are interacting, the user evaluates the system and through the evaluation outcome the user demonstrates their emotions, motivation, perception and reflection about the system (Kuusinen et al., 2016; Santosa, 2016). Saariluoma and Jokinen (2014), emphasise that the emotion of the person affects the behaviour and experience of the person when working on the system. UX focusses on the entire

interaction of the user with the system including feelings, opinions and perceptions about the system (Van Staden, Van Biljon, & Kroeze, 2015).

Moczarny, De Villiers and Van Biljon (2012) argue that "[a] satisfying experience is generally one that addresses the particular human needs of the user" (p.216). There is an assumption that the user's emotions can either be positive or negative, and it is assumed that the positive emotions or a positive attitude is associated with a good UX (Langenhoven, 2016).

Based on the definitions that have been put forward, it can be concluded that the definition of UX includes the person (user), interaction, system (mobile technologies), context of use (schools), emotions, behaviour, perceptions, experience, expectations, and satisfaction. This study adopted the definitions proposed by Santosa (2016) and Scapin et al. (2012) which state that characteristics such as perception, emotions, attitude, behaviour and expectations are incorporated when users interact with the system, which results in a UX being formed. According to Van Staden, Van Biljon and Kroeze (2017), of primary importance to UX is the experience of the user after interacting with the system.

This study explored the teachers' attitudes, perceptions, expectations, emotions, and opinions about their experience with the mobile technology, which contributed to the development of a conceptual theoretical framework for the UX. However, for the purposes of this study, the feelings of the user such as joy, sadness or the user's mood, were not considered, but the study does discuss emotional state, such as emotions and anxiety, of the user.

Table 2.2 presents a summary of the different definitions of UX from various researchers. These definitions share common denominators which were identified as components, namely: user, system, environment or context.

Table 2.2: Summary of the different UX definitions

Authors	***Explanation of the definitions***	***Common components identified in the definition***
Hassenzahl (2008)	Evaluation of the feelings, hedonic qualities of the users during interaction	User
Hassenzahl and Tractinsky (2006)	Assess the internal state, system design and the context where interaction occurs	System, User, Environment

Authors	*Explanation of the definitions*	*Common components identified in the definition*
ISO 9241-11:2018 (2018)	Response of the user, anticipation about the system	System, User
Kuniavsky (2010)	Perception of the user, the efficiency and effectiveness of the product or system	System, User
Law et al. (2009)	Model that focusses on system and user	System, User
Roto (2006)	Component to examine qualities of the system, through user's feedback	System, User
Scapin et al. (2012)	The involvement of emotions, perception, behaviour of the user, as a result of system functionality, performance, interaction in the context of use.	System, User, Environment
Tullis and Albert (2013)	Concentrate on interaction	System

It is logical to assume that the key factors of UX are based on human needs where user's emotions are involved, which includes their opinions and expectations about the product during/after the interaction with the system or product based on their needs. These are "[u]ser needs that go beyond tasks, goals and their efficient achievement" (Mahlke, 2008, p.1).

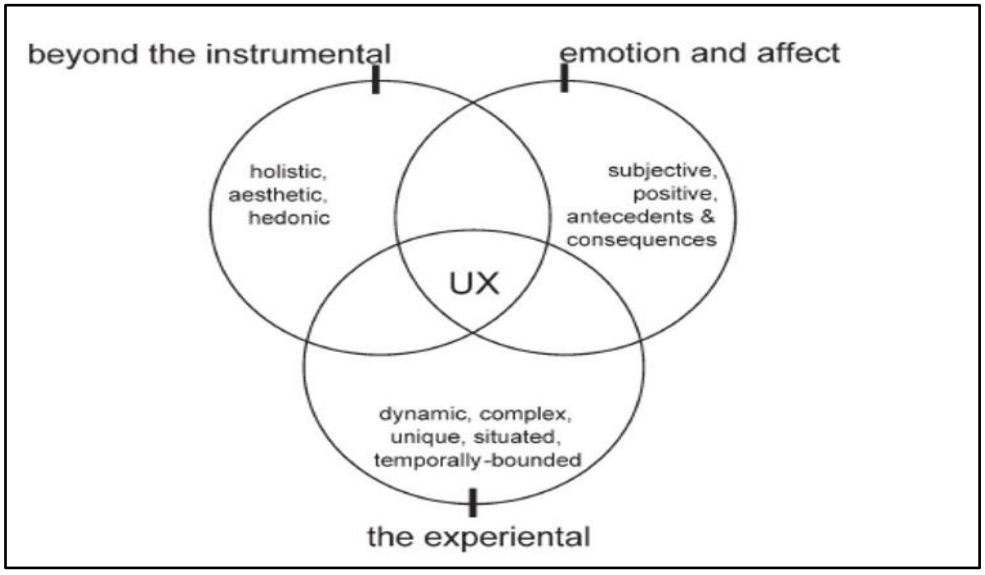


Figure 2.3: Facets of UX (Hassenzahl & Tractinsky, 2006)

Figure 2.3 depicts the facets of UX, indicating the aspects that are incorporated depending on the perspective and the interest in the system (Hassenzahl & Tractinsky, 2006). User Experience goes beyond the functionality of the system itself and emotions reflect the outcome of the interaction. UX is broad but can be limited depending on the focus of the study.

There is a perception that UX and Usability are similar, if not related (Moczarny, 2011). The following section addresses the difference between UX and Usability.

2.2.2.1 Difference between User Experience and Usability

UX involves the interaction between the user and the system (mobile technology). One might presume that the same is true for the Usability of the system. However, researchers maintain that UX and Usability are not the same concept (Moczarny, 2011; Moczarny et al., 2012). The current section will explain the difference between 'UX' and 'Usability'.

Usability involves the functionality of the system. It focusses on "the ease of use and learnability of a human-made object" (Maguire, 2013, p.186). ISO 9241-11:2018 defines Usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241-11:2018, 2018).

Usability can further be defined as: "How quickly can people learn to use the system, how efficient they are whilst using it, how memorable it is, how error-prone it is, and how much users like using it" (Pretorius & Calitz, 2014, p.26).

Usability addresses the easiness, efficiency of the system and how the system should function. Users not only want good Usability but also demand high-quality UX to accept the system (Miki, 2014). User Experience is considered to be subjective because it involves emotions and personal preferences. Usability is objective, it is evaluated based on the number of clicks and errors occurred during interaction (Bevan, 2009; Tan, Gencel & Rönkkö, 2013). Usability evaluates how effectively the user interacts with the system using mobile technologies, and UX is considered to be the best component to examine certain qualities of the system based on the user's feedback after interacting or using the system (Harpur, 2013).

The UX evaluation differs from the Usability evaluation. For Usability the focus is on the efficiency and effectiveness. UX focusses on hedonic characteristics including pragmatism characteristics (Kaasinen et al., 2015; Kuusinen et al., 2016; Roto, Obrist, Vaananen-Vainio-Mattila, 2009).

Usability considers performance, satisfaction and achievement, focussing on how the system functions (Tullis & Albert, 2013), and the errors and glitches that are encountered in the system. UX is about self-expression and stimulation, and is more concerned with perception, attitude and expectations when interacting with the system (Scapin et al., 2012; Van Schaik & Aranyi, 2014).

Although there is a difference between the concepts of UX and Usability, there is a link between the two, because some of the attributes of UX can be measured using Usability metrics. Usability is not User Experience, rather it is one part of UX (Kuusinen et al., 2016; Van Schaik & Aranyi, 2014). Both "usability or user experience can be measured during or after use of a product, system or service" (Bevan, 2009, p.1).

Table 2.3 summarises the differences between Usability and User Experience, and is based on the aspects defined by Petrie and Bevan (2009).

Table 2.3: Summary of aspects that distinguish user experience from usability (Petrie & Bevan, 2009)

Aspects	Usability	User Experience
Holistic	Focusses on user's performance and satisfaction with the task and achievement in defined context of use.	It is more a hedonic aspect, such as beauty, challenge, stimulation and self-expression.
Subjective	Emphasises the objective of measuring components, such as the percentage of task achieved for effectiveness, task completion time and error for efficiency.	More concerned with user's subjective reaction to the system, perception of the system and interaction with the system.
Positive	Focus on the removal of barriers or problems in the system, as the method to improve the system.	More concerned with the positive aspect of system use, to maximise the aspects, be it joy, happiness or engagement.

In brief, the factors that contribute to Usability are embedded in the factors that contribute to UX. "A person's 'perceptions and responses' in the definition of user experience are similar to the concept of satisfaction in usability" (Bevan, 2009, p.1). According to Moczarny (2011), UX and Usability are overlapping concepts, the different viewpoints present different aspects or views where the one concept either includes or subsumes the other concept. Figure 2.4 shows three different views. In View 1, Usability is subsumed within User Experience. In View 2,

UX is subsumed within Usability, and in View 3, UX and Usability share the user satisfaction component.

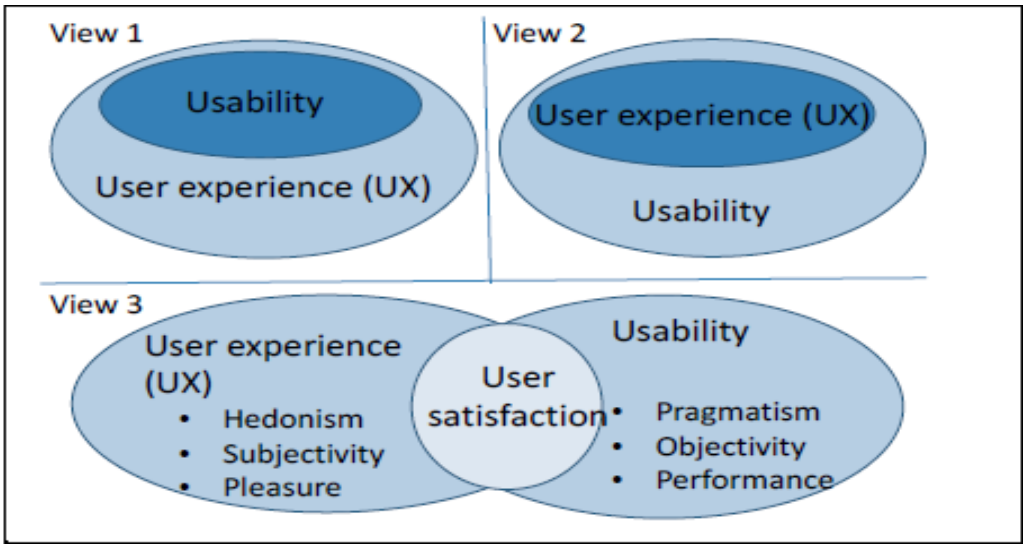


Figure 2.4: Different views of the relationship between usability and user experience (Moczarny, De Villiers & Van Biljon, 2012)

For the purposes of this study, Usability will be seen as a component embedded inside UX, where attributes such as pragmatism, satisfaction, efficiency and effectiveness will be included as the factors of the UX, in order to evaluate the UX of the teachers using mobile technologies.

The following section discusses the components of UX that were identified in the different frameworks.

2.2.3 The UX components

2.2.3.1 Components identified in different UX frameworks

According to Roto and Rautava (2008), each design or system development may have different goals for UX, therefore, the components of each system may differ depending on the purpose and context of use of the system. This section presents different frameworks that have been used to design and evaluate UX, and the UX processes. The UX frameworks comprise components and factors that were identified as having an influence on the UX of teachers using mobile technologies in resource constrained environments.

A "**component**" is defined as "any element of context [used] to combine the previously used terms of factors, components, dimensions, aspects, state, and environment to under same umbrella" (Jumisko-Pyykkö & Vainio, 2010, p.4). The components discussed in this section have been taken from different literatures, taking into consideration that in various literature

studies components are referred as elements, aspects, dimension, factors or facets. For the purposes of this study the word "components" will be used as defined above and ***factors*** will be used to refer to the subcomponents.

UX factors "can be used to describe the situation in which a person felt a particular UX" (Roto et al., 2011, p.10); for the purposes of this study ***characteristics*** of the factors will be interrelated to the factors that affect components of the UX.

The following section focusses on a discussion of these UX frameworks and how they formed part of this study.

What is a framework? A framework is defined as "a real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful" (TechTarget, 2015, Para. 1). According to Mabila, Van Biljon and Herselman (2016), frameworks are a necessity in any project; they act as guidelines to set out standards that can be followed in implementing a specific plan.

The identified UX frameworks explored in this section assisted with the investigation and helped to partly answer research sub-question one. They also guided the researcher in identifying the components relevant to this study. This section will group the frameworks into three categories, namely:

- UX product design frameworks
- UX evaluation frameworks
- Related frameworks

2.2.3.1.1 UX product design framework

This section focusses on the frameworks that are used in designing or developing the product or system. However, it must be clarified that this study is not focussed on developing the product, but rather on people's experiences of using the already designed product. The researcher chose to use the listed frameworks because the product design framework consists of components and subcomponents that have been identified as having an influence on UX. These components contributed to the development of the framework for this study. The three UX product design frameworks discussed in this section are: User Experience Evolution Lifecycle (UXEL) framework, UX framework and UX honeycombs.

1. User Experience Evolution Lifecycle framework

Figure 2.5 illustrates the UXEL framework, which identifies entities and factors that shape UX (Abbasi, Lew, Rafique & Li, 2012). This framework can be used when developing a product or system, and is used for UX requirements and evaluation processes (Abbasi et al., 2012). Figure 2.5 shows different actors and describes the different entities and factors of UX. The actors are defined as User, Product, Environment and Designer where each actor is influential in UX (Abbasi et al., 2012).

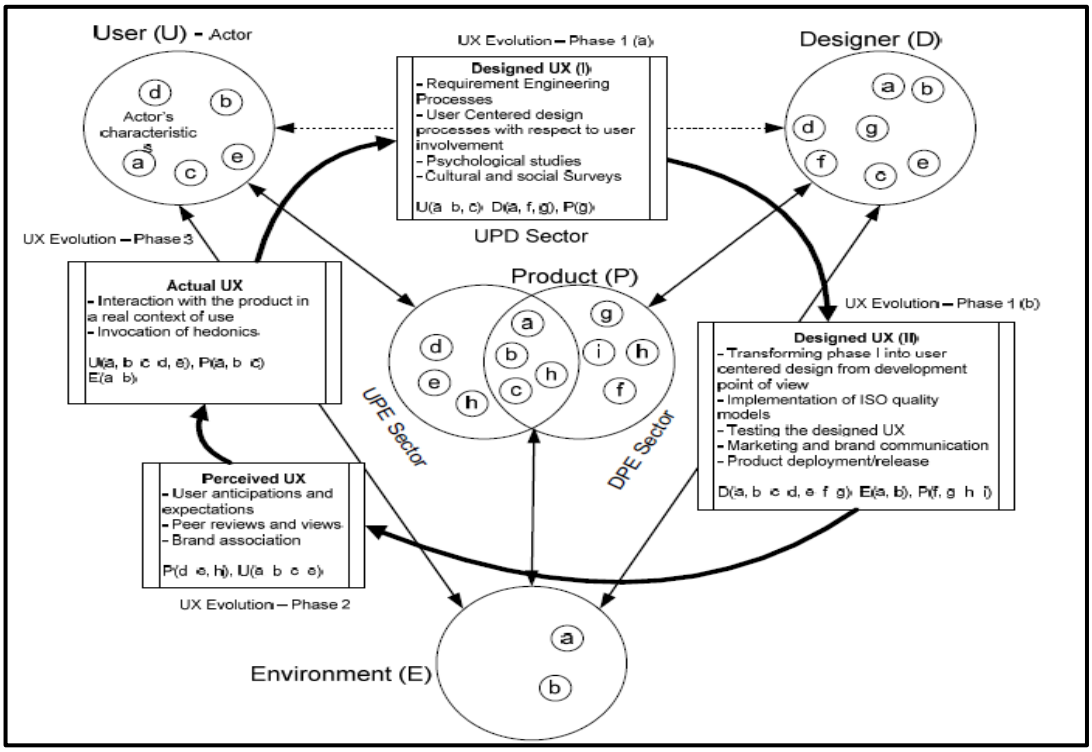


Figure 2.5: UXEL framework (Abbasi et al., 2012)

The UXEL framework takes the form of a lifecycle, illustrating the connections between the actors. The link between the user and the designer depicts the user requirements, which involve the user's needs. The link between the user and the product depicts the interaction between the user and the product (system), it is a continuous process and is identified as the main connection in the UXEL framework because it triggers some of the user's hedonic attributes such as satisfaction, behavioural stimulation and pleasure (Abbasi et al., 2012). The connection between the environment (context) and the user, depicts the context of use of the product by the user. The environment has an influence on the hedonic attributes experienced during the interaction. The connection between the environment and the product describes how the UX of

the product is influenced by the context where the interaction occurs and how the product pragmatics vary with the circumstances of the environment (Abbasi et al., 2012). Three approach sectors are utilised to form the link interaction in the UXEL framework, namely: designer-product-environment, user-product-environment and user-product-designer.

2. UX framework

Figure 2.6 illustrates how the components reflect the relationship between the system design and UX. A product consists of a certain design that reflects the characteristics of the product such as pragmatic and hedonic components, and these components are referred to as design elements with emotion being the fundamental feature (Kort, Vermeeren & Fokker, 2007).

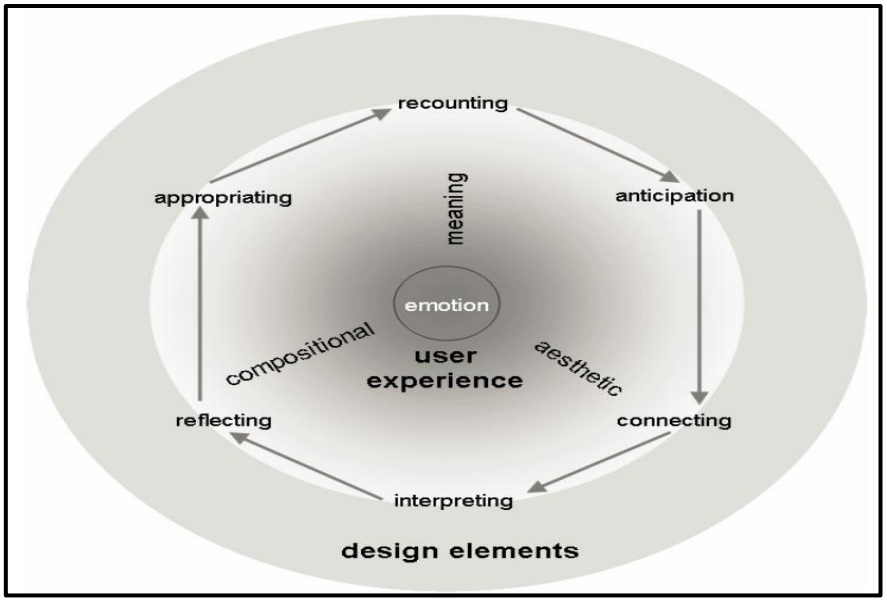


Figure 2.6: UX framework (Kort, Vermeeren and Fokker, 2007)

Kort et al. (2007) identified three design components in the framework, namely: compositional aspect, aesthetic aspect and the aspect of meaning. Each component represents properties of design that create experiences for the user. The identified components are crucial in the design of the product. The three components of the UX are discussed by Kort et al. (2007) as follows:

- **Compositional aspect**: is mostly related to Usability and consists of attributes such as pragmatic and behavioural characteristics. This aspect results in feelings of understanding the system functionality, and the feeling of making progress does satisfy the user.

- **Aesthetic aspect**: this aspect works on the senses of the user and concerns the look, colour and sound of the product or system. This aspect exposes the user's feelings about the system including excitement, fear, awkwardness and perception.
- **Aspect of meaning:** the focus is on the goals of the user, using cognitive processes to uncover characteristics of the product, where interaction results in feelings like satisfaction, fulfilment, fun and inspiration. Each of these factors represents and incorporates the properties of design components.

Discussions concerning the evaluation of the system and the efficiency of the system should not be the central issue. Discussions should rather be centred on the people who operate the technology (Mahlke, 2008). The fundamental issue is that UX happens internally in the person (Roto, 2007), hence there are emotions involved when a user interacts with the system.

3. User experience honeycomb

Morville (2004) proposed that when developing or designing the system, the focus should move beyond Usability and focus on UX. He then proposed the UX honeycomb for the interpretation of his study. Figure 2.7 depicts the factors of the UX honeycomb, illustrating what is expected from the system's components to deliver a positive UX.

Figure 2.7: User experience honeycomb (Morville, 2004)

- Usable: The system is expected to be efficient and easy to use. Usability of the system (mobile technology) has the potential to satisfy the teacher's needs, which may result in a positive UX.
- Useful: It is vital to know the usefulness of the system. The system is likely to be recommended should it appear to be useful and meet the user's needs and expectations.
- Accessible: Any person should be able to access the system. Teachers should be able to access any other functionality, such as admin or research, and not only be limited to teaching and learning regardless of the location where they are accessing the system from.
- Desirable: The system should look attractive; pragmatism is important in the acceptance of the system and users should find the system emotionally desirable.
- Findable: Users should be able to find what they are looking for in the system, they should be able to easily locate what they need. Teachers (users) are likely to find the system user friendly if they are able to find anything that they are looking for in the system.
- Credible: Credibility is imperative for users. The system should be trusted and not give users a reason to question its credibility.
- Valuable: Teachers need to find value in the system. This is usually achieved by it meeting the needs of the user.

The following discussion concerns the UX frameworks used for the evaluation of UX during and after using the system.

2.2.3.1.2 UX evaluation frameworks

It has been explained that UX is based on the viewpoint of the user and varies from system to system, and also from user to user. It is common for the system or product developers to focus on the factors that are related to that system for a context of use (Roto et al., 2011). The following is a discussion of the UX evaluation frameworks that focus on the experience of the user after using the system. The three identified UX evaluation frameworks discussed in this section are: User experience research framework, Usability & User Experience Framework (U2E-Frame) and UX during interaction.

1. User experience research framework

Figure 2.8 depicts the UX research framework designed by Mahlke (2008), which illustrates the interrelation of antecedents, important components and consequences of the UX. The framework can be expanded and used as the basis for conducting research in UX. The following components influence the factors of UX, namely: system properties, user characteristics and context parameters (Mahlke, 2008).

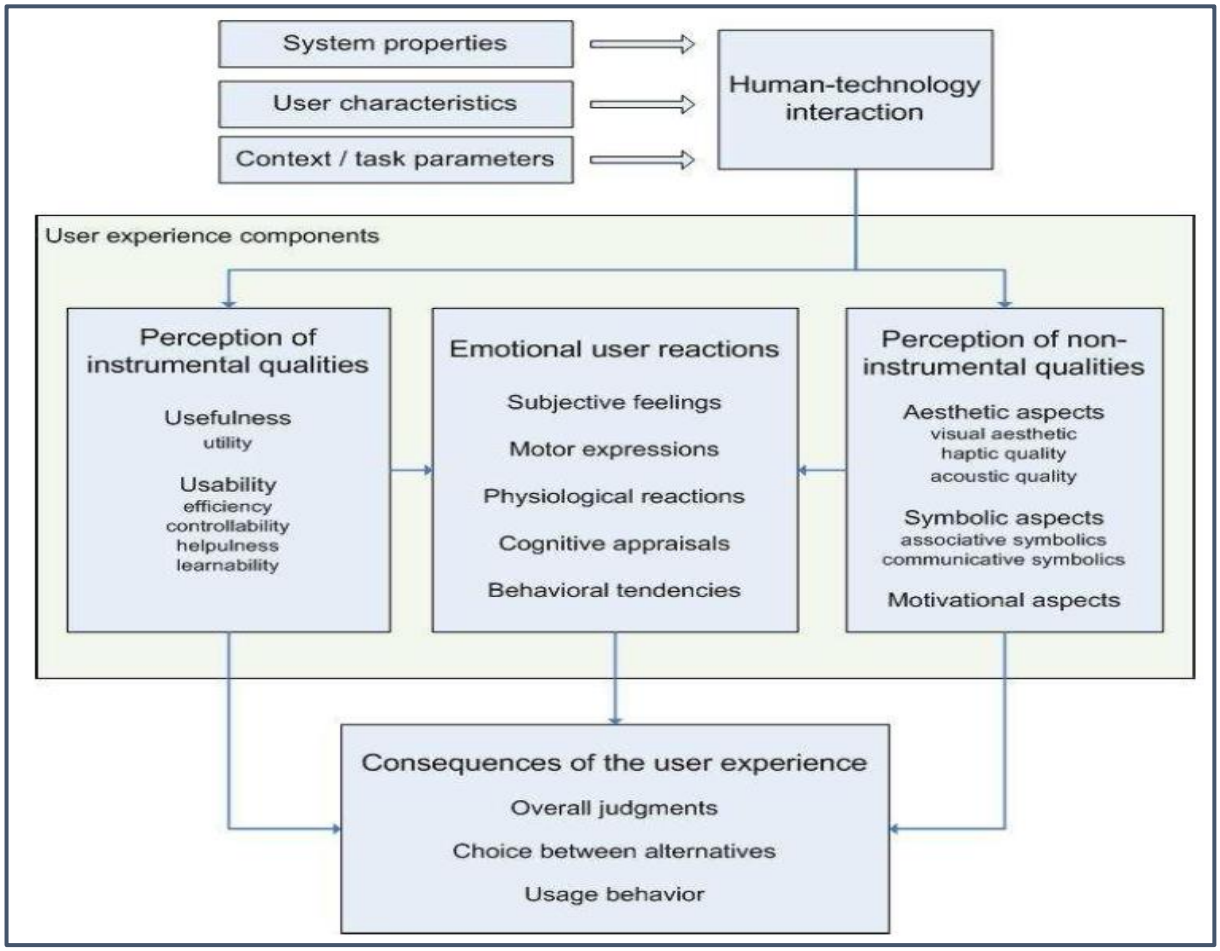


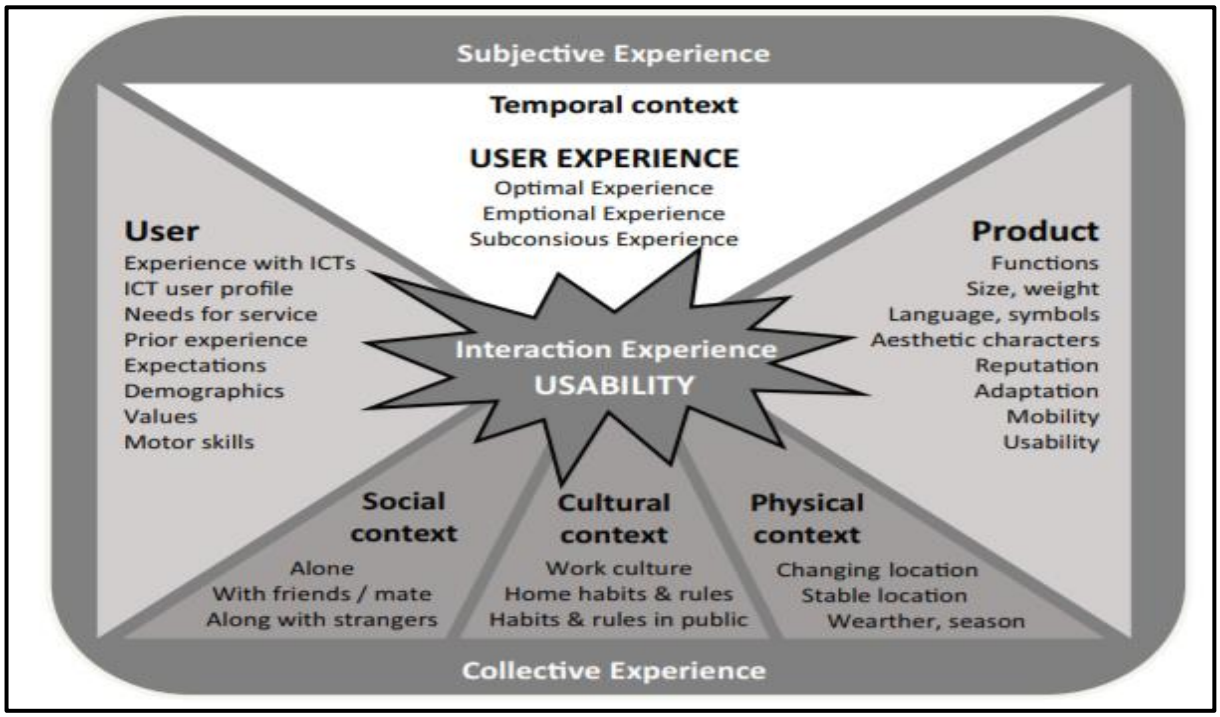
Figure 2.8: User experience research framework (Mahlke, 2008)

In the UX research framework, Mahlke (2008) describes three components of UX, namely: Emotional user reaction, Instrumental quality perception and Non-instrumental quality perception. Mahlke also suggests that when there is an interaction between the user and the system the results will be the consequence of the UX, which comprises the following: overall judgement, usage behaviour and preferences for an alternative system. These consequences are defined as the outcomes of emotional user reaction, perception of instrumental qualities and perception of non-instrumental qualities.

Instrumental qualities are concerned with the ease of use of the system, the support service provided by the system, as well as the effectiveness of the system. The non-instrumental qualities are concerned with the appearance, and the look and feel of the system features, such as visual aesthetic and haptic quality (Mahlke & Thüring, 2007). Emotional reaction is influenced by both instrumental and non-instrumental qualities. How the user perceives the system has a possibility of changing the user's feelings about the system, and this shapes the emotional experience for the user (Mahlke & Thüring, 2007).

2. Usability & User Experience Framework

Figure 2.9 illustrates the interaction with the product in a particular context resulting in different levels of experience, which can be optimal, emotional or subconscious. The framework shows the components that have the largest impact on the UX, including the user, product, and context. These components can be used to evaluate the UX using the factors that are identified under each component (Arhippainen, 2009). For example, under the component "user" there are subcomponents such as expectations, experiences and needs, which can be studied in different contexts.



[1]**Figure 2.9: Usability & User Experience Framework (U2E-Frame) (Arhippainen, 2009, p.95)**

[1] Figure 2.9 transcribed verbatim from the source, with spellings noted.

Section 2.2.2.1 discussed how Usability is viewed as a component embedded inside UX. It is, therefore, imperative to understand that the study is evaluating UX not Usability. Although the framework in Figure 2.9 includes both UX and Usability, the focus is on UX.

3. UX during interaction

Figure 2.10 shows the UX during interaction framework as identified by Roto (2007), which illustrates the interaction between user and system in a specific context. The components user, system and context, along with the attributes of each component, are identified as having an influence on the UX when interaction between the user and the system occurs in a specific context.

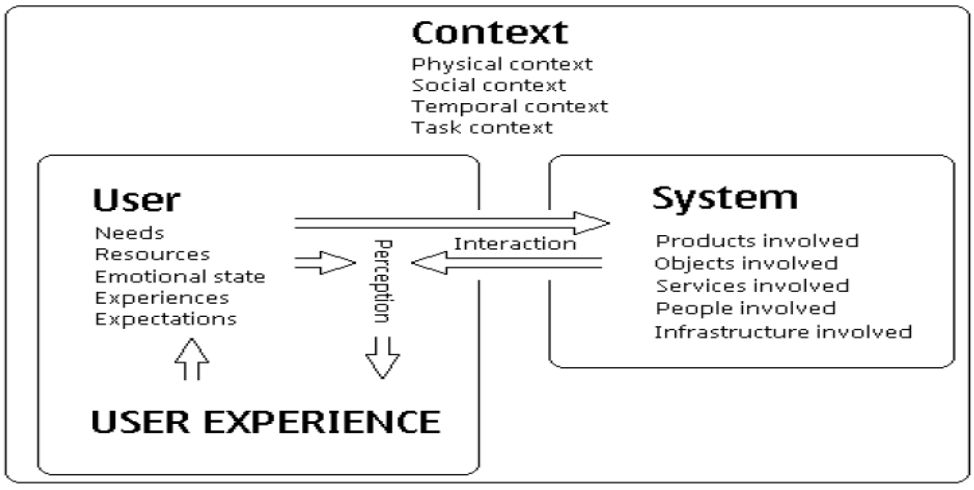


Figure 2.10: UX during interaction (Roto, 2007)

It is understood that the internal state of the user before, during and after interaction, exposes the user's perception of the system based on the context where the interaction occurs (Roto, 2007). The evaluation of UX is incomplete without the three components user, system and context (Keskinen, 2015; Roto, 2007).

2.2.3.1.3 Related theoretical framework

Although the Sustainability framework for mobile technology integration in schools in resource-constrained environments in South Africa (SFMTIS) relates to some extent for the purposes of this study, the researcher found that certain aspects of the framework could be useful for this research. Mabila (2017) who designed the SFMTIS framework, proposed that the framework should be used as a guideline for researchers when integrating technology in resource constrained environments to support teaching. The SFMTIS framework focusses on the sustainability of integrating ICT at schools that are based in a resource constrained

environment. Sustainability includes flexibility and adaptability on the part of the technology, and also includes teacher's preparedness, competence and ICT skill (Mabila, 2017). Mabila's (2017) study also acknowledges the barriers that impact the adoption of technology in the classroom by teachers, including ***attitude***, ***beliefs*** and ***environment***. The SFMTIS falls within the education domain, making it useful to this study because the focus is on the context of schools. The SFMTIS framework contributed towards the theoretical framework of this study.

2.2.3.1.4 Discussion of the components identified from the frameworks

The UXEL framework, created by Abbasi et al. (2012), identified the influential actors of UX, namely: user, product, environment and designer (see Figure 2.5). The identified actors — user, product and environment — in the UXEL framework can be adapted and used in the User Experience framework for teachers in resource constrained environments. This study identified the user (teacher), system (product) and context (environment) as the components of the framework for the UX of teachers using mobile technologies in resource constrained environments. Factors such as perception, expectations and hedonic were also identified in the UXEL framework.

The UXEL framework consist of three approaches that form the interaction in the framework, namely: the designer-product-environment sector, the user-product-environment sector and the user-product-designer sector. The user-product-environment approach identified in the UXEL framework was used to evaluate the UX of the user in this study, because of the three identified components: user, system and context.

The framework developed by Kort et al. (2007) established three design components within its framework (see Figure 2.6), namely: compositional, aesthetic and the aspect of meaning. Each of these aspects consist of different properties that develop experiences for the user. Factors such as usability, behavioural characteristics, satisfaction, aesthetic, perception and emotions were identified in the framework. This study focusses on the UX of the user, and the aspects established in this framework contributed to the formulation of the User Experience framework for teachers using mobile technologies in resource constrained environments.

Morville's (2004) framework proposed the subcomponents (factors) that can be used to deliver a positive UX, namely: usable, useful, accessible, desirable, findable, credible and valuable. Factors such as ease of use, user's needs, pragmatism, hedonic, easy access, and satisfactory are identified in the user experience honeycomb framework.

Mahlke's (2008) framework identified three components of UX, namely: emotional user reaction, instrumental quality perception and non-instrumental perception. These occur when there is an interaction between a user and the system (product), and such behaviour affects the user experience. Factors such as perception, emotions, usability, efficiency, effectiveness, behaviour and motivational aspects were also identified in the UX research framework. This research adopted most of the aspects found in Mahlke's (2008) framework as these were relevant to the study.

Arhippainen's (2009) framework demonstrates the interaction with the product in a particular context. The components that were identified in the framework that influence the UX are: user, product, context. The subcomponent (factors) under each component (such as needs, expectations, experience, social context, physical context, usability) can be used to evaluate UX. Arhippainen's (2009) framework is relevant to this research because the UXFTMTR framework also includes the user (teacher), the product or system (mobile technologies) and the context (school). Additionally, the environmental context in which this framework was tested in, using an iPad, makes it particularly relevant to this study.

Roto's (2007) framework demonstrates the UX of the user during the interaction with the system in a specific context. Three components were identified: user, system and context. Each component has subcomponents that were identified as possibly having an influence on the UX.

The SFMTIS framework proposed by Mabila (2017) was used as a guideline to sustain the integration of ICT in a resource constrained environment. Teacher's preparedness, flexibility and adoption of technology are acknowledged as the fundamentals of ICT sustainability at schools. The environment, attitude and behaviour of the teachers are recognised as the elementary barriers to ICT adoption at schools in resource constrained environments. Therefore, these factors have been identified as influencing the UX in this study. The SFMTIS framework contributed to the theoretical development of the UX framework for teachers using mobile technologies in resource constrained environments. Table 2.4 summarises the components explicitly identified in the frameworks in this section.

Table 2.4: Summary of explicitly identified UX components

Author	Identified components	Factors linked to the components
(Abbasi et al., 2012)	Framework identified the influential components of UX, namely: **user**, **product**, **environment** and **designer**	The identified components illustrate the user-product-environment interaction, which is equivalent to the teacher-technologies-school structure, of the UXFTMTR framework. Perception, expectations, hedonic were also identified in the framework and these factors are relevant for the evaluation of UX in this research.
(Kort, Vermeeren and Fokker, 2007)	Established the three design components framework, namely: **compositional**, **aesthetic** and the **aspect of meaning**	The components consist of factors such as usability, behavioural characteristics, satisfaction, aesthetic, perception and emotions which are relevant to the evaluation of the UX of the teachers.
(Morville, 2004)	The framework identified the **system** component	The factors that were identified as influencing the UX in relation to the system component include: useful, usable, desirable, valuable, findable, accessible, credible
(Mahlke, 2008)	The framework identified three components of UX, namely, **emotional user reaction**, **instrumental quality perception** and **non-instrumental quality perception** which occurred when there is an interaction.	Factors of the identified components such as efficiency, flexibility, and usability are suitable for evaluating the technologies, behaviour, emotions and perceptions, and will be used to evaluate the teachers' user experience of technologies.
(Arhippainen, 2009)	The framework demonstrates the interaction with the product in a particular context. The components - **user**, **product,** and **context** were identified.	Each of the identified components consists of factors that can be used to evaluate UX. Factors include experience, expectations, skills, usability, aesthetic characteristics, and contexts where the interaction occurs. These factors are suitable for the evaluation of the UX of teachers at schools using the technologies.
(Roto, 2007)	The factors identified in the framework are: **user, system** and **context**	Factors include: attitudes, expectation, knowledge, motivation. The product includes people, infrastructure, and services involved during interaction. The social context includes physical context, and task context.

The discussion of components continues in the next section. It must be noted that the previous section only discussed components explicitly identified in the following frameworks: UX product design frameworks, UX evaluation frameworks and related theoretical framework. The following components that are to be discussed in the next section are implicitly derived from various studies. This section aims to identify the components and factors of user experience that are relevant for teachers using mobile technologies in resource constrained environments.

2.2.3.2 Additional UX components that were identified

The advancement of technology is undeniable, and so is the rapid growth in, and demand for, new systems or products. Gone are the days when users only focussed on the functionality of the product, what currently satisfies the user about the system or product are the hedonic needs and aesthetic attributes (Abbasi et al., 2012), not just the functionality of the system. UX is only concerned with the user's internal state, which is reflected in the use of the system and the environment where the interaction is taking place (Scapin et al., 2012).

System developers' opinions about the system often differ from that of the user because developers view the system as an object whereas users view the system as an entity they operate through (Clemmensen, Hertzum, Yang & Chen, 2013). Therefore, it is also important to know and understand the components that affect the results of the system evaluation (Roto, 2006).

Hassenzahl and Tractinsky (2006) describe the components of UX as:

> A consequence of a ***user's internal state*** (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed ***system*** (e.g. complexity, purpose, usability, functionality, etc.), and the ***context*** (or the environment) within which the interaction occurs (e.g. organizational/social setting, meaningfulness of the activity, voluntariness of use, etc.). (p.95)

As indicated in section 2.2.3, the components discussed in this section were abstracted from different literatures. It was also mentioned that in various literature studies components are referred to as elements, aspects, dimension, factors or facets. However, this study adopted the term "components" and the term "factors" will be used to refer to the subcomponents.

Roto's (2006) study identified five components that affect UX, namely: user, social factors, cultural factors, context of use and product. She also argued that each component has its own attributes and emphasised that not all attributes will affect the UX. According to Hassenzahl and Tractinsky (2006), the components that frame a user experience include, but are not limited to, the user, system and context. Depending on the focus of the study, the components of the UX can be expanded and incorporated into any user experience (Botha, Calteaux, Herselman, Grover & Barnard, 2012).

Gentner et al. (2013) identified three of the independent components of UX, namely:

- Aesthetic pleasure — users use their senses to perceive the product, and the more their senses are used, the richer the experience.

- Semantic interpretation — the user experiences the technology through the shape of the object-system (mobile technology — tablet), its look and attributes can contribute to the user's interaction and experiences.
- Emotional response — when using the system, the moods and feelings of the user can determine the user's interest in the product (p.320).

Gentner et al. (2013) discussed how the identified components are influenced by other factors such as:

- Personal characteristics — attributes such age, gender and a person's character can influence the experience of the user.
- Interaction — the feedback that the user receives when operating the system will influence the experience of the user.
- Product — the design of the product, its functionality and appearance, is influential to the user experience.
- Context attributes — the environment, time and space where the interaction occurs has the potential to influence the experience of the user (Gentner et al., 2013, p.320).

Scapin et al. (2012) discussed five of the components that reflect and measure the experience of the user, namely: aesthetics, emotions, observing, questionnaires and heuristics. However, this study will only discuss the aesthetics and emotions as factors, because there's not much of discussion on observing, questionnaires and heuristics components and does not add value in this research.

Roto (2006) identified five components that affect UX, namely: user, social factors, cultural factors, context of use and product. Roto (2006) further adopted the high-level categorisation used by Hassenzahl and Tractinsky (2006) to identify UX components in this context:

- System (product, service or infrastructure)
- Context (the environment, social and temporal factors)
- User (the mental and physical state of the person interacting with the system)

Roto et al. (2011) listed the components that affect UX, which can be used to determine the experience of the user:

- User: UX is vigorous, so is the person experiencing the system
- System: the user's perception of the system's properties naturally influences the User Experience
- Context: where the interaction occurs, refers to social context, physical context, task context and technical context
- Other factors include social and aesthetic aspects, which are largely different from the traditional concerns such as performance and smooth interaction (p.10).

Roto et al. (2011) indicate that although these factors are used to define UX, they can also be used to describe when the person felt the particular UX and the factors that influenced the person's UX.

Maguire (2013) identified the following four factors of UX:

- Value — usefulness of the system
- Usability — easiness of the product or system
- Adoptability — easy to start working on the system
- Desirability — engagement with the system

2.2.3.2.1 Discussion of the components identified from various studies

The components that were identified in section 2.2.3.2 are discussed in this section and summarised in Table 2.5.

- **User component:** Hassenzahl and Tractinsky (2006); Roto (2006); and Roto et al. (2011) identified user component as the internal state of the user, where the user has expectations about the system, which may alter the mood of the user resulting in a change in motivation to use the system and influences the user's expectations. The other studies agree with user being the internal state of the user. In her study, Roto (2007) expanded the description to include attitude and knowledge.
- **The System component:** is viewed as the product, infrastructure or services involved when the user interacts with the system (Roto, 2006; Roto, 2007). Although Hassenzahl and Tractinsky (2006) focussed on the characteristics of the system, including the functionality and usability of the system, Roto et al., (2011) presume that it is the properties of the system that influence the user's reaction or perception of the system.

- **The Context component:** is viewed as the environment where the interaction with the system occurs (Hassenzahl & Tractinsky, 2006; Roto, 2006; Roto et al., 2011). There are different contexts where the interaction may occur: physical context, social context, task context, and technical context (Roto, 2007; Roto et al., 2011).
- **The Aesthetic component**: evokes the cognitive response of the user, where senses such as pleasure, subjectivity and objectivity are used to perceive the system (Gentner, 2013). To further address the Aesthetic component, it is argued that the psychological and physiological measurements are involved when the interaction occurs (Scapin et al., 2012).
- **Emotions component**: involves the moods, feelings, and behaviour of the user when interacting with the system (Gentner et al., 2013; Scapin et al., 2012).
- **Social component**: is influenced by people who are concerned with the user's expectation or willingness to participate in a social situation (Roto, 2006).
- **Semantic interpretation component**: involves the attributes of the product, the shape, colour, and qualities of the product; these are aspects the users use to give feedback about the product or the system (Gentner et al., 2013).

As mentioned in section 2.2.3.2, components such as observing, questionnaires, and heuristics will not be discussed in this study because there's not much of discussion in the literature review about these components and the information provided doesn't add value to this study. Table 2.5 summarises the UX components that have been discussed.

Table 2.5: Summary of implicitly identified UX components

Author	Identified UX components	Factors linked to the UX components
Hassenzahl & Tractinsky (2006)	User, System, Context	The user's internal state includes: expectations, motivation, mood, predispositions. The characteristics of the system: functionality, usability, complexity, and motive. The environment where interaction occurs: organisation, location of use.
Roto (2006)	User, Social factors, Cultural factors, Context of use, Product	The state of the user, this includes mental and physical state, which influences the user's perception. The product, infrastructure involved during interaction. The environment where interaction occurs, social and temporal factors. The influence other people have concerning the user's expectations or willingness to participate in social situations.
Roto (2007)	Components identified, namely: User, Context, System	The user's mental state includes: attitudes, expectation, knowledge, motivation. The product, people, infrastructure, services involved during interaction. The social context, physical context, and task context.
Roto, Law, Vermeeren & Hoonhout (2011)	User, System, Context, Social, Aesthetic	The user's mental and physical state includes: motivation to use the system, mood and expectations. The properties of the designed system influence the user's perception. UX depends on where interaction occurs. Different contexts: physical, social, task, information and technical context.
Gentner, Bouchard & Favart (2013)	Aesthetic pleasure, Semantic interpretation, Emotional response	Cognitive response: product is perceived through senses such as pleasure, subjectivity and objectivity. Affective response: moods, feelings in response to the interaction with the product. Involves the attributes of the product such as the shape, colour, qualities of the product (performance, function).
Scapin, Senach, Trousse & Pallot (2012)	Aesthetics, Emotions, Observing, Questionnaires, Heuristics	Involves psychological and social measurement of the user, also physiological measurement (heart rate, skin response, eye tracking). Emotions such as feelings, behaviour.

2.3The first version of the conceptual framework

In Chapter Two, the researcher aimed to answer research sub-question one: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments? In section 2.2.3 the implicit and explicit components were explored, and Table 2.4 and Table 2.5 provided a summary of the identified UX components. For the purposes of this study the researcher acknowledged the user, system and context components, as the dominant components. The researcher found these three components relevant to the study, while the components that were not adopted, such as emotions, aesthetic, semantic interpretation, compositional aspect, and instrumental and non-instrumental quality perception were acknowledged as being embedded in the three selected components. The outcome of the literature review in Chapter Two is a contribution to the first version of the theoretical framework illustrated in Figure 2.11.

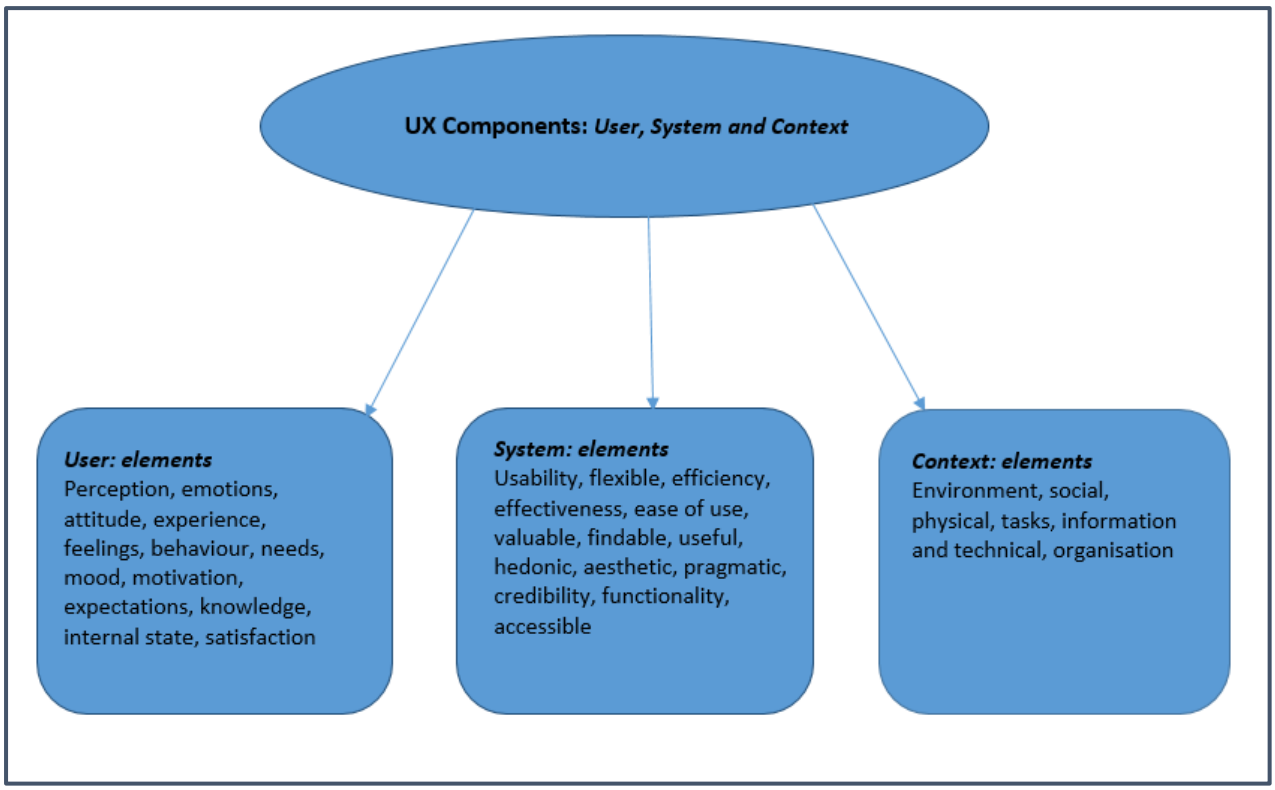


Figure 2.11: Theoretical framework V1 — Components and factors that may influence the UX of the teachers

2.4 Summary of the chapter

Chapter Two aimed to answer research sub-question one: What are the components of user experience that are relevant to teachers using mobile technologies in resource constrained environments? The chapter reviewed the background of UX and offered a conceptualisation of the UX. The difference between User Experience and Usability was discussed in section 2.2.2.1. Usability is presumed to be unable to address the qualities of UX, although Usability is viewed as part of the UX (Kuusinen et al., 2016; Van Staden, 2017). In section 2.2.3 the researcher discussed the identified UX components, including factors that influence the User Experience. Components such as user, system and context were discussed comprehensively, with each component including the factors that influence the use of mobile technologies at schools.

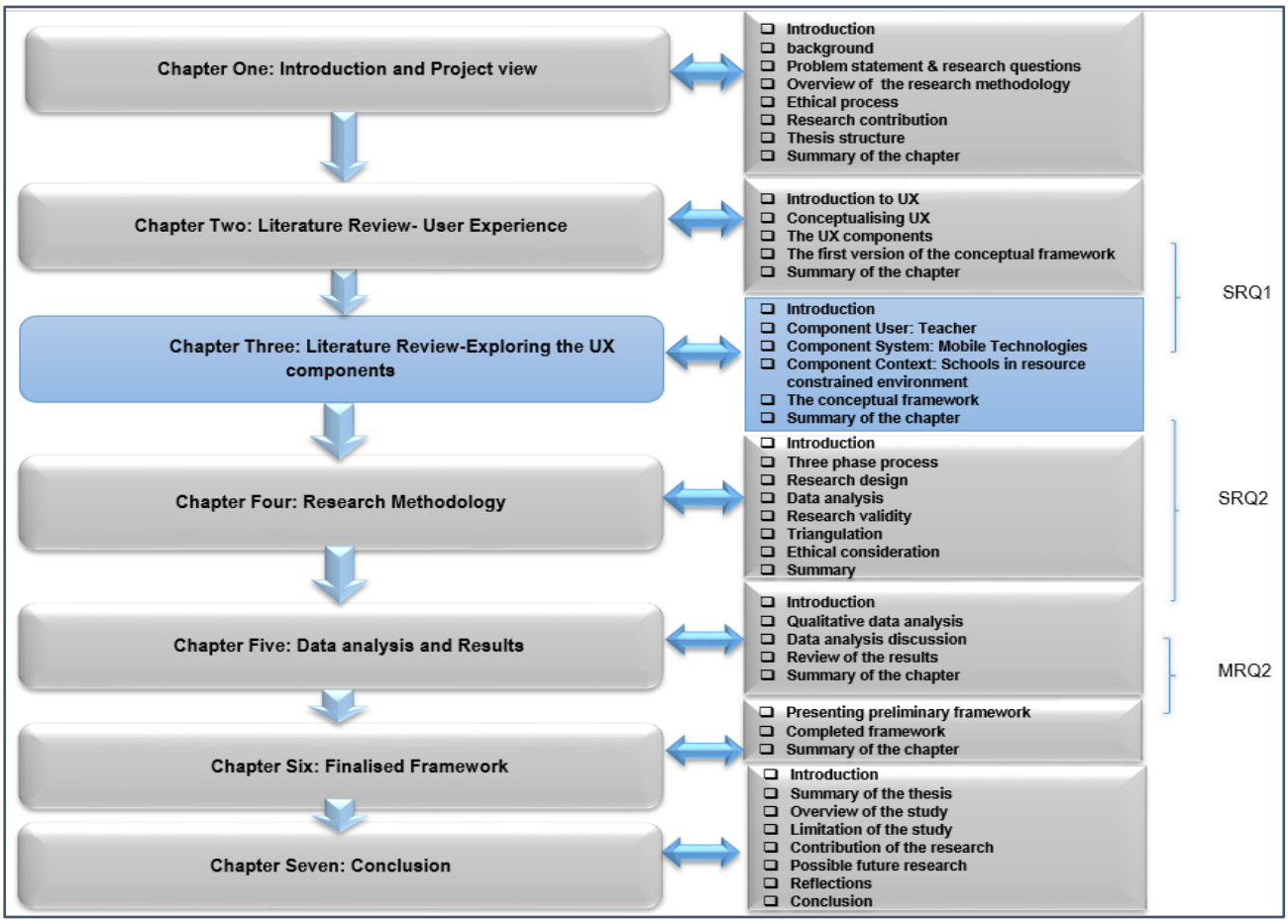
The components identified in section 2.2.3 were used in the development of the framework. Different UX frameworks were identified and used as a theoretical background to the development of the framework. Table 2.6 presents the first version of the theoretical framework in a tabular format.

Table 2.6: Theoretical framework V1 — Components and factors that may influence the UX of the teachers

UX components	Subcomponents — Factors
User	Perception, emotions, attitude, experience, feelings, behaviour, needs, mood, motivation, expectations, knowledge, internal state, satisfaction
System	Usability, flexible, efficiency, effectiveness, ease of use, valuable, findable, useful, hedonic, aesthetic, pragmatic, credibility, functionality, accessible
Context	Environment, social, physical, tasks, information and technical, organisation

The following constitutes part II of the literature review, and focusses on the three components user, system and the context are further explored in Chapter Three.

3. CHAPTER THREE: LITERATURE REVIEW — EXPLORING THE UX COMPONENTS



3.1 Introduction

This chapter explores the UX components identified in Chapter Two. Section 3.1 provides an introduction to the chapter, section 3.2 discusses the user component, section 3.3 discusses the system component, section 3.4 discusses the context component, and section 3.5 presents the proposed conceptual framework.

This study adopted the three components, namely: user, system and context. It is understood that the evaluation of UX is incomplete without these three components (Keskinen, 2015). The components contributed to the development of the conceptual framework, which guided the development of the UXFTMTR framework in this study. The chapter further explores the components that were identified in Figure 2.11 and discussed in section 2.3. This chapter also explores the factors (subcomponents) of each component.

There is an assumption that the internal state of the user before, during and after interaction, exposes the user's (teacher) perception of the system (mobile technologies) based on the context (school) where the interaction occurs (Scapin et al., 2012). Following recommendations proposed by Botha et al. (2012), for the purposes of this study, the components are identified as follows:

- User: The teachers
- System: Mobile technologies
- Context: The rural schools

In the following sections the components are discussed in relation to the subject matter of the study, with the intention of accomplishing the main objective of the study: Designing a framework for the user experience of teachers using mobile technologies in resource constrained environments. This was accomplished, achieving the sub-objectives outlined in this chapter: *Identifying the components and factors of user experience relevant to teachers using mobile technologies* and *Evaluating the constraints that are affecting the provision of mobile technologies in a resource constrained environment*. This chapter partly answers research sub-questions one and two.

3.2 Component User: Teacher

According to Roto (2006), user can be referred to as "her/himself" (p.4), which indicates that the user is a person. Within the context of the study the user(s) are the teacher(s). "Teachers play a very important role in providing children with a technology-supported learning environment" (ChanLin, 2017, p.1935). In the UX context, a "user" is defined as a person who interacts with the system, where factors such as the user's needs, expectation, motivation, perception and mental state are evoked during and after the interaction (De Kock, 2017; Roto et al., 2011). Another definition of user "refer[s] to the entity (individual or social group) interacting with the product" (Mashapa, 2009, p.40). Users are at the centre of the UX, as UX is evaluated through the user's response after interacting with the system, and without the user there is no UX (Mashapa, 2013). The needs, resources, emotional state, experience and expectation factors of the user component, influence the User Experience. This section explains the factors of the user component in relation to the study.

3.2.1 User's needs

Having realised that the user plays an important role in the UX, the researcher explored how the user may have an influence on the UX as discussed in the literature. Needs is listed as one of the factors of the user component that influences the UX of teachers as indicated in Figure 2.10. It is important to evaluate the needs of the users from the system, which will assist in identifying what is required to ensure that a positive UX is achieved at schools when using the technologies. User's needs are often driven by the experience of the system. If the user is satisfied with the system they are bound to indicate this by attaching hedonic qualities to the system (Hassenzahl, 2008). When a system is given to a user to engage with it should not be a burden; there is actually a need to reduce the effort required by the user to use the system (Arhippainen, 2009). Teachers should feel calm when using the technologies. The acceptance of the system after design is very important because the system should have met the users' needs and resulted in a positive user experience (Mashapa, 2013). Acceptance can be justified on the basis of user satisfaction. Satisfaction occurs after the user had a positive experience when interacting with the system.

Tian, Hou and Yuan (2008) define satisfaction as "the degree of the users' subjective satisfaction and acceptance in the process of using a product, [. . .] satisfaction is mainly determined qualitatively from five to ten questions asked after a usability testing session" (p. 39-43). With the satisfaction factor, the user may report that the system was easy to use, or that it was confusing to use the system or that the system did not meet the expectation of the user (Tullis & Albert, 2013). Arhippainen (2009) argues that it is important to consider the location and time where the interaction will take place because the needs of the user depend on the time and place. Users need to be psychologically prepared in order to adopt a system, as the ability of the user to interact with, and to adopt, the system lies in the mind of the user (Toko, 2017). Teachers need to go through the training to prepare themselves to use the technology (Meyer & Gent, 2016). Users consider it a necessity for the system to create a positive experience when interacting with the system (Arhippainen, 2009).

3.2.2 User's emotional state

Every individual has emotions and they are triggered by different situations, be it a good or a bad situation. This means that user's emotions will depend on the experience, the user had when interacting with the system. According to De Kock (2017), "[e]motion is [an] essential part of life as it affects how we feel, how we behave and think" (p.30), therefore understanding

the teacher's emotions regarding mobile technologies, was important for this study. When users are exposed to a new or different system they are likely to experience certain emotions because they find themselves in a different situation and the emotion influences the UX (Mashapa, 2013). In Hassenzahl and Tractinsky's (2006) study, predispositions, expectations, needs, motivation, and mood were identified as consequences of the user's internal state.

Before the user experience of the user can be evaluated after the interaction with the system, it is important to understand the emotional state of the user because it influences the user's UX (Tullis & Albert, 2013). In a situation where the user (teacher) has to work on the system (mobile technologies), but is not in a good emotional state, the results of the UX are likely to be affected. Botha and Herselman (2015a) indicate that the positive attitude of the teacher influences the adoption of the mobile technologies at schools. It is therefore assumed that positive emotions result to a good UX (Langenhoven, 2016). According to Portugal (2014), it is human nature for people in general to be apathetic when the system is not encouraging, which may make them feel frustrated and stressed. Having experienced stress and frustration, users are then likely to lose concentration and become demotivated (Roto, 2006). When a system is designed the functionality and the features of the system alone are not sufficient, the system should meet the user's functional and non-functional requirements and influence the emotional aspect of the user (Mashapa, 2013). There is also a perception that the age group plays a role in influencing the UX of the user. The assumption is that younger people find it easier to engage with the technology (Toko, 2017).

3.2.3 User resources

Resources include time to carry out the activities, physical resources such as building infrastructure, human, devices, and financial resources. The availability of resources does influence the UX (Ouma, 2013). If teachers were not adequately trained in the use of mobile technologies at the school, the study would have been affected because the research relied on trained teachers to use the mobile technologies for teaching and learning.

3.2.4 User experiences

According to Tullis and Albert (2013), experience takes place after the user has engaged with the system. According to Clemmensen et al. (2013) "people relate to systems through their personal experience and concepts" (p.464). The experience of the user goes beyond the functionality and usability of the system (Mashapa, 2013).

"Teacher's attitude and knowledge toward technology integration might change as they gain more experiences from and insights in the adoptions processes" (ChanLin, 2017, p.1936). The attitude and experience of teachers has an impact on the results of the UX; if it is a positive attitude and a good experience the assumption is that UX will be positive. It is understood that the ability of the user to work on a new system and master it lies in the ability of the user, and the usability of the system (Toko, 2017). This determines the willingness and experience that the teachers have to operate the technologies. Mahlke's (2008) study emphasised that system experience and evaluation is not only about efficiency, but also human needs and their experience with the technology.

3.2.5 User's expectation

There is an assumption that the first time a person sees and works on the new system the person will have expectations about the system. The expectations of the user are evoked before the user engages with the system (Mashapa, 2013; Tullis & Albert, 2013). This indicates a link between the user, their expectation and the system. The expectations of the user are met when positive user experience feedback is provided by the user (Mashapa, 2013).

The positive feedback assures that the system is delivered in accordance with what was expected by the user. It is imperative for the expectations to be evaluated at an early stage as expectations of the users may vary from that of the system designers (Ouma, 2013). In brief, what the designers may expect from the mobile technologies may be different from what the teachers may expect. Therefore, if the aim is to achieve a positive UX, it is important for the mobile technologies to be designed to meet the expectation of the teachers.

3.2.6 User perception

"The perceptions that a user will have before interacting with the product, the emotions of the user as well as the context in which the product is used, all influence the user experience" (Mashapa, 2013, p.62). Teachers are key to the acceptance and adoption of change at schools; they are responsible for adopting and implementing curriculum in the classroom (Chiu & Churchill, 2015). The perception they may have about the use of mobile technologies in the classroom has the potential to affect the UX before they even use them.

The following section discusses the system component.

3.3 Component System: Mobile Technologies

3.3.1 Introduction

A system is described as "the application or device under examination which the people interact with" (Mashapa, 2009, p.40). System is amongst the foremost components and UX is not complete without it. For UX to occur, there must be an interaction between a user and the system (Mashapa, 2013). Figure 2.10 illustrated the attributes of a system as described by Roto (2007). This includes the products, objects, services, infrastructure and people involved, and this research focussed on the people.

The world is constantly evolving digitally, which is a result of the significant impact of technology on our daily lives. Technology plays an important role in education by digitalising learning and teaching at schools. The use of mobile phones and mobile technologies has matured tremendously, enabling users to explore the technologies in different tasks and sharing different experiences (Tokarova & Weidman, 2013). The technological demands of the twenty-first century have resulted in many countries moving to digital learning. As a result of this change, the Department of Education (DoE) and other stakeholders in South Africa have progressively introduced the use of mobile technologies in schools (Eicker-Nel & Matthee, 2014). Multiple projects have taken place in South Africa to ensure that the projects fulfil the mandate of transforming education (Mabila, Herselman & Van Biljon, 2016).

In the ICT4E project, teachers (users) were trained to conduct teaching and learning at schools (context) using the technology (system). The adoption of mobile technologies at schools may have an influence on the transformation of traditional learning and teaching into mobile learning. However, there are several challenges to this transformation including the belief, attitude, and anxiety that teachers have about the adoption and integration of mobile technologies at schools (Chiu & Churchill, 2015). The teacher's feedback, opinion and reaction to the system was very important for this study because the research focussed on the UX of the teacher after using the mobile technologies in the classroom with an intention to develop a framework which can be used to improve the experience of the teachers (users).

3.3.2 Background of mobile technologies

The emergence of mobile technologies in teaching and learning demands that education organisations amend their teaching and learning policies and strategies so that these are on par with education transformation (Bidin & Ziden, 2013). Owning mobile technologies such as

smartphones or tablets is no longer a luxury, as it is now a must have (Page, 2014). Most learners are often involved in the media-based world, where mobile technologies are used as a medium to share common interests, which can include collaborating, networking, processing information, and to have fun at schools and in the work environment (Bidin & Ziden, 2013).

Mobile technologies are mobile devices that enable the user to take the devices with when moving around and include devices such as tablets, PDAs, smartphones and portable computers (Huang & Tsai, 2011). The use of mobile technologies plays a vital role in learning and teaching enabling learning and teaching to take place inside or outside a classroom, and enables communication with other learners or teachers using the technology (Kukulska-Hulme, 2010).

Figure 3.1 illustrates the different types of mobile devices, which are also referred to as mobile technologies.

Figure 3.1: Different types of mobile devices

There are many things that one can do with mobile technologies in learning and teaching. Some advantages of mobile technologies include boosting communication and collaboration, cost reduction, and increasing opportunities for where learning and teaching can take place (Ishtaiwa, 2014).

Using mobile technologies saves teachers' time on doing manual administration such as planning, sharing documents, storing learners' data, and addressing their personal development and training skills (Becta, 2010). Not only can teachers use the mobile technologies to teach and perform administrative tasks, but they can also use the technologies to collaborate and learn from one another (Blackboard, 2008). The attitude of teachers in the classroom when using mobile technologies in teaching is imperative. "Teachers who hold positive attitudes towards using a new technology in teaching are more likely to use the technology in their classrooms" (Chiu & Churchill, 2015, p.6).

3.2.2.1 Relation of mobile technologies and mobile learning

3.2.2.1.1 Mobile technologies

Technology has advanced in the last two decades and the drastic growth of technology has resulted in industries, as well as education, adopting the technologies offered for the digital world. For example, sectors such as banks, healthcare, libraries and retail have moved their services to the digital world using mobile technologies (Ally & Prieto-Blazquez, 2014; Chipangura, Van Biljon, & Botha, 2012). In the early 1980s no one would have thought that mobile technologies would have such a significant impact on our lives, specifically in education (Hlagala, 2015).

With the advancement of mobile technology comes the demand to do more with the technologies, and so the user experience has also evolved. As the rate of mobile technologies use increases, the effectiveness and the ease of use of the product becomes crucial. Therefore, there are factors that need to be taken into consideration when developing an efficient and effective system. Two important factors are the user experience (UX) and usability (Chan & Johansson, 2016).

3.2.2.1.2 Conceptualising mobile learning

The definition of m-learning or m-learning has been widely debated since its emergence. As technology evolves so does the definition of m-learning (Van Biljon & Dembeskey, 2011). Huang and Tsai (2011) define mobile learning as "using mobile technologies to facilitate learning" (p.65), which means that mobile technologies are a catalyst for m-learning. Huang and Tsai (2011) also state that mobile learning allows for 'learning on the go', which is emerging in the landscape of technology that is supporting learning. According to Bidin and

Ziden (2013), m-learning can be either formal or informal learning, and students can choose when they should do the work.

Although mobile learning and e-learning were once considered to be the same, it has since been established that mobile learning is not e-learning. There are certain characteristics that separate the two (Traxler, 2005), such as learning anywhere and being able to move around. Mobile learning enables learners to learn anywhere at any time using mobile technologies such as smartphones, tablets, iPads and personal digital assistants (Barnes & Herring, 2011; Traxler, 2015). Studies indicate that the concept of mobile learning enables learning to happen while you are on the move, anywhere and at any time (Deegan & Rothwell, 2010; Mehdipour & Zerehkafi, 2013; Murphy, Farley, Lane, Hafeez-Baig, & Carter, 2014). In contrast to e-learning, m-learning has no limitations in terms of location because the devices are portable (Thomas, Thomas & Fluck, 2014). Traxler (2009) describes the difference between m-learning and e-learning as follows:

> 'Mobile learning' is certainly not merely the conjunction of 'mobile' and 'learning'; it has always implicitly meant 'mobile e-learning' and its history and development have to be understood as both a continuation of 'conventional' e-learning and a reaction to this 'conventional' e-learning and to its perceived inadequacies and limitations. (p.1)

Brown and Mbati (2015) indicate that there is a misperception that mobile learning means mobility, learning while "on the move" (p.116). Brown and Mbati (2015) agree with Parsons (2014) that the misperception about mobile learning is that students rarely learn while physically on the move. Pietrzyk, Semich, Graham and Cellante (2011) summarise mobile learning as "learning that happens across locations, or that takes advantage of learning opportunities offered by portable technologies" (p.3). Based on this, it can be concluded that mobile learning is dependent on mobile technologies, "[m]obile technologies is a fundamental infrastructure to support mobile learning" (Bidin & Ziden, 2013, p.721). It is, therefore, important to understand how mobile technologies fit into the learning environment.

3.3.3 User Experience in mobile technologies

The use of mobile technologies in education has been the focus of various initiatives implementing digital learning at schools, which have shown the capabilities of overcoming the barriers of learning and teaching at schools (Botha, Herselman, & van Greunen, 2010). There is little doubt that ICT enhances learning and teaching at schools. It is, therefore, important to

ensure that the demands for ICT are met so that high-quality education can be delivered as expected. These mobile technologies offer the potential to provide students with new ways to develop their problem-solving skills, critical thinking skills and communication skills, enabling them to transfer these skills to different contexts and reflect on their thinking when collaborating with their peers (Saavedra & Opfer, 2012). Figure 3.2 shows teachers and learners interacting with the mobile technologies.

Figure 3.2: Teacher and learners interacting with mobile technologies (tablets) (Argus, 2019)

Vavoula and Karagiannidis (2005) state that when mobile learning applications or technologies are designed there are several things that need to be taken into consideration to ensure that the application (mobile technology) is designed for learning and teaching. In one of the discussions that was held in 2016 under the topic 'Deliver a richer learning experience', one of the guests, Ben-Carl, emphasised that for mobile technologies in teaching and learning to be a success, the product developers need to be clear about the purpose of the system and be in a position to understand the user's needs and expectations (Trialogue, 2016).

However, Arhippainen's (2009) study indicates that the user's (teacher) interaction with the system (mobile technologies) and the context where the interaction is taking place may have a large influence on the UX of the user.

According to Bischoff (2016), UX is a metric that makes it possible to evaluate the technology through the user's feelings, emotions and suggestions about the product or system. Therefore, it is essential that when a mobile technology or device is developed, the developer must have

the user in mind in order to attract the user and to ensure that they do not just use the system (mobile technology), but that they also appreciate using the system (Chan & Johansson, 2016).

UX focusses on the entire interaction of the user with the system including feelings, opinions, emotions and perceptions (Van Staden et al., 2015). It has been confirmed that when a system (mobile technology) is easy to use the user shows appreciation through hedonic and positive feedback (Chan & Johansson, 2016).

As discussed in section 3.3.2, tablets are mobile technologies, and they enable learning to happen anywhere. In this study, teachers used the mobile technologies to teach learners in a rural environment. In order for mobile technologies to be fully utilised in schools, particularly in rural schools, it was appropriate for this study to indicate factors that may influence the UX of the teachers when using the technologies to conduct teaching and learning.

According to Bidin and Ziden (2013), there are factors that influence whether teachers use mobile technologies in schools. Table 3.1 illustrates factors that influence the use of mobile technologies for learning in education. In order for mobile learning to be successfully utilised in schools, these factors should be adopted (Bidin & Ziden, 2013). The factors are divided into three categories and sub-divided into sub-categories.

Table 3.1: Factors influencing mobile technologies in education (Bidin & Ziden, 2013)

Factors	Sub-factors	Description
Features of the devices	Usability	The features of the device should be easy to use and flexible, enabling the user to carry it anywhere and anytime.
	Functional	The functionality of the device should allow the user to use it without any constraints, regardless of the environment where they interact with the device.
Users Expectations	Ownership	Having control over the device is important for the user.
	Privacy	Privacy is important for the users, it provides safety and motivation for users.
	Self-regulated learning (Control of the learning)	The use of mobile technologies at school establishes a platform for users to take control of learning, by determining their own goals and, therefore, contributes to motivation.
	Flexible learning	Mobile learning provides flexibility by allowing learning to happen anywhere and anytime.
	Life-long learning	Mobile learning is viewed as the tool that can materialise life-long learning.

Factors	Sub-factors	Description
	Fun	Mobile learning introduces excitement to learning.
Pedagogical advantage	Collaborative learning	Collaboration allows learners to work together to achieve a common goal, encouraging participation.
	Blended learning	The combination of classroom instructions with mobile learning to enhance face-to-face learning, enables projects and assignments to be accessible on mobile devices.
	Interactive learning	The level of interactivity and engagement with technology acts as an agent where functionality of the mobile device is triggered when learning happens.
	Experiential learning (Learning in context)	Allowing learning to happen in any environment, the use of technology to connect school work and other activities.
	Problem-based learning	Discovering the content that will be necessary to solve the problem given by the teacher.

The three main factors listed in Table 3.1 are: features of the devices, user expectations and pedagogical advantage. Pedagogical advantage factors and its subcategories will not be considered in this study because it does not focus on the method or practices of using the mobile technology. Factors such as features of the device will be considered because it was mentioned in section 2.2.2.1 that usability is the component embedded in the UX. As a result, these factors will also be evaluated in this study with the intention of identifying UX factors. The user expectations category forms part of the factors that may influence the UX, hence it will be evaluated. These factors are interpreted in the formulation of the conceptual framework and are discussed extensively in section 3.5.

The UX involves the characteristics of the system, which includes functionality, the complexity of the system, its purpose and usability (Hassenzahl & Tractinsky, 2006). Therefore, it can be concluded that factors that influence usability, may also influence the UX since usability may be directly presented as one part of the UX. Flexibility, effectiveness, satisfaction, look (hedonic), aesthetic and efficiency of the system are recognised as factors that influence usability (Toko, 2017).

Efficiency enables teachers to use the technologies without experiencing glitches in the system (mobile technologies). This factor shows the usability or ease of use of the system, which is one of the factors that should be taken into consideration when the system is used by the user (Chan & Johansson, 2016). UX is used to evaluate the effectiveness and efficiency of the

system through the user's (teacher) feedback, by way of emotions, behaviour, attitude, expectations and perception about the system (mobile technologies) (Roto, 2006). Poorly designed systems (mobile technologies) may result in frustration and make it difficult for users to adopt the system. It complicates what is expected from the user (teacher), making it difficult for the user (teacher) to finish the tasks successfully, thus disrupting the user's interaction with the system and the overall UX (Mashapa, 2009).

According to Bidin and Ziden (2013), and Morville (2004) mobile technologies are required to be:

- Usable — efficiency (ease of use)
- Desirable — satisfaction
- Valuable — meet user's needs
- Effective — enable work without constraints
- Flexible — can be used anywhere
- Pragmatic — attractiveness
- Hedonic — appearance and fulfilment

With the demand for mobile technologies to be implemented at schools, it has become necessary for teachers to have the required skills to be able to use the technologies effectively and efficiently. The following section discusses the mobile technology skills required for teachers to effectively deliver teaching and learning using the technologies.

3.3.4 Twenty-first century mobile technology skills using mobile technologies

We are living in the twenty-first century where most manual processes in the majority of institutions are now digitalised, be it the banks, hospitals, shopping centres or libraries. The education system is challenged by the demands of the twenty-first century, which includes mobile technologies skills such as problem-solving skills, innovation, communication skills, critical thinking and collaboration (Hlagala, 2015). According to Payton and Hauge (2010), technological skills, such as creativity, enable one to think creatively and innovatively about technology. There is support from the South African government for building a twenty-first century schooling system. Teachers are advised that not only learners should be prepared for this transformation. (Becta, 2010). "There is an expectation that all teachers should have 21st-century skills to teach with technology to enhance their teaching practice" (Herselman et al., 2020, p.24). Much learning and training should be provided to both novice and intermediate

teachers to assist them with understanding the twenty-first century skills needed to use mobile technologies and tools (Becta, 2010; Herselman et al., 2020).

Twenty-fist century tools, such as mobile technologies, are available to support teachers not only in teaching, but also with communicating with parents and assessing learners' performance (Blackboard, 2008). Teachers are expected to deliver lessons and to enhance teaching through the use of technologies. Teachers can make teaching exciting by creating a conducive environment for learners by using the technologies to communicate with learners and by providing special skills for special learners (Becta, 2010). "High quality teachers are the most important factor in a child's education" (Blackboard, 2008, p. 4). According to Isaacs (2012), improving the quality of teachers will also improve the quality of education.

It is alleged that teachers are influential in the success of the learners and are rated as a predictor in a student's achievement (Herselman et al., 2020). The dominant structure world-wide is the transmission model, where teachers are transmitting knowledge to learners (Saavedra & Opfer, 2012). For the mobile technologies skills to be effective at schools, teachers need to train to become experts in the mobile technology field. In countries such as Singapore, it is a prerequisite for teachers to participate in 100 hours of professional development on a yearly basis (Saavedra & Opfer, 2012). It is understood that for someone to be relevant to the current generation the world of technology and technological skills are essential (Mbebe, 2017).

To become fully literate in today's world, students need to become proficient in the new literacies of twenty-first century technologies (Herselman et al., 2020; Hutchison, Beschorner & Schmidt-Crawford, 2012). For transformation to happen at schools, the curriculum framework and instruction methods need to be changed. This includes teacher training, teacher development and the practice in teaching profession (Saavedra & Opfer, 2012).

In section 3.3 the researcher aimed to identify the factors (subcomponents) of UX that influence UX when using the mobile technologies. Factors such as usability, flexibility, desirable, pragmatism, creativity, critical thinking, problem solving, and functional skills are amongst the factors identified as being relevant to this study. The following section discusses the context component.

3.4 Component Context: schools in resource constrained environments

3.4.1 Introduction

According to Wan (2009), the Oxford English Dictionary defines context as "the circumstances that form the setting for an event" (p.33). The context of use is defined as "the circumstances

under which the activity […] takes place" (Jumisko-Pyykkö & Utriainen, 2010, p.2). What is Context in UX? Context refers to the physical environment where the user interacts with the system (Hassenzahl & Tractinsky, 2006; Roto, 2006; Roto et al., 2011). According to Chipangura (2016), context can either be an object, person or place that forms part of the interaction between the user and system. Gentner et al. (2013) describe context as the environment, space and time where the interaction occurs. In a situation where the user uses mobile technologies as a tool to access information, context can be understood as the location of use, which includes the physical place and social conditions where the interaction occurs (Chipangura, 2016). It is understood that "context is an essential part of user experience" (Jumisko-Pyykkö & Vainio, 2010, p.3).

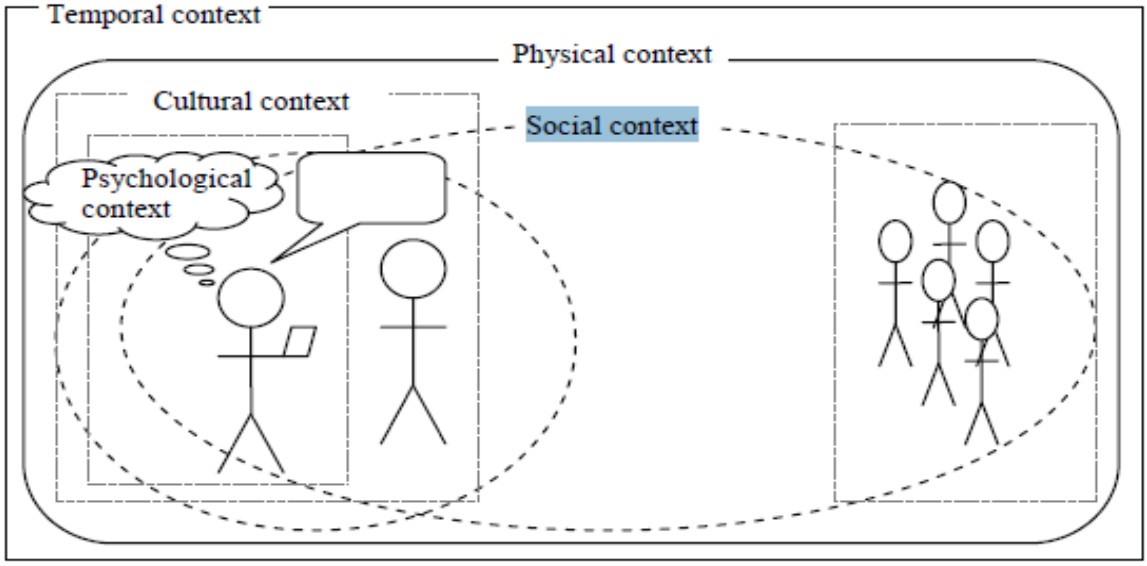


Figure 3.3: The model of UX context in mobile circumstances (Arhippainen, 2009, p. 204)

Figure 3.3 illustrates the model of UX context in the mobile setting. The study of Arhippainen (2009) demonstrates that if the user experiences social issues in the physical context it becomes difficult for the user to accept the system. When the user stays in the same physical context, the social and psychological situations of the user are bound to change continuously. The psychological state of the user has an impact on the acceptance and adoption of the system (mobile technologies) (Arhippainen, 2009).

In this research, schools in the rural areas of South Africa constitute the physical context where the interaction takes place. The social context includes the culture, people involved, opinions of others (i.e. colleagues, school governing body, principal) and limited knowledge of the use

of technology in resource constrained environments. The task context concerns the use of the technologies at all levels, be it in teaching and learning, research or administration.

There is an assumption that the system experience differs from environment to environment, and for positive UX the system needs to adjust to the current context (Roto et al., 2009). The experience of teachers using mobile technologies in the resource constrained environment will be affected by the lack of resources, which may impact their interaction with these technologies. Deegan and Rothwell (2010) emphasised that the deepest concern when the user interacts with the system is the context where the interaction is happening. It is believed that UX may change when the context changes even though the system remains the same, and in the UX domain context can be referred to a mix of social, physical, task, technical and information contexts (Roto et al., 2011). Figure 3.4 illustrates Jumisko-Pyykkö and Vainio (2010) description of five different contexts of use and their attributes, namely: physical, temporal, social, task and technical.

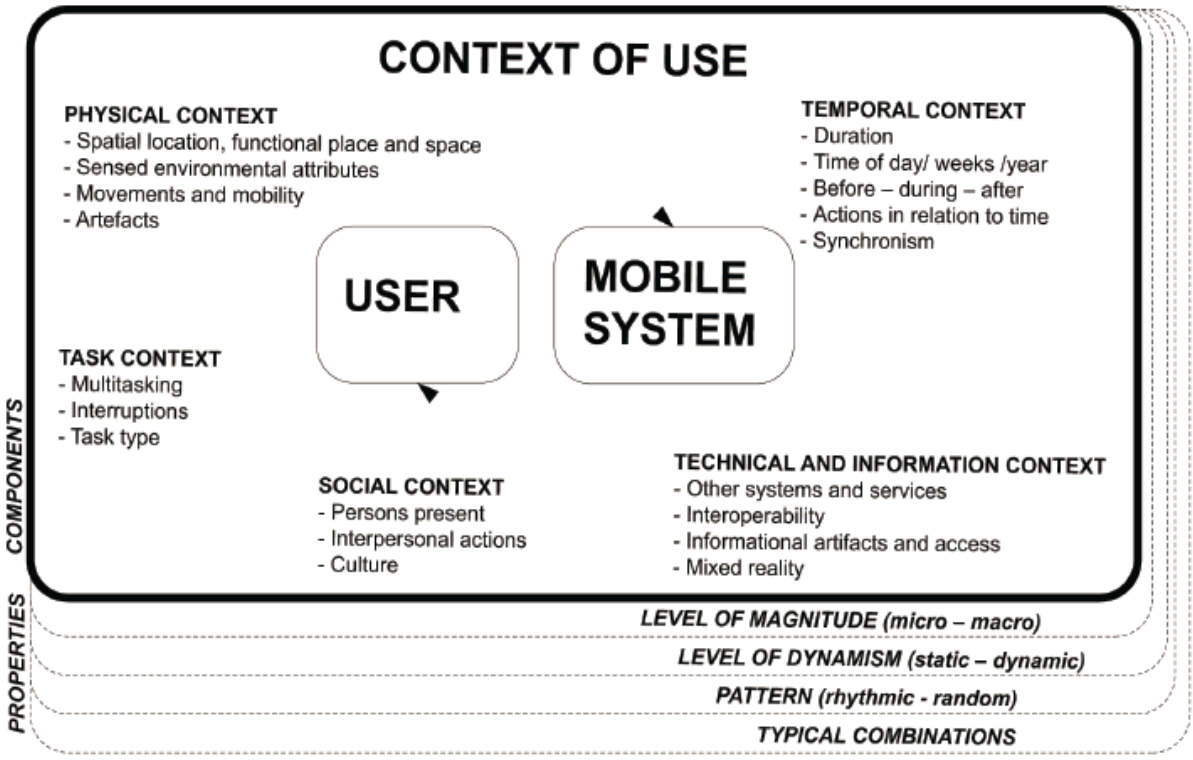


Figure 3.4: Model of context of use in Human-Mobile Computer Interaction (Jumisko-Pyykkö & Vainio, 2010)

The "context of use is related to user's characteristics, task, as well as technical, physical and social environment" (Jumisko-Pyykkö & Vainio, 2010, p.3). The following discussion explores the different contexts from the viewpoint of the study.

- **Physical context**

  This context refers to the environment where human-mobile interaction takes place. The physical context includes attributes such as location, place, environmental attributes, movement and mobility, and artefacts (Jumisko-Pyykkö & Vainio, 2010). Ouma (2013) describes physical context as the constraints within the environment where the mobile technologies are operating. Other limitations include the weather and noise where the interaction occurs. Physical context has an influence on the UX (Mashapa, 2013). The physical place of the teachers at schools is the classroom where they conduct learning and teaching.

- **Social context**

  Social context refers to the involvement of other people and includes their characteristics and roles, their influence on the user, and the culture that influences the interaction of the user and the system (Jumisko-Pyykkö & Vainio, 2010). This involves the presence of other people and their opinions during the interaction, and how this presence impacts the user's response to the system and influences the UX (Arhippainen, 2009). The school setup, the culture of the school and the attitude of the school towards the use of mobile technologies in teaching and learning has an impact on the UX, as does the involvement of certain individuals be they the principal of the school, school governing body, or the admin officer (De Kock 2017; Ouma, 2013).

- **Task context**

  This context refers to other tasks that the user maybe doing while interacting with the mobile technologies, which results in multitasking, interruption and task domain (Jumisko-Pyykkö & Vainio, 2010). The focus is on the task that the user performs and the targeted goals involved when finishing the task (Ouma, 2013). At schools, the teachers are not only using the mobile technologies for teaching and learning, but are also using them to do research and administration, enabling teachers to multitask as they interact with the mobile technology.

- **Temporal context**

  This context refers to the user's interaction with the mobile technology, specifically the time it takes for the user to interact with the system. The situation before and after the interaction will influence the context of using the system and impact the UX (Jumisko-Pyykkö & Vainio, 2010). It is very important to evaluate how UX evolves over time as UX does not stay constant. It is, therefore, ideal to evaluate UX before, during and after the interaction (De Kock, 2017). The results of the UX in the temporal context are influenced by time, as something may have occurred before the user could interact with the system; such occurrences play a vital role in the results of the UX (Ouma, 2013).

- **Technical and information context**

  This context refers to the device involved, infrastructure, and other relevant services including application and network (De Kock, 2017; Jumisko-Pyykkö & Vainio, 2010). The availability of services, hardware, software and network at all times is vital in the ICT environment as users rely on all the related factors (Ouma, 2013). The school's infrastructure has an impact on the result of the UX, as teachers may experience connectivity issues or slowness in the system response, which may result in dissatisfaction with the system and negatively influence the UX of the teachers.

Contexts such as physical, social, tasks and technical and information were selected from this framework for the purposes of this research and were included in the creation of the conceptual framework. Although temporal context has been discussed it will not be used to evaluate the UX of the teachers. Temporal context involves time and time is measured using other UX metrics that have not been defined in this study. Therefore, it will be excluded from the formulation of the conceptual framework.

3.4.2 How is the use of mobile technologies in rural resource constrained environments influenced?

The adoption of ICT in rural environments will reform education in South Africa. According to Mbebe (2017), ICT refers to various technologies, including the Internet, which make it possible to process information. The technologies include *mobile technologies*, such as mobile phones, computers, tablets, iPads, etc. "ICT has become an important aspect of teaching and learning in primary schools across the world because of its potential to improve the quality of learning" (Meyer & Gent, 2016, p. 8). It is important to understand that technology is not a primary tool to conduct teaching and learning, but it is used to support teaching and learning

(education) (Meyer & Gent, 2016). For the purposes of this study, ICT was used interchangeably with technologies, and technologies include mobile technologies.

Technologies have the potential to affect different aspects of human activities as they have become part of our daily lives. They also have the potential to bring about change within the resource constrained environment including development or transformation in education (Mbebe, 2017). The integration of technologies into education does not only have an impact on creating an informed society, it also has an influence on transforming learners into productive knowledge workers (Simuja et al., 2016).

If technology is well implemented, it can contribute to the development of the country. Other benefits of technology include communication and the exchange of information between entities, such as government sectors or educational institutions (Mamba & Isabirye, 2015). Across the African continent and developing countries, including South Africa, most teachers do not have adequate skills to integrate ICTs at schools and, as a result, only a few schools are using ICT (mobile technologies) in rural areas for teaching and learning (Nkula & Krauss, 2014). Most studies have indicated that there are challenges to sustaining ICT projects in the resource constrained environment (Mabila, Herselman & Van Biljon, 2016). Teachers in resource constrained environments are eager to use technologies in the classrooms for teaching and learning, but they lack pedagogical and technological skills to integrate ICTs or technology in teaching and learning (Botha & Herselman, 2016).

3.4.3 Technologies at schools and the education system in South Africa

According to Simuja et al. (2016), "[e]ducation is a human right that enables people to improve their lives and transform their societies" (p.1). Over the past two decades the South African education system has faced challenges in providing quality education. These challenges include underperformance, school fees burdens, accumulative number of learners and the development of qualified teachers (Chisholm, 2011). Teachers are critical to schools and, according to the National Planning Commission (NPC), most challenges at schools are related to the teachers' performance (Chisholm, 2011).

Teachers are under pressure to ensure that they supply essential skills to bring transformation to schools, and to assist learners with adapting to the new dawn of education in the classrooms (Blackboard, 2008). For learners to become effective global citizens, teachers are required to assist learners with becoming competent in the use of technology. Teachers are expected to transfer skills such as collaboration, problem-solving skills and critical thinking skills to

learners (Mabila, Herselman & Van Biljon, 2016). Teachers can use technology (mobile technologies) to develop and share the best practices in the classroom to improve the quality of education (Saavedra & Opfer, 2012).

The integration of technologies into education systems has formed part of the discussion about the reforms needed in the current education system (Chinapah & Odero, 2016). Benefits of ICT include development, economic growth, providing access to distance learners, the creation of job opportunities for online tutors, and enabling learners from rural areas to have access to education (Mbebe, 2017). Technology has the ability to change the practice of teaching and learning. Although some rural areas have access to ICT the issue is slowness of utilisation, with the schools focussing on basic access and not on the bigger picture, such as integration into teaching and learning (Simuja et al., 2016). Figure 3.5 depicts technology integration in the classroom, and illustrates how mobile technologies such as PC's, laptops, tablets and mobile devices, including physical classes are utilised in the educational environment using internet technology.

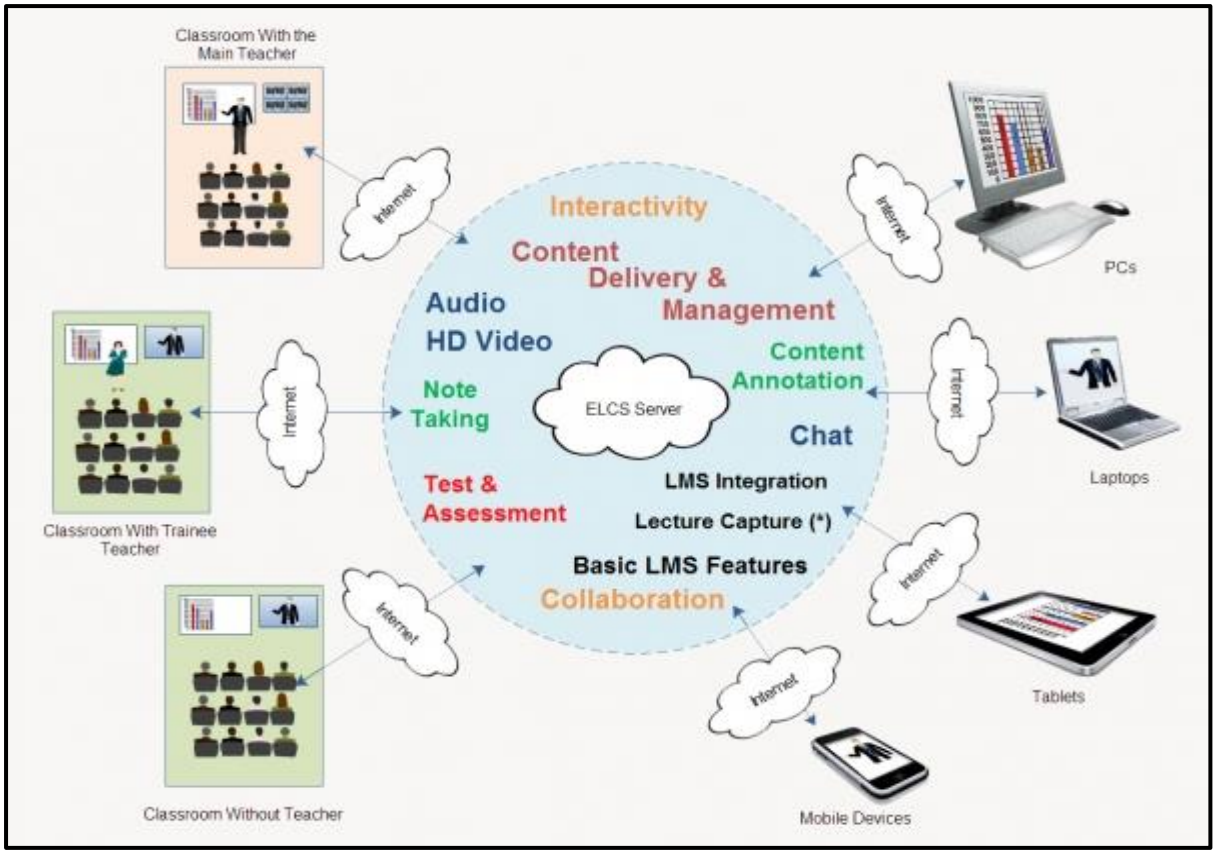


Figure 3.5: Technology integration in the classroom

Botha and Herselman (2017) emphasised that there is willingness and commitment from teachers in rural areas to use technology to support teaching and learning, but the issue is that they lack the knowledge to integrate technology into their teaching activities. According to Meyer and Gent (2016), the provision of ICT in learning and teaching needs to be defined, which would clarify the purpose of ICT in the classrooms.

About five percent of South Africa's Gross Domestic Product (GDP) is spent on basic education to support transformation and development at schools (Mabila, Van Biljon & Herselman, 2016) and part of the development includes the use of ICT. Although the South African government claims to have a large budget for the enhancement of the education system, the budget is minimal when compared to other African countries like Botswana, Kenya and Namibia that are likely to invest more into education (Chisholm, 2011).

It is without doubt that ICT is an essential tool for the education system, which can transform learning practices in the classroom (Botha & Herselman, 2016). Teachers who believe in their ability to teach are more likely to adopt, implement and integrate ICTs in their classrooms (Nkula & Krauss, 2014). The teacher's ICT literacy skills and competence are important factors in ensuring the use of technologies in the classroom and sustaining ICT integration in schools (Mabila, 2017).

3.4.3.1 ICT policies in education

The Education white paper 6 was introduced with new policies that align the South African education system with ICT integration, which includes building an integrated system for all schools in South Africa (Donohue & Bornman, 2014). A study by Mamba and Isabirye (2015, p.136) revealed that "developing countries lack implementation frameworks that are relevant to their context". The Department of Basic Education has adopted strategies and put plans in place to lead ICT transformation in education, which will result in better access to education, and high quality in teaching and learning (Mabila, Herselman & Van Biljon, 2016).

In September 2016, parliament approved the integrated ICT policy white paper, which intends to improve the growth of the economy. The policy includes the rolling out of broadband infrastructure countrywide and the reduction of the same ICT projects (Fin24, 2016). However, parties such as the Free Market Foundation do not support the implementation of the ICT policy white paper, stating that the policy is flawed, and it could either make or break the ICT industry (Venktess, 2017). On 15 February 2017, the Minister of Telecommunication and Postal Services, Siyabonga Cwele, addressed parliament about the policy inclusion. He also indicated

that the CSIR had confirmed that the ICT sector has invested over R78bn in the infrastructure over the past three years and confirmed that there has been progress from this investment (Bateman, 2017). The first paragraph of the policy highlights the purpose of the amended policy stating that "the main purpose of this white paper is to unlock the potential of ICTs to eliminate poverty and reduce inequality in the country by 2030" (Bateman, 2017, para. 5).

The unequal education policies at schools have been discussed since the 1990s in an attempt to prioritise equal education, yet the challenge is to amend and implement the policies (Chisholm, 2011). Most countries, including South Africa, are failing to put educational policies into practice. Part of the policies implementation includes training for educators, and ICT adoption and integration at schools (Donohue & Bornman, 2014). According to Mamba and Isabirye (2015), the implementation of policies is being slowed down by stakeholders who are apprehensive of change.

If South Africa's focus is to ensure the reduction of inequality and poverty elimination through the project's implementation of ICT by 2030, policymakers and stakeholders should play an important role in formulating and implementing relevant policies (Opertti, 2017). The delay of policy implementation has an impact on ICT adoption.

According to Burgess and Sievertsen (2020, para.2) "[g]oing to school is the best public policy tool available to raise skills". However, the outbreak of the Covid-19 pandemic globally, exposed most of the countries' education systems and inequalities in education including South Africa. During the pandemic outbreak countries were forced to lockdown and schools, colleges and universities were also forced to close down (Shenoy, Mahendra & Vijay, 2020). It is in this period where some schools pronounced to offer online classes; "[s]tudents are being educated remotely using technology [and] [t]his is being done through a variety of online courses and electronic textbooks" (Patrinos & Shmis, 2020, para.3). Most universities and colleges moved from traditional exams to online assessments using the technologies (Burgess & Sievertsen, 2020). Yet not every school managed to achieve the use of technology to provide online learning; "governments around the world will need to reassess learning systems to meet these challenges. [t]his is a once in a generation opportunity to improve education" (Giannini, 2020, para.6).

3.4.3.2 Technology challenges in resource constrained environments

Technology has rapidly grown worldwide, bringing changes to sectors such as banking, social media, education, etc. Despite all the positivity reported regarding the existence of ICT, some

sectors have been slow to utilise the benefits that come with ICT or technology, which has resulted in a digital divide (Chinapah & Odero, 2016). It is without doubt that ICT plays a vital role in education by transforming teaching and learning at schools (Nkula & Krauss, 2014). The assumption is that should schools function as expected, ICT could improve the poor communities provided there is support from education leadership, management and availability of resources (Chisholm, 2011). The standard of living for people in impoverished or rural areas could possibly benefit at a commercial and educational level if ICT applications are executed correctly (Mbebe, 2017). Despite all the benefits that technology offers in transforming education, lots of schools in rural areas in South Africa are struggling to get access to ICT, and some of the schools that have access to ICT use it in a limited manner (Nkula & Krauss, 2014).

In developing countries, schools in underprivileged areas are recognised for the benefits they provide in grooming and strengthening the abilities of learners in compromised environments (Simuja et al., 2016). It is understood that schools in underprivileged areas in South Africa have the ability to contribute to development in resource constrained environments (Simuja et al., 2016). However, more needs to be done to close the gap between rural and urban schools.

Africa is affected by poverty and a lack of development, hence it is ranked low globally in terms of access to the Internet, and many are excluded from participating in the information society (Bornman, 2015). The challenge regarding poverty or poor people is not only that they are being deprived of information, but there is also discrimination and social inequalities that hinder development and progress in that particular community (Chinapah & Odero, 2016). It is remarkable that there is a digital divide across the African continent that includes South Africa (Bornman, 2015). The digital divide is the gap between those who can access and benefit from ICT and those who cannot (Mbebe, 2017). According to Bornman (2015), the digital divide refers to the imbalance in ICT access, mainly the Internet.

South Africa is amongst the 180 countries that committed towards the adoption of the Millennium Development Goals (MDG) that seek to provide quality education for all (Donohue & Bornman, 2014). Part of the MDG includes a focus on ICT (Mamba & Isabirye, 2015). Despite the commitment that South Africa made to improve education, the quality of education is still poor, particularly in the areas of mathematics and reading where learners are still underperforming when compared to other African countries (Donohue & Bornman, 2014). According to Chisholm (2011), inequalities in education become apparent when comparing children from wealthy households to those from poor households. What is evident is that those

coming from poor backgrounds perform poorly. Most studies show that in terms of access to ICTs, Internet is mostly preserved for the wealthy people and educated elite (Bornman, 2015). Another barrier that needs to be addressed is the lack of access to resources. Schools in rural areas have limited access to hardware and software, and find it difficult to integrate ICT (Nkula & Krauss, 2014). Bornman (2015) identifies four barriers that contribute to the digital divide and may slow the implementation and adoption of ICT:

> First barrier 'Mental Access' this relates to lack of interest to digital or online experiences, digital anxiety, second barrier 'Material Access' not having access to technology, third barrier 'Skill Access' the lack of skills to use the technology and forth barrier 'ICT usage'. (p.4)

There are still challenges to implementing technological programmes at schools to enhance education, due to unskilled personnel and improper ICT infrastructure, especially in resource constrained environments (Chinapah & Odero, 2016). There are challenges to information access in rural environments, which hinders development in those areas. The introduction of ICT could be the solution to prompting development in the rural areas (Mbebe, 2017). Due to a lack of infrastructure in rural areas much needs to be done to ensure that ICT is properly installed. The success of technology adoption and integration at schools or in the classroom lies with the positive attitude of the teachers (Botha & Herselman, 2015a). However, the inequalities in the society have led to a digital divide at schools; "the problems associated with ICT inequalities start with the general diffusion of ICTs, as mental, skills and usage barriers will influence the efficient usage of available ICT infrastructure" (Bornman, 2015, p.4). It is the responsibility of the province, department and schools to ensure that the adopted ICTs are not wasted and diluted, sustainability is key (Meyer & Gent, 2016).

This section presented three components: user, system and context. It also identified the subcomponents, referred to as factors, which may have an influence on the UX of teachers using mobile technologies in resource constrained environments. The following section presents the conceptual framework developed from the literature review in Chapter Two and Chapter Three of the study.

3.5 The conceptual framework

The objective of this section was to draft a conceptual framework presenting the components and factors that were identified in the literature study, which may have an influence on the UX

of teachers using mobile technologies at schools for teaching and learning in resource constrained. According to Jabareen (2009), a conceptual framework is not a collection of concepts, but constructs where each concept plays an essential role in building the framework.

Maxwell (2005) defines a conceptual framework as the framework of "concepts, assumptions, expectations, beliefs, and theories that supports and informs your research" (p.33). Adom, Hussein and Joel (2018) study describes the conceptual framework as "a structure which the researcher believes can best explain the natural progression of the phenomenon to be studied" (p.439). A conceptual framework is something that is built, not something that is found, by incorporating pieces of work found here and there to form a structure not currently in existence. Therefore, it is important to revisit the existing theories that are relevant to the study (Maxwell, 2005).

Rocco and Plakhotnik (2009) state that without a history of the literature, a discussion and framework, the research paper is worthless. The conceptual framework makes it easier for the researcher to define the concept of the problem of the study by showing the variables' relationship using a graphical or narrative technique (Adom et al., 2018). "Whether researching a new or existing topic, this type of literature review requires conceptual and methodological rigor" (Rocco & Plakhotnik, 2009, p.127).

This study adopted Adom et al.'s (2018) and Maxwell's (2005) definitions of a conceptual framework as being a structure that describes the progression of the phenomenon, and is developed using the pieces of work with the aim to build an informative structure that outlines the outcomes of the study. The conceptual framework is presented in Table 3.2 and was derived from Chapter Two and Chapter Three of the literature study. In Chapter Two, version one of the conceptual framework was produced, which contributed towards the conceptual framework presented in this section. The first field in the conceptual framework concerns the components that were identified as being relevant to this study. The second field presents the subcomponents referred to as factors. The third field presents the characteristics of factors of the UX for teachers, and the last field presents the references from the literature that supports the identified components and factors.

Table 3.2: Overview of the conceptual framework

Components	Subcomponents — Factors	Factors (characteristics) that may have an influence on teachers' UX	References and literature section
User: Teachers	• User's o Needs	Teachers need to be satisfied with the use of the technologies.	(Mashapa, 2013) **3.2.1**
		Teachers need the technologies to be user friendly — ease of use.	(Chan & Johansson, 2016) **3.3.3**
		Teachers need to accept the use of technologies at school.	(Mashapa, 2013) **3.2.1**
		Teachers need to be able to perform tasks using the technologies.	(Mahlke, 2008) **2.2.3**
		Teachers need to be encouraged when engaging with the system.	(Portugal, 2014) **3.2.1**
	o Perceptions	The teachers' perception of the system does have an influence.	(Roto et al. (2011) **2.2.3.2**
		Teachers need to perceive the technologies as useful.	(Maguire, 2013) **2.2.3.2**; (Morville, 2004) **2.2.3.1.1**
	o Attitude	The teachers' attitude towards the use of the system does have an influence on the experience of the user.	(Langenhoven, 2016) **2.2.2**; (ChanLin, 2017) **3.2.4**; (Chiu & Churchill, 2015) **3.3.2**
	o Expectation	Teachers expect the technologies to support their teaching and learning needs.	(Botha & Herselman, 2017) **3.4.3**
		Teachers expect the technologies to meet the functionality and non-functionality requirement.	(Gentner et al., 2013) **2.2.3.2**; (Tan, 2009) **2.2.1**
	o Experiences	The experience of the teachers when using technologies is very important, evaluated.	(Roto, 2006) **1.2**; (Langenhoven, 2016) **1.2**
		Age and gender may influence the experience of the teacher.	(Gentner et al., 2013) **2.2.3.2**
	• Features of the device	The features of the technologies should be ease of use, efficient, quick to learn and flexible to be carried anywhere anytime.	(Pretorius & Calitz, 2014) **2.2.2.1**; (Chan & Johansson,

Components	Subcomponents — Factors	Factors (characteristics) that may have an influence on teachers' UX	References and literature section
System: Mobile technologies	○ Usability		2016) **3.2.2.1.2**; (Bidin & Ziden, 2013) **3.3.3**
		The errors that the teachers may encounter have an impact.	(Bevan, 2009) **2.2.2**
		The satisfaction and performance of the teachers is important.	(Petrie & Bevan, 2009) **2.2.2**
	○ Hedonic and Aesthetic attributes	The hedonic and aesthetic attributes satisfy the users, evoke the cognitive response of the teacher. Aesthetic affects the response of the user psychologically.	(Gentner et al., 2013) **2.2.3.2**; (Scapin et al., 2012) **2.2.3.2.1**)
	○ Functionality — Efficiency	Functionality of the technologies should enable teachers to navigate the system without any constraints.	(Bidin & Ziden, 2013) **3.3.3**
	User's expectation	Privacy — motivates the user, in the administration of duties privacy is crucial.	(Bidin & Ziden, 2013) **3.3.3**
	○ Control & Ownership	Control and ownership motivate the user to navigate the system freely.	(Bidin & Ziden, 2013) **3.3.3**
	○ Flexibility	Flexibility — gives the user freedom to work anywhere, this motivates the user as there is no limitation, learn while physically moving.	(Brown & Mbati, 2015) **3.2.2.1.2**
	○ Credibility	System should be reliable, credibility of the system is very important.	(Morville, 2004) **2.2.3.1.1**
	○ Valuable	The teachers need to find value in the system, by meeting the needs of the teachers.	(Morville, 2004) **2.2.3.1.1**
	○ Desirable — Pragmatism	Teachers should find the system emotionally desirable, system should look attractive to the teachers.	(Morville, 2004) **2.2.3.1.1**
	• Digital skills	Teachers need to know how to operate the technologies, for teaching, learning and other administrative functions.	(Mbebe, 2017) **3.3.4**; (Botha & Herselman, 2016) **3.4.2**

Components	Subcomponents — Factors	Factors (characteristics) that may have an influence on teachers' UX	References and literature section
	○ Technological skills ○ Critical thinking	Teachers require critical thinking skills to engage with the technologies and their content, teachers expected to transfer skills to learners.	(Mabila, Herselman & Van Biljon, 2016) **3.4.3**
		Teachers require problem-solving skills to learn to use the system in an unfamiliar environment and when working on difficult tasks.	(Hlagala, 2015) **3.3.4**
	○ Problem solving	Teachers require creative skills to think creatively and innovatively using the skills to apply knowledge when using the technologies.	(Payton & Hauge, 2010) **3.3.4**
	○ Creativity	Teachers' training to focus on ICT integration and in support for using mobile technologies at school.	(Mabila, 2017) **1.3.1**; (Chisholm, 2011) **3.4.3**
	○ Qualified teachers	Skilled and qualified teachers are critical in the school factors, teachers require training and professional development to enhance teaching and learning using technologies.	(Chisholm, 2011) **3.4.3.2**; (Becta, 2010) **3.3.2**
Context: Resource constrained environment	• Context ○ Physical context	The location where the technologies are used has an influence on the teachers' experience, shortage of ICT resources and limited knowledge will have an impact on the user experience.	(Chipangura, 2016) **3.3.3**
		The physical environment where the teaching will occur may be limited by attributes such as weather, noise, connection which may influence the use of the technologies.	(Mashapa, 2013) **3.4.1**; (Ouma, 2013) **3.4.1**
	○ Social context	Social context, the involvement of other teachers, staff members, school governing body and their opinion on how the system should operate. The attitude of the school towards the use of technologies at school.	(Arhippainen, 2009; Ouma, 2013; De Kock 2017) **3.4.1**
	○ Task context	Task context, teachers focus on the task that is performed. It is important as multitasking may interrupt the teacher's concentration.	(Jumisko-Pyykkö & Vainio, 2010); **3.4.1**
	○ Technical and information context	Technical and information context, the availability of service, hardware, network at all times, as the technologies rely on all the related factors. School infrastructure has an impact on the UX as it may result in connectivity and slowness issues.	(Ouma, 2013) **3.4.1**

Components	Subcomponents — Factors	Factors (characteristics) that may have an influence on teachers' UX	References and literature section

	• ICT integration
	  ○ Lack of policy implementation
	  ○ Training
		Lack of ICT policies strategies and implementation of the frameworks has an impact on the use of mobile technologies at schools.	(Mamba & Isabirye, 2015) **3.4.3.1**; (Donohue & Bornman, 2014) **3.4.3.1**

		Shortage of adequate skills in using technology at rural schools has an impact on delivering proper teaching and learning using the technologies.	(Nkula & Krauss, 2014) **3.4.2**
		Teachers are under pressure to ensure that they supply essential skills to bring transformation to schools.	(Blackboard, 2008) **3.4.3**
		Teachers' ICT literacy skills and competence are imperative factors to ensure the use of technologies in the classroom.	(Mabila, 2017) **3.4.3**
		Teachers require knowledge to operate the technologies and to deliver the lessons in the classroom using the technologies.	(Botha & Herselman, 2017) **3.4.3**

The conceptual framework presented in Table 3.2 is outlined in the form of a diagram in Figure 3.6, which aims to illustrate the proposed framework structurally. This was done because the study adopted Adom et. al's (2018) and Maxwell's (2005) definition of a conceptual framework as being a structure. Figure 3.6 depicts the identified components and their factors for a Conceptual framework that may influence the UX of the teachers in resource constrained environments. The illustrated conceptual framework in Figure 3.6 in conjunction with Arhippainen's (2003) framework depicted in Figure 2.2, were adopted and applied in the development of the proposed UXFTMTR framework for this study. The intention of the conceptual framework is to answer RSQ1: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments?

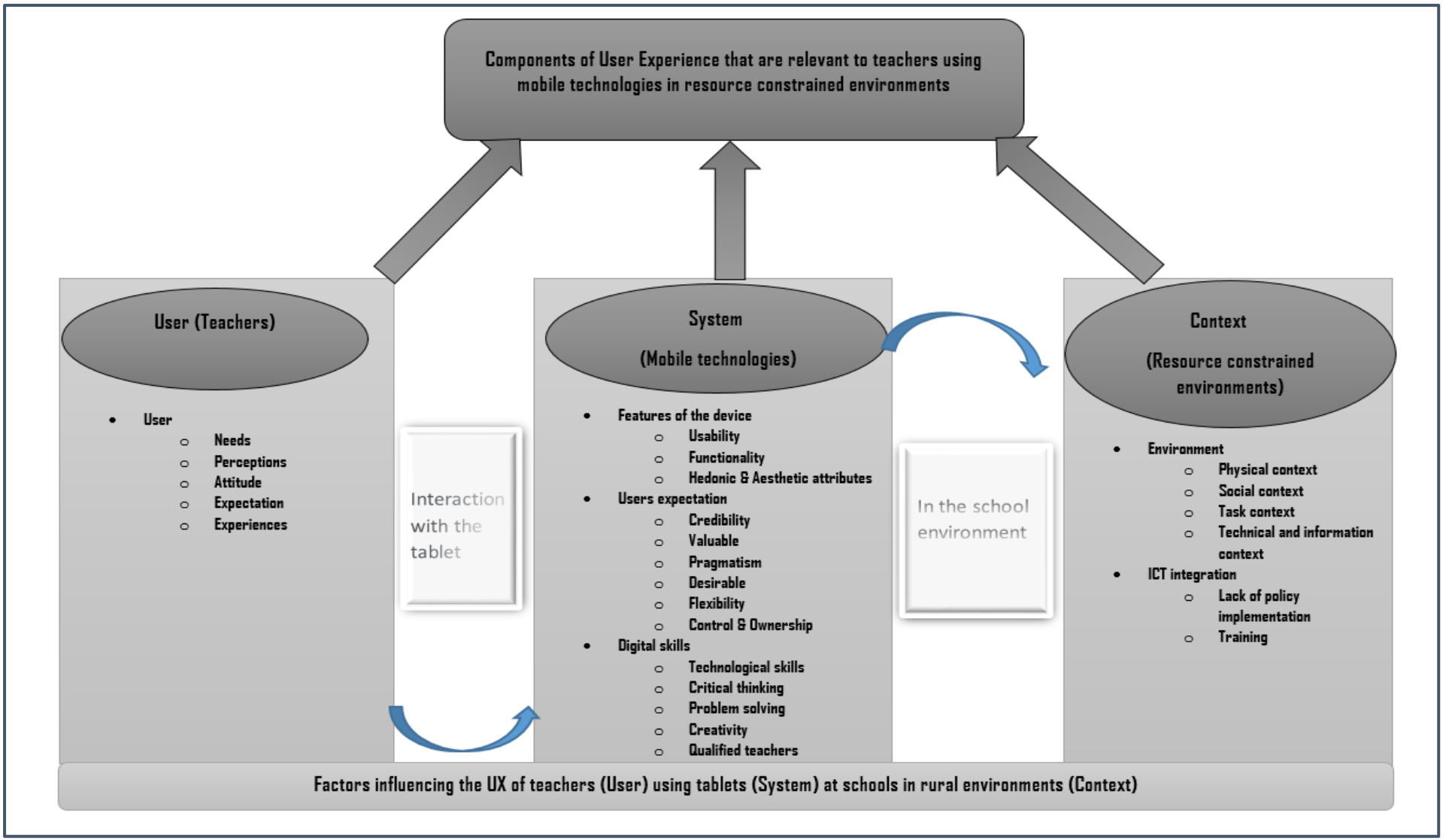


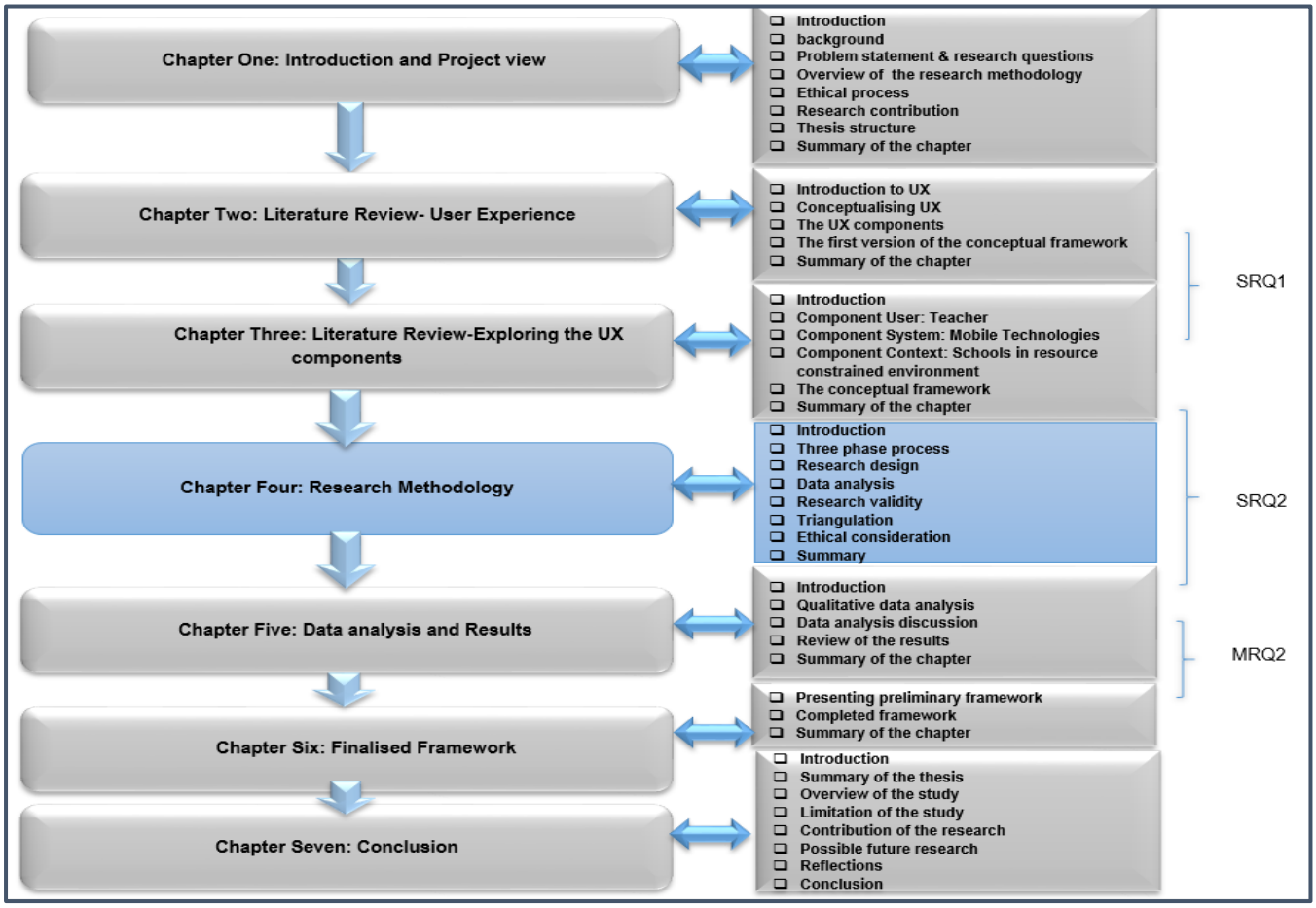
Figure 3.6: Conceptual framework of the components and factors that may influence the UX of the teachers

3.6 Summary of the chapter

The chapter explored the three components user, system and context within the context of the study, with the aim to answer research sub-question one and partly research sub-question two. The objectives were to identify factors with the characteristics that affect the UX of the teachers using mobile technologies for teaching and learning in resource constrained environments, and to evaluate the constraints affecting the provision of mobile technologies in a resource constrained environment.

The chapter discussed the subcomponents (factors) such as needs, resources, emotional state, experience, expectations, and perception including the characteristics factors of the components. Mobile technology as the system component was introduced, a background to mobile technologies was provided and twenty-first century mobile technology skills were discussed. Different subcomponents of the mobile technologies component were identified, such as usability, effectiveness, flexibility, valuable, etc. Context in UX was discussed, and context factors were identified. Technologies and the education system in South Africa were addressed, including the challenges being faced and ICT policies. The final conceptual framework was formulated and presented in this chapter.

4. CHAPTER FOUR: RESEARCH METHODOLOGY



4.1 Introduction

This chapter discusses the study's research methodology, the research approach, and the design that was selected to develop the proposed framework. The data collection method and the research method that were used to approach this study are also addressed in this chapter. This research adopted Saunders, Lewis and Thornhill's (2012) research onion model, discussed in Chapter One (section 1.4), to depict the research methodology used for this research.

Research methodology is described as a philosophical approach that is used to determine the style of research (Ihuah & Eaton, 2013). Research methodology can be described as the way the research ought to be conducted, depending on the aim of the research and the research problem which needs to be well defined (Walliman, 2011). Paul (2004) argues that the type of research methodology selected should be determined by the research itself. According to Oates (2006), studies are based on a philosophy and every research uses its own research design and strategy to achieve its primary goal. Creswell (2013) states that when conducting research, some appropriate research strategies should be followed. The research methodology chapter

includes all the phases of the research, from the theoretical underpinning of data collection to data analysis.

The objective of conducting any research is to answer the study's research question by identifying the aim of the study and the objectives of the study. As indicated in Chapter One, this study sought to explore and develop a framework for the user experience of teachers using mobile technologies in resource constrained environments. The framework will be recommended for use in the implementation of mobile technologies across the country. Table 4.1 shows the strategies that the researcher used to answer the research questions.

Table 4.1: Mapping of research questions

Research question	Objective	Research strategy	Research chapter
MRQ: How can the components of a framework for the user experience of teachers using mobile technologies enhance their classroom practice in resource constrained environments?	To design a framework for the user experience of teachers using mobile technology in resource constrained environments.	Data Analysis	Chapter Five
RSQ 1: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments?	To identify the components of user experience relevant to teachers using mobile technologies.	Literature Review	Chapter Two Chapter Three
RSQ 2: How is the user experience of the teacher reflected in the use of mobile technology for teaching in resource constrained environments?	To evaluate the perceptions and expectations of the teachers when using mobile technologies in resource constrained environments. To assess the experience of the teachers using mobile technologies in resource constrained environments.	Research Methodology (Questionnaire)	Chapter Four

4.2 Three phase process

This study followed a three-phase process in collecting both primary and secondary data, where results from the data collected from the first phase were used to build the second phase, which assisted with the development of the final framework proposed for this research. Figure 4.1 illustrates how the phases were connected.

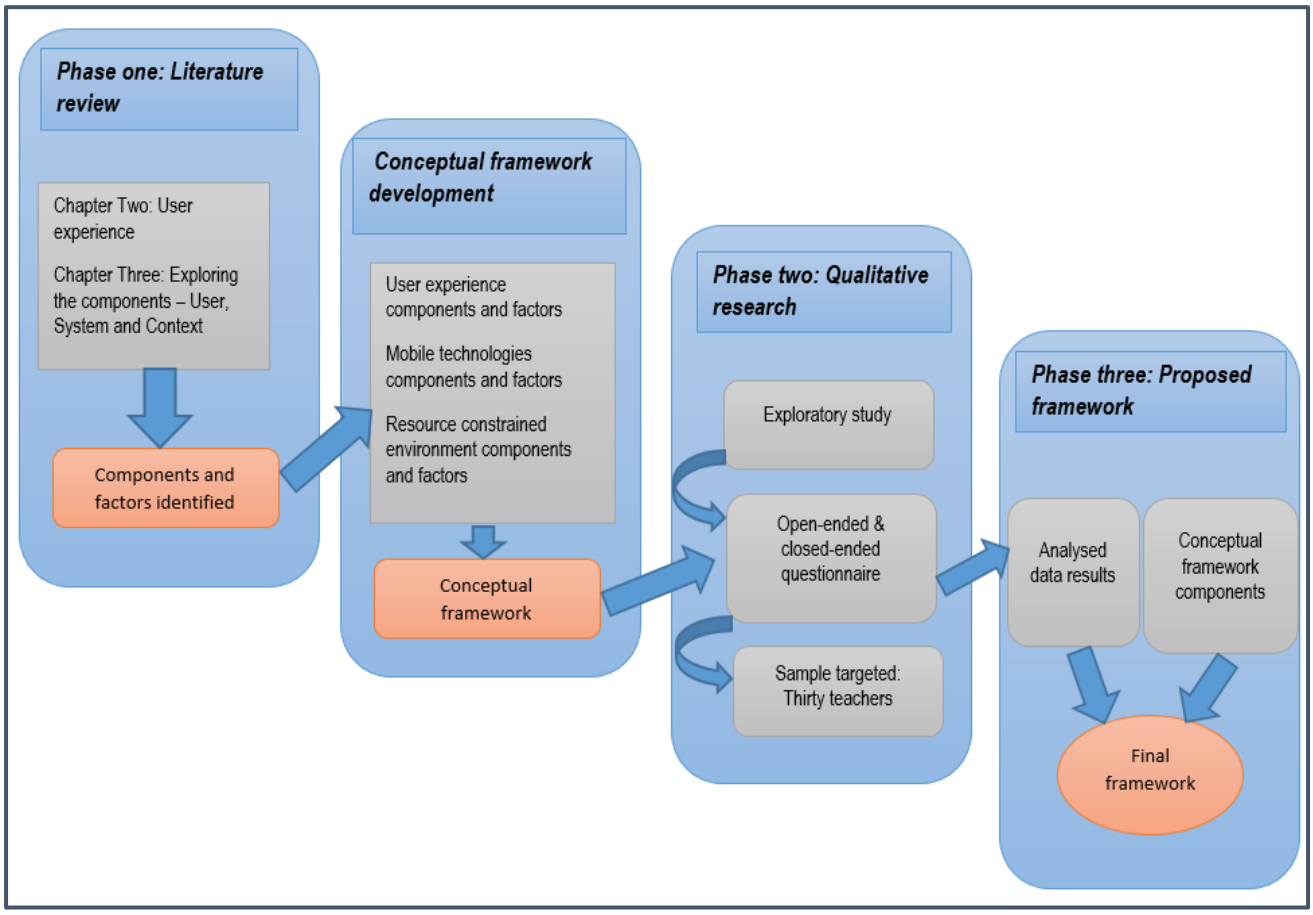


Figure 4.1: Research process of the study

4.2.1 Phase One: Literature Review

The literature review involves the study of various research papers to explore the phenomenon that is being researched. The aim was to collect relevant studies to assist with answering the research question and to collect relevant data from those studies to assist with building the appropriate argument to support the study. The aim of this phase was to answer research sub-question one: What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments? In order to answer the research question, the literature review was divided into two chapters: Chapter Two, discussed the UX concept and UX frameworks, the first version of the conceptual framework

and Chapter Three, exploring the UX components with the aim of identifying the factors that may affect the UX of the teachers using mobile technologies in resource constrained environments. Three components: user, system and context were identified. Each component has subcomponents called factors, and the factors have characteristics that form the factors and components of UX. The end product of this phase was the *Conceptual framework of the components and factors that may influence the UX of the teachers in resource constrained environments*.

4.2.2 Phase Two: Qualitative research

A questionnaire comprising both open-ended and closed-ended questions was compiled from the conceptual framework developed in phase two and was used to collect qualitative data. A pilot test of the questionnaire was conducted prior to the actual distribution to the targeted participants. The pilot was tested by three academics from different institutions and four experts in the UX and Mobile Technology field. This was done to test whether the questions were understandable, transparent and equitable. A finalised questionnaire was distributed to the targeted teachers after the original was refined based on the feedback from the pilot test.

4.2.3 Phase Three: Proposed framework

Data was analysed using themes and codes following a thematic analysis process. This was done using the responses from the questionnaire and the drafted conceptual framework developed in phase one. The results were used to improve the drafted conceptual framework to generate a finalised framework for the study, with the aim of achieving the main objective: Designing a framework for the user experience of teachers using mobile technologies in resource constrained environments. Phase three was conducted with the aim of answering the main research question:

> **How can the components of a framework for the user experience of teachers using mobile technologies enhance their classroom practice in resource constrained environments?**

The following section discusses the research design used for the study, which includes the research paradigm, approach, strategy, data collection methods, ethical procedures, targeted population and data analysis.

4.3 Research design

A research project requires you to have a research design that can be used as a plan of the methods and procedures used by researchers in the study to collect and analyse the data. "The research design articulates what data is required, what methods are going to be used to collect and analyse this data, and how all of this is going to answer your research question" (Van Wyk, 2012, p.4). There are three different types of research design: exploratory, descriptive and explanatory (causal) (Malhotra, 2010; Van Wyk, 2012). Table 4.2 compares the differences between the research designs.

Table 4.2: Comparison of research design (adapted from Malhotra, 2010; Van Wyk, 2012)

Exploratory study	Descriptive study	Explanatory study
Seek insight and understanding, problem not well understood	Test specific hypothesis, provision of valid and accurate representation	Analytical study, a change in a single variable changes the study
Lacks formal structure and is flexible	Formal and more structured compared to exploratory	Formal and structured compared to exploratory, information depends on variables
Develop hypothesis but does not test it, create theory	Develops the hypothesis and tests it	Goes beyond the descriptive, any explanation of the reasons
Case studies and secondary data: expert surveys, pilot surveys (questionnaire), observations, interviews, focus groups, qualitative research	Surveys/experiment, panels, observation and other data, quantitative research	Lab experiment, field data, field experiment, quantitative research
Sample is small and non-representative. Analysis of primary data is qualitative.	Sample is large and representative. Data analysis is quantitative.	Sample is large and representative. Data analysis is quantitative.

For the purposes of this study, the exploratory study was deemed to be the most suitable research design, because this research seeks the insight of the phenomenon, as a result the study was explored flexibly in three different provinces. The study used a questionnaire to gather data, the sample size is small and data was analysed qualitatively.

This section discusses the structure of the research methodology and the techniques that were used to collect and analyse data for the study. Section 4.3.1 discusses the different research paradigms that were identified and provides insight into the selected paradigm of the study. In section 4.3.2 the research approach is discussed. The research strategy is discussed in section

4.3.3, and in section 4.3.4 the different research methods are discussed. Section 4.3.5 offers a discussion about the preferred data collection technique that was used in the study, and section 4.3.6 discusses the source of data and the participants.

4.3.1 Research paradigm

According to Ihuah and Eaton (2013), in research methodology it is imperative to understand the different research philosophies and their paradigms, thus enabling the researcher to make a proper decision when selecting the research paradigm. A paradigm is described as "a set of scientific and metaphysical beliefs that form a theoretical framework within which scientific theories can be tested, evaluated and if necessary revised" (Photongsunan, 2010, p.1). Oates (2006) defines a paradigm as "a set of shared assumptions or ways of thinking about some aspects of the world" (p.282). This means that different philosophical paradigms consist of different views about the world and the way we acquire knowledge, which is reflected in the research strategies used in research (Oates, 2006).

Saunders, Lewis and Thornhill (2016) identified four paradigms that are commonly used in research: positivism, realism, pragmatism and interpretivism. The four different research paradigms are described or explained as follows:

- Positivism — The positivist paradigm refers to an approach that believes in reality and truth regardless of what people think, and this knowledge is gained through experiment or comparative analysis (Walliman, 2011). The assumptions of the positivist are that everything in the world is stable and organised, and that there is only one universal knowledge and solution to the existing problem (Shah, 2015). Positivists use an inductive approach and a quantitative analysis method to validate the hypothesis (Oates, 2006).
- Realism — Realists believe that reality is the truth. There are two types of realism: critical realism and direct realism (Saunders, Lewis & Thornhill, 2009). Realism is concerned with the reality of understanding people's beliefs and their behaviour, and shares the principles of both Positivism and Interpretivism (Vosloo, 2014).
- Pragmatism — "Pragmatism is based on the belief that theories can be both contextual and generalizable by analysing them for 'transferability' to another situation" (Shannon-Baker, 2016, p.322). The pragmatist philosophy is concerned with choosing one position, it can either be positivist or interpretative and focusses

mostly on the research problem adopting different approaches to understand the research question (Creswell & Plano Clark, 2011). This paradigm is suitable for both qualitative and quantitative methods to address real-life challenges (Ihuah & Eaton, 2013). This paradigm uses practical solutions to solve the problem (Shannon-Baker, 2016).

- Interpretivism — Refers to a philosophy that seeks to view reality as a human construction (Kroeze, 2011). This philosophy is about values, beliefs and social phenomena and the assumption is there are no facts but interpretation (Shah, 2015). Interpretive research does not focus on using the hypothesis method, but explores and explains the social context with the aim of creating a rich understanding in that context using the qualitative data analysis method (Oates, 2006).

For the purposes of this study, the interpretivist philosophy will be adopted**.** The interpretivist paradigm seeks to understand how humans view and make sense of the world (Kroeze, 2011). "[The] interpretive paradigm assumes that there are no facts, only interpretations, it aims to explore individuals' perceptions, share their meanings and develop insights about the observed cases" (Shah, 2015, p.956). This paradigm does not aim to prove or disapprove the hypothesis, but focusses on exploring and explaining factors that affect the social setting and how people (teachers) perceive the world (Oates, 2006).

It is understood that interpretivist theory is in opposition to positivist theory because the research strategies used by these paradigms differ greatly (Kroeze, 2011; Shah, 2015). Interpretivist researchers use open-ended questions, focussing on qualitative data where the researcher will interpret the meaning of the data, and rely on a small number of participants because they do not generalise, but explore (Shah, 2015).

One of the main characteristics of interpretivism is multiple subjective realities, which states that "there is no single version of truth, what we take to be real or knowledge is a construction of our minds" (Oates, 2006, p.292). Hence the study will link the philosophy with qualitative data collection methods to interpret what is being presumed by the teachers and to refrain from generalising and making assumptions. The different criteria that determine the quality of interpretivism are identified by Oates (2006). Interpretivist research criteria includes:

- Trustworthiness: interpretivism focusses on how much trust can be put in the research, not the research validity as is the case with positivism.

- Confirmability: focus on connecting the findings from the studied data, being able to confirm the results from the study.
- Dependability: the ability to trace the research process or documented data for others to be able to carry on with the research.
- Credibility: the evaluation of the research problem if it was well defined and the accuracy of the findings of the study.
- Transferability: ensuring that the findings are appropriate and can be transferred to others for results to be relevant.

The study adopted the identified criteria as these enabled the researcher to avoid bias and be in a position to follow the interpretivist research processes. For the purposes of this research, an explorative qualitative study using an interpretative paradigm was adopted, with the aim of exploring the social context of the study by interpreting the qualitative data. The qualitative data was collected using open-ended and closed-ended questions. The interpretivist paradigm was adopted in order to explore the teacher's experience of using the technologies at schools, and aimed to interpret what the teachers know, what they believe, their perceptions and attitudes.

- **The philosophical assumptions**

The interpretivists have their own understanding of different types of philosophical assumptions including ontology, epistemology, methodology and axiology (Vaishnavi & Kuechler, 2013). Epistemology is the theory of knowledge. This assumption concerns what actually exists in reality, what it is that we need to know and how can we acquire that knowledge (Walliman, 2011). Epistemology is more concerned with nature and the validation of knowledge (Kroeze, 2011). Ontology is the study that describes the nature of reality, and how the community perceives reality in different ways (Kroeze, 2011; Vaishnavi & Kuechler, 2013).

Methodology is described as the philosophical assumption underlying the procedures and principles in a particular study (Shah, 2015). Vaishnavi and Kuechler (2013) describe methodology as the process of the research and axiology as being about the value of the study. Table 4.3 summarises the philosophical assumptions of the research and indicates how interpretivism was applied.

Table 4.3: Philosophical assumptions adopted for this research (Vaishnavi & Kuechler, 2013)

Assumption	Interpretivism attributes	Assumptions for this study
Ontological (the nature of reality)	There are multiple realities, socially constructed realities and socio-technological enabled realities.	This study used the feedback from the participants with the aim of understanding what is real in the phenomenon. Acknowledging that reality is based on the individual's perspective, which makes it unique and it cannot be generalised.
Epistemological (nature of knowledge)	Available knowledge is either objective or subjective. Generating the meaningful knowledge. Knowledge depends on the participant's interaction with the researcher, formulating findings.	Researcher interacted with the participants who were involved in the ICT4E project, their knowledge about the use of technologies was beneficial to the study. Construction of questionnaires to test, evaluate and generate the knowledge within the context.
Methodological (the use of processes)	Use of methods and processes in the research, planning how research will be conducted. The study followed an explorative qualitative strategy, exploring and evaluating the new phenomenon.	Development of processes to be followed when gathering data. This study chose the qualitative method strategy for data collection, adopted qualitative analysis for data analysis.
Axiological (value of study)	Acknowledging the value of the study, concerned with credibility, trustworthiness and biases of the study.	Understanding the value of the participants, what they hold as the contribution to this study. Ensuring that the study is trustworthy and credible by implementing the inductive approach which is based on the evidence.

4.3.2 Research approach

This section discusses the research approach used for this study. The purpose is to indicate how the approach is connected to the research paradigm, research strategy and data collection method, making it suitable for this study.

There are two different approaches to research that can be used in a research methodology: inductive and deductive. In general, deductive is mostly, but not always, associated with quantitative research methods, while inductive is associated with qualitative research methods. Deductive research is based on logic and inductive based on evidence. Therefore, the deductive-quantitative approach is more structured than the inductive-qualitative approach

(Van Wyk, 2012). The inductive approach is often used in the interpretivist paradigm and is associated with qualitative research, making it suitable for this study. Table 4.4 illustrates the differences between the inductive and deductive research approaches.

Table 4.4: Difference between inductive and deductive approach

Comparison Basis	Inductive Approach	Deductive Approach
Approach	Bottom-up	Top-down
Process	Observation>Pattern> Hypothesis >Theory	Theory>Hypothesis> Observation >Confirmation
Research method	Qualitative	Quantitative
Data intensity	High	Low
Research paradigm	Interpretivism	Positivism

Figure 4.2 illustrates the application of the inductive approach process. The approach begins by making an observation of the world by describing the phenomenon that is being studied. After the phenomenon being studied is understood a pattern will be formed using the collected data. A hypothesis will then be created out of the pattern through exploration and validation, and then a theory is formed from the hypothesis. The interpretivists do not commonly begin with the theory, they work on the views, backgrounds and experiences to form a pattern throughout their research, which develops a theory of the phenomenon that is being studied (Hlagala, 2015). It is understood that with the inductive approach, a theory and a conceptual framework cannot be formulated without competent knowledge in the subject area, which may be obtained through a literature review (Saunders et al., 2012). Therefore, it is important to observe the phenomenon and understand the whole picture of the study to avoid repeating work that has already been done.

This study followed the inductive approach, starting with a premise not a conclusion, and it did not generalise, but rather developed the theory by working on related issues, in this case the experience of the teachers using mobile technologies, which might differ depending on individual experience.

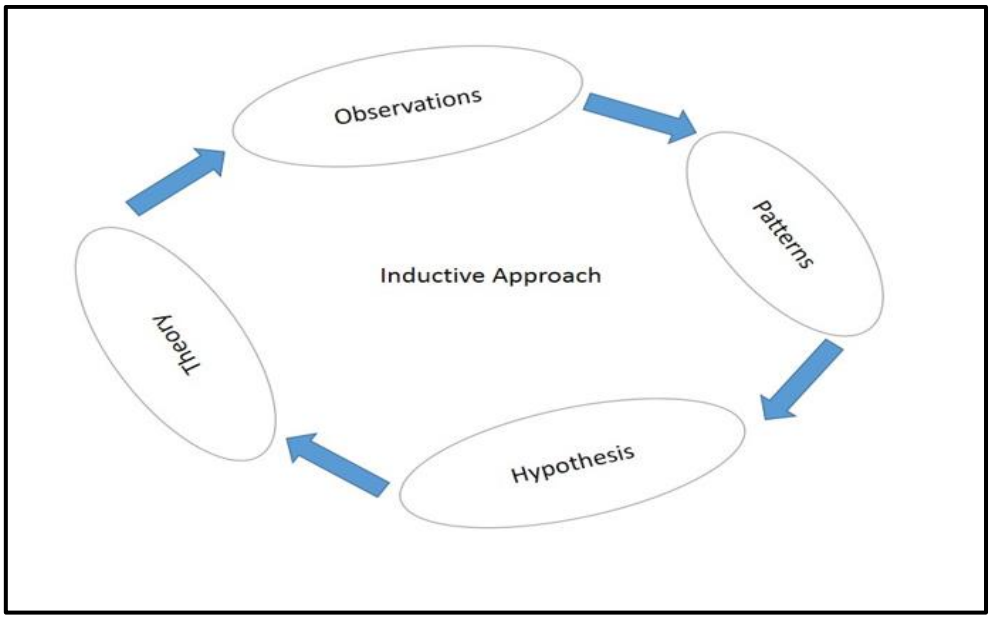


Figure 4.2: Inductive approach adapted from Hinkelmann and Witschel (2013)

Following the inductive approach, the researcher observed the ICT4E project. Teachers, who were the participants in this project, were trained to use mobile technologies at school. The researcher developed an understanding of how teachers were using the technologies at schools, which was then used to explore what needed to be studied in the UX phenomenon. The pattern phase formed as the project moved and was piloted in rural schools in different provinces. A pattern was formed by exploring the teachers' experiences after receiving the technologies from the ICT4E project and being provided with training to use the technologies in teaching and learning. Therefore, the study adopted the inductive approach illustrated in Figure 4.2. Data was collected and theory was developed from the results of the analysed data (Saunders et al., 2009).

The following section discusses the research strategy used to collect and analyse the data.

4.3.3 Research strategy

The research strategy is used to plan how the researcher will answer the research question through the collection and analysis of data using methods that are linked to the research strategy. The research strategy is used as a strategic plan for how the research should be conducted.

This study selected an explorative qualitative research strategy, which comprises explorative and qualitative research. Explorative research explores the phenomenon; it focusses on seeking out a new phenomenon or new insight about a phenomenon, where the problem is broad and

not yet defined (Malhotra, 2010). This study explored the ICT4E project that was implemented in rural schools.

According to Van Wyk (2012), explorative study is flexible and not formally structured, which makes it easier to implement. Its aim is to identify the variables that may be the source of the problem. There have been studies done on the use of mobile technologies at schools in rural environments, however, not many studies focused on the user experience (UX) of teachers using technologies at schools in resource constrained environments in South Africa. This research focussed on seeking new insight into this phenomenon and filling this gap in the UX body of knowledge. The study explored the user experience of the teachers, getting feedback from the teachers after they had experienced using the mobile technologies at schools.

Explorative research compliments the qualitative research, as the qualitative research enables the researcher to explore the study and answers the explorative questions (Swanson, 2015). The "qualitative research is often associated with an explorative approach" (Evers, 2016, p.3). Explorative research involves the use of qualitative data collection techniques such as focus groups, interviews, open-ended questions, observations and literature study to find the gaps in the study (Malhotra, 2010; Swanson, 2015).

The aim of the qualitative study is to gain insight into the identified problem by exploring the study through questions and observations with the aim of developing an initial understanding of the study (Malhotra, 2010). Qualitative research encompasses many research methods including data collection and the interpretation of textual information, and uses the inductive approach to generate novel insight (Young & Hren, 2006). Qualitative research enables participants to express their perspectives, beliefs, opinions and experiences (Young & Hren, 2006). This research strategy is relevant to the study as the perspective, belief, opinion and experience of the teachers is important. It is understood that "qualitative research often begins with a small sample size (sometimes an individual participant, a solitary text document or a small group), and follows a rigorously applied but loosely defined pathway" (Nicholls, 2009, p.590).

In explorative and qualitative research, the sample size of the participants is small, open-ended questionnaires are used to collect data and qualitative data analysis is used to analyse data (Swanson, 2015). For the purposes of this study, explorative qualitative research was used as the research strategy because it enables the researcher to explore the phenomenon with the aim of finding gaps in the study and gaining insight into the identified problem. Furthermore,

explorative qualitative research involves the use of questionnaires for data collection, a small sample size of participants, qualitative analysis to analyse data and the results may lead to further studies.

As discussed in the literature review, relevant literature was studied in order to explore the phenomenon. Although the study was divided into three sections — user experience, mobile technology and resource constrained environment — the scope was narrowed to create the main objective of the study and a conceptual framework was produced with the aim of answering research sub-question one. The literature review explored the difference between the UX and Usability, the UX frameworks that were adopted when developing the framework for this study, the ICT skills required for teachers to be able to use the technology in the classes, and the resources required to ensure that the use of technologies at schools is well received. Qualitative research enabled the study to partly answer research sub-question two and the main question, by collecting and analysing the data qualitatively. As a result, the adopted research design is appropriate for this study.

It can be concluded that explorative qualitative study can be conducted to explore, evaluate and clarify the nature of the problem. The research method that was used to collect data in the study was important as it led to suitable analysis techniques that were used to analyse data. The following section discusses the research method.

4.3.4 Research method

Research methods are strategies that incorporate the research philosophies or paradigms, research approach and strategies, as well as data collection techniques. The research method influences the way data is collected by the researchers (Padayachee, 2013). There are three research methods that are used to collect data: qualitative, quantitative and mixed method. The difference is the use of numbers and non-numbers. The selection of each method depends on the type of study and the problem that the study is trying to solve.

- **Quantitative Method:** Quantitative is used to answer questions such as how much and how many (Swanson, 2015). Quantitative is used to quantify the problem using numeric data (DeFranzo, 2011). Numbers in the quantitative method are used to record information about society, population density and apply statistical analysis (Walliman, 2011). Quantitative uses structured techniques with a larger sample population (DeFranzo, 2011). In the quantitative approach you begin with the

question you want to answer, and the study is not allowed to be off target of its original purpose (Nicholls, 2009).

- **Qualitative Method:** Qualitative is used to answer exploratory 'why' questions (Swanson, 2015). According to DeFranzo (2011), qualitative is used to gain insight into the problem and generate an understanding of the ideas, and motivations. This method includes the use of words, where peoples' judgement, feelings, emotions, beliefs and perceptions can be expressed through words not in numbers (Walliman, 2011). Qualitative uses unstructured or semi-structured techniques for data collection and the sample size is small (DeFranzo, 2011). In the qualitative method approach the study evolves naturally as the research takes place, rather than imposing a rigid methodological approach from the beginning of the study (Nicholls, 2009).
- **Mixed Method:** The mixed method includes the use of both qualitative and quantitative methods. Pragmatic researchers often use both qualitative and quantitative methods because this approach uses both open-ended and closed-ended data collection strategies (Creswell, 2013).

Figure 4.3 shows the differences between qualitative and quantitative research methods. Young and Hren (2006) describe attributes such as approach, goal, the research setting, the type of sampling and data analysis that differentiate the two methods.

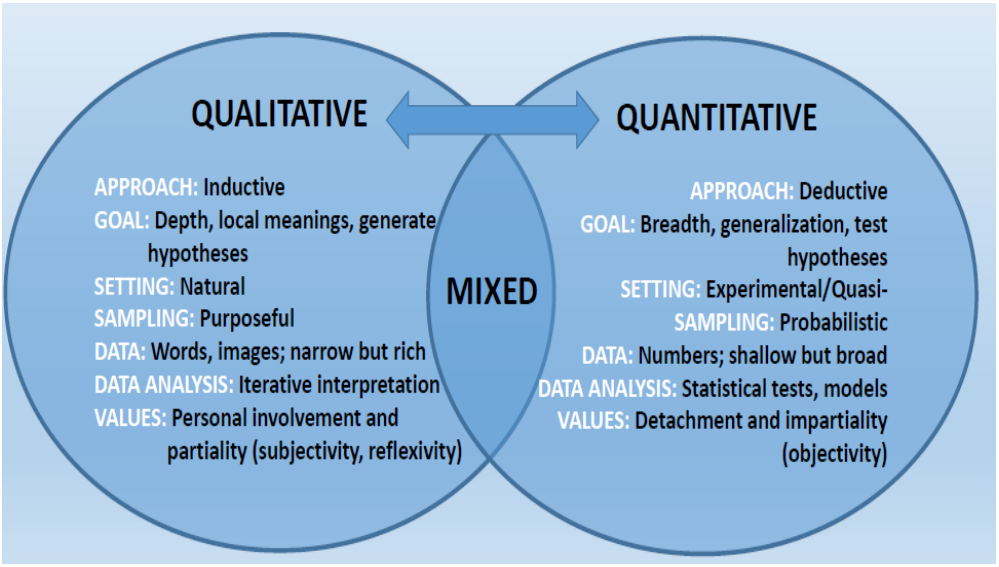


Figure 4.3: Differences between qualitative and quantitative (Young & Hren, 2006)

This study used the qualitative method as it adheres to the research methodology of the study. This aligns with the paradigm (interpretivism), research approach (inductive), research strategy (explorative qualitative research), the data collection (questionnaire) and sampling type (purposeful). This research method was selected in order to gain insight into the identified problem by using the questionnaire to explore the teachers' experiences, perceptions and expectations regarding the technologies. Table 4.5 shows a summary of the characteristics of the qualitative research method used in the study.

Table 4.5: Summary of qualitative research method selection

Characteristics of qualitative method	Linked to the study
Approach	Inductive
Goal	Depth to gain insight into the identified problem
Setting	Natural
Sampling	Purposeful
Data	Words
Data Analysis	Qualitative analysis

The following section discusses the data collection method used in this study.

4.3.5 Data collection method

The use of data collection techniques enables researchers to collect the relevant information needed to prove and conclude the study, and the selected method depends on the research type (Abawi, 2013). There are different methods that can be used to collect data. According to Walliman (2011), research methods are tools that are used to conduct research, and the type of method selected is based on the objective of the study. Different types of data collection techniques include interviews, questionnaires, observations, and document reviews (Oates, 2006).

For the purposes of this study, a questionnaire was used to collect qualitative data. The qualitative method is a non-numeric technique that relies on words, pictures and video clips to collect data (Saunders et al., 2016). Ahmad (2012) defines a questionnaire as "a set of questions on a topic or group of topics designed to be answered by the respondent" (p.2). Whilst Abawi

(2013) defines a questionnaire as a "data collection instrument consistent of a series of questions and other prompts for the purpose of gathering information from respondents" (p.2).

A questionnaire may be designed with either open-ended (unstructured) or closed-ended (structured) questions depending on the research strategy selected and type of data required for that particular study (Ahmad, 2012). With open-ended questions the respondents answer the questions using their own words, whereas with closed-ended questions the respondents select one or more answers from a set of answers provided (Abawi, 2013). The open-ended questions in a questionnaire in which respondents reflect on their opinions, provide responses that are to be analysed qualitatively (Hancock, Windridge & Ockleford, 2009). This study used both closed-ended and open-ended questions presented in a questionnaire.

In this study a questionnaire (see Appendix D) was formulated based on the conceptual framework, which was designed using the literature review. The questionnaire was initially sent to four academics each with a PhD degree who are experts in the field, and amendments were made based on the advice received. The amended questionnaire was then sent to the two supervisors specialised in UX and mobile technology for approval, which was later sent to a language editor for editing before submission for examination. After approval, the designed questionnaire was distributed to the teachers in Gauteng, North West and Limpopo, targeting the teachers in the schools that were involved in the ICT4E project. The questionnaire was distributed to the teachers through an email, with a detailed explanation of how the teachers should respond to the questions.

The teachers' contact details were obtained from the training list provided by the CSIR so that they could be contacted regarding participation in the study. Forty-five teachers were listed from the targeted schools. The teachers were first contacted by instant messaging (sms) to inform them about the study and ask for their permission to call them after hours to explain the study and their involvement. After receiving a positive response regarding participation telephonically, an email with the ethical clearance document and a consent form for participation attached was sent to the teachers. Another email was sent to the teachers providing details about the study, why they were selected as participants, and the importance of the study.

After receiving a low response from the teachers, another email was sent to remind the teachers about the questionnaire and the importance of their participation, but the response remained low. A second reminder email was sent, but participation was still low. Due to their busy

schedules at school a number of teachers requested the researcher to collect the data from their schools. Arrangements were made with the principals from the schools, and specific days and times were agreed upon for data collection in the three provinces.

The questionnaire consisted of four sections, the closed-ended questions were designed using a five-point Likert scale (1 = Strongly Agree, 2 = Agree, 3 = Not sure, 4 = Disagree and 5 = Strongly Disagree). The open-ended questions took the form of a comment and were used to enable participants to include more information about their feelings, attitude, expectations and perceptions. According to Joshi, Kale, Chandel and Pal (2015, p.397):

> [a] Likert scale is a set of statements (items) offered for a real or hypothetical situation under study. Participants are asked to show their level of agreement (from strongly disagree to strongly agree) with the given statement (items) on a metric scale.

The first section concerned the demographic details of the teacher, but did not contain sensitive information such as the name and surname of the participants. The second section explored the user component and included closed-ended and open-ended questions. The third section consisted of closed-ended and open-ended questions about the system components. The fourth section covered the context component (school) and also included closed-ended and open-ended questions. The comments included in the open-ended questions were important to this study because the study intended to uncover the feelings, perceptions and expectations of the teachers after using the technologies. “It is usually a good idea in any survey, no matter how large, to leave an open-ended comments question at the end. This is especially true in the case of a survey asking closed-ended questions on attitudes, opinions, or behaviours” (Survey monkey, 2019, para.4).

4.3.6 Sources of data and participants

This study used purposeful sampling, which is a widely used technique in qualitative research, to collect desirable information. It involves selecting a group of individuals who are knowledgeable or experienced about the specific phenomenon (Creswell & Plano Clark, 2011). The study selected teachers who were involved in the ICT4E project as participants who had gone through training and were in a position to use the mobile technologies at their schools. In purposeful sampling the individuals must be available and be willing to participate in the study (Etikan, Musa & Alkassim, 2016).

Sampling is based on the qualitative data, where participants offer rich information about the targeted phenomenon (Nicholls, 2009). In qualitative study, the researcher believes that everyone is different and that their opinions, beliefs and experiences will be unique, no single member is expected to represent the group or the masses (Nicholls, 2009). Therefore, this study relied on a number of teachers from different schools to participate and expected their responses about the use of mobile technologies at school to differ. The sampling was done in the following way:

- The researcher approached the 45 teachers to participate in the study with the objective of getting a minimum of 30 responses.
- The teachers who were approached were participants in the ICT4E project conducted by the CSIR Meraka Institute.
- These teachers went through the training and through the TPD programme, which was conducted for a period of a year, and arranged by the CSIR in collaboration with the University of the Free State.
- These teachers had passed the training, and had received their badges, certifications and technologies to use in schools for teaching and learning.
- Although there were other teachers from other provinces involved in the ICT4E project, this study targeted teachers from schools in Gauteng, North West and Limpopo.

Figure 4.4 depicts the process that was followed to collect data for this study.

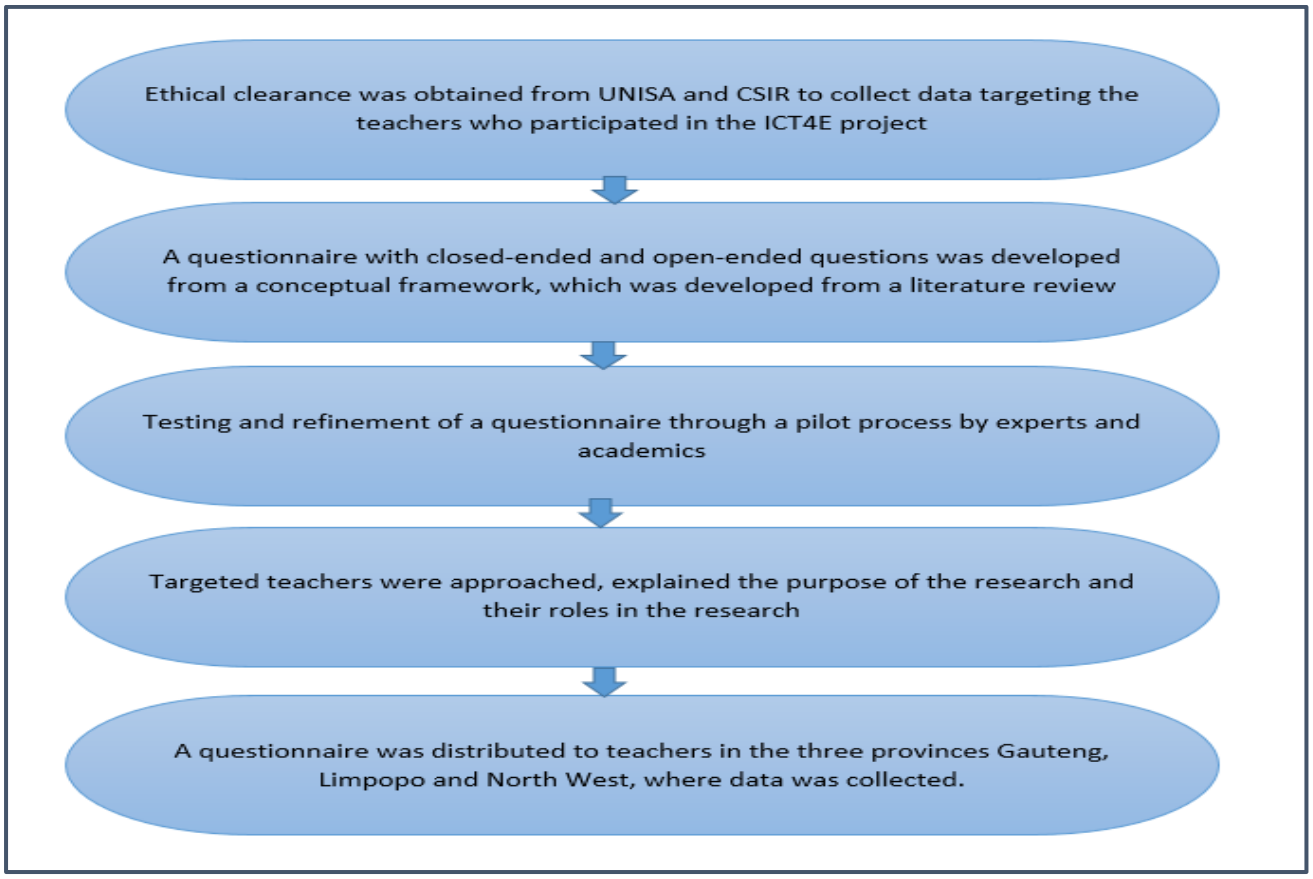


Figure 4.4: Data collection process

Table 4.6 provides information about the provinces that were targeted in this study, the names of the schools, the number of teachers from the schools who were in the list of contacted teachers.

Table 4.6: Participants' information

Province	School	Number of teachers
Gauteng	Magaliesburg State School	4
	Kwaggafontein Primary	2
North West	AG Malebe Primary	1
	Boskuil Combined	7
	Tsholofelo Secondary	6
Limpopo	Matsiri Primary	9
	Mochocho Primary	9
	Mohlapetse Secondary	7

4.4 Data analysis

Data analysis is defined as "the process a researcher uses to reduce data to a story and its interpretation" (Kawulich, 2004, p.97). This study used a qualitative method to collect data using a questionnaire comprising both closed-ended and open-ended questions. Although the questionnaire contains closed-ended questions, the answers to the questions were interpreted qualitatively. Therefore, the results from the analysis of the data were presented in a textual method (Evers, 2016).

There are different ways to analyse qualitative data and a combination of factors need to be taken into consideration when making a choice. Factors include the research question being asked, the theoretical foundation of the study and the techniques that will make sense when interpreting the data (Evers, 2016; Flick, 2014). Qualitative data analysis involves reading the collected data, segmenting data into smaller units, and presenting codes and themes to sort the data; this process is known as thematic analysis (Evers, 2016).

This study made use of thematic analysis, by choosing codes and themes derived from the literature review and the conceptual framework to analyse the data. In the past, data analysis was done manually. However, researchers now prefer using data analysis tools, such as Atlas.ti, to analyse the raw data and manage the collected data (Smit, 2002).

The Atlas.ti tool is a powerful workbench for qualitative data analysis, particularly for large sections of text, visual and audio data. This software offers support to the researcher during the data analysis process, in which texts are analysed and interpreted using coding and annotating activities (Smit, 2002, p.65).

For this research, the data collected from the open-ended questions was transcribed and typed into an Excel spreadsheet, then segmented into smaller units that were analysed using the Atlas.ti version 8.0 tool. The analysis involved reading the data, then separating words, and then organising the data using themes and codes with the intention of interpreting the data. The grouping of data into themes and codes is addressed comprehensively in Chapter Five along with the analysis and results.

4.5 Research validity

It is important to ensure that the data collected in the study measures what it is intended to measure. If the collected data is intended to measure or evaluate the UX of the teachers that is what it should achieve. It is, therefore, important that data be validated before it can be

presented. Even though certain standards may have been followed to analyse the data it is also important to do data cleaning, which involves dealing with data errors that might have occurred during writing or reading. This is done by making data accessible so it can be verified by others through systematic review (Peersman, 2014).

Research design involves the use of reliability and validity to validate the strategies used to collect data and to ensure accuracy of the study (Creswell, 2013). Validity involves the use of relevant data collection instruments and strategies to ensure that the intended data is collected (Saunders et al., 2009). The following is a discussion of the instruments that were used for data collection and the strategies followed to ensure data validity and reliability.

- The literature review used relevant studies to identify the components. The identified components were used to construct the conceptual framework. The constructs derived from the conceptual framework contributed towards the proposed final framework for the study.
- The study used the Atlas.ti tool for data analysis, rather than the manual (physical) process, because it made it easier to evaluate the results. The themes used to analyse the data were compared to the themes from the conceptual framework designed in Chapter Three, which was derived from the literature review (Chapter Two and Chapter Three) of the study. The conceptual framework was used to construct a questionnaire that was used to collect data. Both closed- and open-ended questions were used in the questionnaire.
- The conceptual framework and the questionnaire were evaluated through a peer review process. The four reviewers were academics holding PhDs who are experts in the field of UX and mobile technologies. The input from the reviews was used to improve the conceptual framework and the questionnaire prior to it being sent to the teachers. As suggested by Peersman (2014), the collected data can be accessed for data validation.

A questionnaire was piloted with three academics from the University of the Witwatersrand and Tshwane University of Technology, to test if the questions were understandable, transparent and equitable. The feedback was used to refine the questions as "careful development of the questionnaire provides a basis for validity. A thorough examination of previous studies, an ongoing review by a panel of experts, and carrying out a field test makes the case for construct, content, and face validity" (Radhakrishna, Tobin, Brennan & Thomson, 2012, p.2).

4.6 Methodological triangulation

Triangulation involves seeking data results using multiple data collection methods (Creswell, 2013). In this study, the secondary data was collected using the literature review and the primary data was collected using a questionnaire. The experts' reviews were taken into consideration and used to test the data collection process during the pilot, which was implemented before the data was collected from the participants.

4.7 Ethical considerations

Ethics are standards that need to be followed when conducting research. The ethical rules need to be considered when research is done. "Ethical considerations can be specified as one of the most important parts of the research. Dissertations may even be doomed to failure if this part is missing" (Research methodology, 2019, para.1). UNISA follows an ethical consideration policy that enables students who partake in research studies to abide by the policy and ethics standards. The ethical policy includes the process of students applying for ethical clearance from the University, where a dedicated committee grant ethical clearance to students if all requirements are met by the applicant. This study was granted ethical clearance to conduct the study using the teachers who participated in the ICT4E project as the participants (Appendix B). Since the study involved a targeted group of individuals, the study also needed to obtain ethical clearance from the CSIR. An application for permission to involve the teachers who participated in the ICT4E project conducted by the CSIR was submitted, and permission was granted (Appendix C).

The study considered the ethics principles suggested by Fouka and Mantzorou (2011), which include:

- Informed consent: ensured that there was willingness to participate in the study, that teachers were doing it voluntarily, and that the teachers' right to autonomy was protected. Consent forms (Appendix A) were sent to teachers prior to the distribution of the questionnaire.
- Beneficence: ensured that the study would not subject the participants to any harm. This was verified through the application for and granting of ethical clearance.
- Anonymity and confidentiality: ensured that the teachers' anonymity was protected and that their identities could not be linked to personal responses, the feedback from teachers remained confidential and was not discussed with fellow participants. Personal

information such as name, surname, and school name were excluded from the questionnaire sent to teachers (Appendix D).

- Privacy: ensured that teachers were answering the questionnaire in their own private space, where they would feel comfortable about expressing their feelings, beliefs and opinions without fear of, or being judged by, other participants or the researcher.

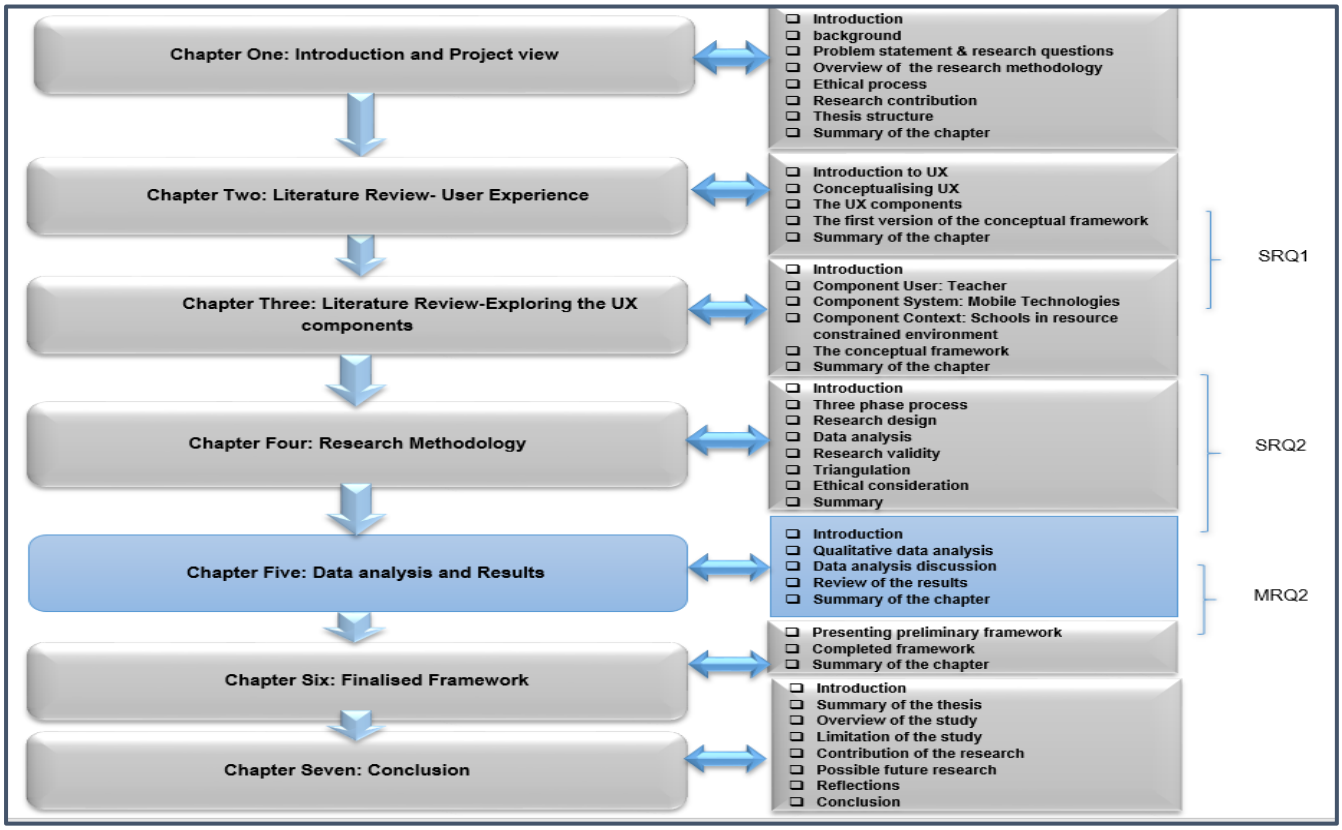
These principles, regarding the ethical considerations of research, were applied to this study.

4.8 Summary of the chapter

This chapter outlined the research methodology used for this research. Section 4.3 explored the research design and included the research paradigm, research approach, research strategy, research method, data collection method and participants.

The chapter also covered the data analysis strategy in section 4.4, discussed the research validity in section 4.5, the use of methodological triangulation in section 4.6 and ethical considerations in section 4.7.

5. CHAPTER FIVE: DATA ANALYSIS AND RESULTS



5.1 Introduction

This chapter presents the findings of the analysed data, and aims to answer the main research question:

How can the components of a framework for the user experience of teachers using mobile technologies enhance their classroom practice in resource constrained environments?

The two research sub-questions were used to achieve the purpose of the study:

- What are the components and factors of user experience that are relevant to teachers using mobile technologies in resource constrained environments?
- How is the user experience of the teacher reflected in the use of mobile technology for teaching in resource constrained environments?

In order to answer the two research sub-questions, data was collected by conducting a literature review (Chapter Two and Chapter Three) and using a survey. The ICT4E project was used to support the investigation in this study, which aimed to gain new insight into the user experience of teachers using mobile technologies in rural schools. Data was analysed by implementing the approach illustrated in Figure 5.1.

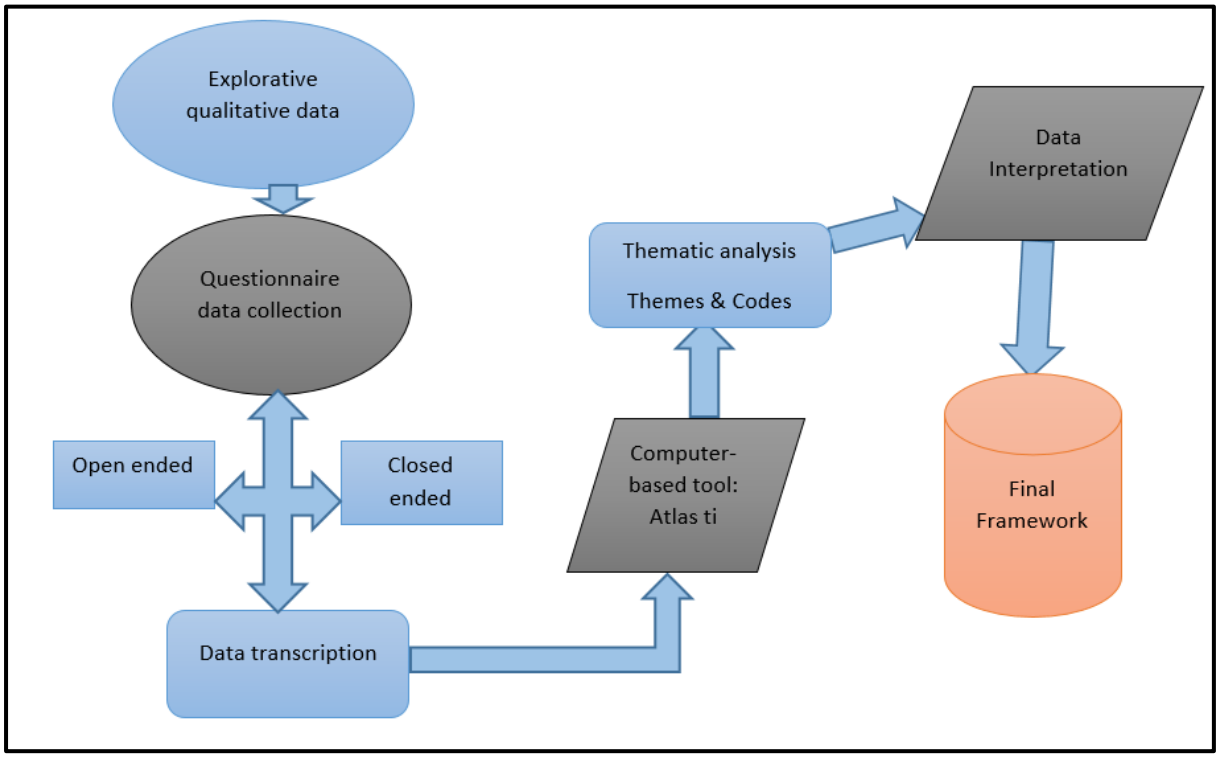


Figure 5.1: Analysis approach

As illustrated in Figure 5.1, the study used an explorative qualitative research strategy to explore the phenomenon. Relevant data was gathered through the literature review to support the study and to build the conceptual framework. The extracted components from the literature review were used to develop the conceptual framework presented in section 3.5. The literature review was used to design a questionnaire to collect data and a survey was conducted using the questionnaire.

A questionnaire comprising open- and closed-ended questions was used to collect qualitative data. This comprised a five-point Likert scale designed to collect closed-ended data as well as a section where participants could add comments (open-ended). Data was transcribed in a word document with the aim of segmenting it into smaller units, thus enabling it to be read effortlessly. The collected data was managed through the Atlas.ti tool, where thematic analysis was applied using themes and codes to analyse the transcribed textual data. The UXFTMTR framework was developed as the final proposed framework for this study.

The following section will illustrate and discuss how data was analysed in this study.

5.2 Qualitative data analysis

5.2.1 Qualitative analysis

According to Maguire and Delahunt (2017), the qualitative method is mostly used in learning and teaching studies, and requires a lot of reading to translate and analyse the data. In a qualitative analysis, a qualitative data collection method is used to gain new insight into a social phenomenon where respondents are allowed to reflect on and express their views in various ways (Jugder, 2016). This research followed a qualitative approach to enable the teachers to express their perceptions about the use of technologies at schools in teaching and learning. Qualitative analysis was applied to gain in-depth understanding of the teacher's feedback. "[Q]ualitative data analysis is mainly inductive in nature, which leads to themes" (Costa, Breda, Pinho, Bakas & Durão, 2016, p.36). The themes were developed through the use of a thematic analysis process (Braun & Clarke, 2006).

Denscombe (2010) suggests a few principles that should be followed when approaching a qualitative analysis:

- Compile raw data into a brief structure
- Develop a relationship between the research objective and the summary of the research
- Develop a model or improving the conceptual basis of the research

In this study the collected raw data was analysed using a thematic analysis process that structured the data with the aim of developing a framework.

5.2.2 Thematic analysis

Thematic analysis is widely used in the qualitative analytic method and is considered to be the foundation for qualitative analysis (Braun & Clarke, 2006). This study followed a thematic analysis approach using the Atlas.ti tool to analyse the data qualitatively. Thematic analysis is defined as "a method for identifying, analysing, and reporting patterns (themes) within data. It minimally organises and describes your data set in (rich) detail" (Braun & Clarke, 2006, p.6). Another definition for thematic analysis "[i]s the process of identifying patterns or themes within qualitative data" (Maguire & Delahunt, 2017, p. 3352).

Figure 5.2 illustrates the steps proposed by Braun and Clarke (2006); Clarke and Braun (2013) that should be followed when using a thematic analysis approach. According to Clarke and Braun (2013), these steps should not be viewed as a linear model where the next step cannot

be achieved if the previous step was not effective. This type of analysis should, therefore, be thought of as a recursive process.

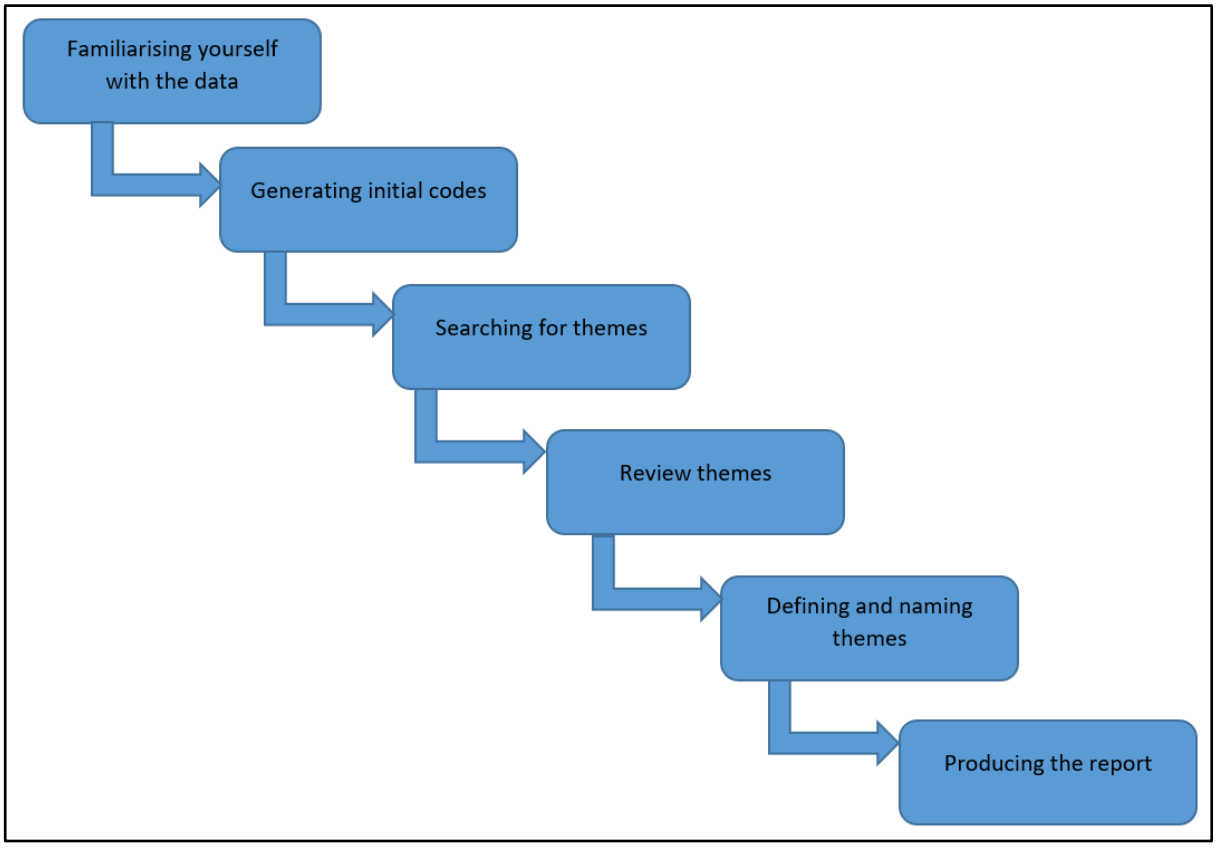


Figure 5.2: Thematic analysis steps adapted from Clarke and Braun (2013)

The following is a discussion about how the study applied the proposed thematic analysis steps to the research.

- Being familiar with data

The first step in research analysis is you should be familiar with any data in your research be it secondary data (literature review) or primary data (questionnaire), reading and re-reading the transcribed data. Familiarity can be achieved by making notes and jotting down impressions in the data (Maguire & Delahunt, 2017). This can be referred to as an early analysis. “It is vital that you immerse yourself in the data to the extent that you are familiar with the depth and breadth of the content” (Braun & Clarke, 2006, p.16). For the purpose of this study, the collected data was transcribed verbatim into an Excel spreadsheet. Each of the responses to the questions and the comments from individual teachers were recorded on a single sheet for each

teacher. This was done with the intention of repeatedly reading the data thoroughly in a single document, and to get the depth of the content and to identify similarities from the data.

- Generating codes

This stage begins when data has been read thoroughly and ideas are generated. In this stage data is organised in a meaningful way. This stage involves the production of codes from the transcribed data, where data is segmented so that it can be assessed in a meaningful way (Braun & Clarke, 2006). Codes can be referred to as the building blocks of analysis, where each piece of data is significant (Braun & Clarke, 2012). "Coding requires another thorough read of every data item, and you should code each data item in its entirety before coding another" (Braun & Clarke, 2012, p.6).

It was during this stage that this study segmented the data into categories looking for anything that was potentially relevant to the research question. This was initially achieved through an Excel spreadsheet by using the quick analysis tool embedded in Excel. The data was then uploaded to the Atlas.ti tool and 27 documents of transcribed data (one for each participant) were generated in the Atlas.ti project. Codes were created using the tool and assigned to specific quotations also known as text. According to Archer, Janse van Vuuren and Van der Walt (2017), it is advisable not to use broad codes. Codes must be refined and indicate specific details, which will make it easier to combine them after the coding. The codes generated in this phase or stage are presented in Table 5.1.

- Searching for themes

Stage three occurs after the coding has been completed, data have been collated, and a long list of codes compiled in the data set (Braun & Clarke, 2006). In this phase analysis starts to take shape, yet it is important to note that the themes are generated from the data and not discovered, although the phrase says 'searching' this does not necessarily mean it is searched from the data, rather it is formulated from the data (Braun & Clarke, 2012). Theme is defined as a "pattern that captures something significant or interesting about the data and/or research question" (Maguire & Delahunt, 2017, p.3356). If codes are the building blocks then themes are the roof panels, at this stage the researcher looks at the themes that fit into the codes, and the phase ends when the researcher collates the codes to the themes (Clarke & Braun, 2013). It is advisable to produce a visual presentation such as a table, mind map or theme-pie at this stage (Braun & Clarke, 2006). Themes were generated in this study using the Atlas.ti tool. First, 27 documents

(data produced from the questionnaire) with the transcribed responses from each of the teachers were generated. The documents (transcribed data) were uploaded to the Atlas.ti tool creating a project for data analysis for this study. Then the uploaded documents (data) were used to produce codes using the quotations functionality available for this purpose on the Atlas.ti tool. Themes were formulated from the documents (data) based on the responses' pattern, then the identified themes were linked to the codes as shown in Table 5.1. The first column in Table 5.1 identifies the factors presented in the questionnaire (see Appendix D). The factors (from the questionnaire) were linked to generate the codes and themes. The second column presents the generated themes and the third column presents the generated codes.

Table 5.1: Initial themes introduced

Subcomponents (Factors)	Themes linked to codes	Generated codes
B1.1 Needs	Users necessities	Easy to use, teacher's requirement, performance
B1.2 Perception	Users necessities	Being encouraged, makes teaching easy, increasing efficiency, lessons attract learners
B1.3 Attitude	Users necessities	Always positive, teachers' comfort, acceptance of the tablets
B1.4 Experience	Users necessities	Skills requirements, younger teachers, not gender-based
B1.5 Expectations	Users necessities	User friendly, reduction of workload
C1.1 Usability	Device features	Working effectively, easy to work with, reduction of paper workload
C1.2 Hedonic and Aesthetic Attributes	Device features	Pleasing visualisation, enhances teaching, enjoyment of the tablets, sophisticated
C1.3 Functionality	Device features	Error handling, tablet is accessible easily, navigate easily

Subcomponents (Factors)	Themes linked to codes	Generated codes
C2.1 Control & Ownership	Requirements of the system	Teacher requires privacy, confidentiality purpose
C2.2 Flexibility	Requirements of the system	Portability requirement, flexible to move everywhere
C2.3 Credibility	Requirements of the system	Reliability of the tablets, school work monitoring
C2.4 Valuable	Requirements of the system	Tablets adding value
C2.5 Desirable	Requirements of the system	Motivating, attractive to work with, enjoyable
C3.1 Technological skills	Digital platform requisite	Operating the tablet
C3.2 Critical thinking	Digital platform requisite	Applying the learning content, Innovative
C3.3 Problem solving	Digital platform requisite	Providing solutions to learning
C3.4 Creativity	Digital platform requisite	Innovative learning
C3.5 Qualified teachers	Digital platform requisite	Skilled teachers, sufficient trained teachers
D1.1 Physical context	Environmental context	Environmental learning
D1.2 Social context	Environmental context	Involvement of stakeholders, School social factors
D1.3 Task context	Environmental context	Tasks completion, multitasking
D1.4 Technical and information context	Environmental context	ICT services at school
D2.1 Policy implementation	Educational policies	Policy for using tablets at schools
D2.2 Training	Digital literate	Training requirement, competence to ICT

- Reviewing themes

This phase focusses on reviewing the identified themes from the previous stage. This phase can be referred to as the quality-checking phase because it checks the themes against the collated extracted data (Braun & Clarke, 2012). The reviewing and refinement of themes takes place in this phase, which is done by reading the collated extract of the themes and checking whether they do form a pattern. If themes do not match with the code the researcher might

consider revising the process of linking the codes with themes (Braun & Clarke, 2006). The researcher will have to review whether the generated themes tell a story about the data. If not, they will have to begin the process of developing themes again (Clarke & Braun, 2013). The study followed the process of reviewing and refining themes. Themes that were not collated to the codes were discarded and some themes were split into subthemes. Some additional themes were generated in this phase. The revised themes are presented in Table 5.2.

- Defining and naming themes

The researcher is trying to understand "[w]hat is the theme saying? If there are subthemes, how do they interact and relate to the main theme? How do the themes relate to each other?" (Maguire & Delahunt, 2017, p.33511). This phase involves deep analysis of the thematic analysis process, and the creation of meaningful data that the reader can also understand when data is interpreted (Braun & Clarke, 2012). In this study the Atlas.ti tool was used to identify the essence of each theme.

In Table 5.1 the initial themes: *Users necessities, Device features, Requirements of the system, Digital platform requisite, Environmental context, Educational policies, Digital literate* were generated and presented in stage 3: Searching for themes. In stage four: Reviewing themes, themes were reviewed and new themes were produced and others discarded. In stage five: Defining and naming themes, six themes were finalised in this phase and the themes were linked to the codes which were also identified and refined through the Atlas.ti tool.

Table 5.2 illustrates the revised (new) themes and the codes linked to the themes. Six new themes were produced after the review and were connected to the components identified in the literature review as follows:

- User
    - ***Users prepossession theme***: this theme represents participant's needs, feelings, attitude, perception and expectations about the mobile technologies
- System
    - ***Mobile device attribute theme***: this theme represents the system (mobile technologies) features and its functionality, the purpose it serves for the teachers when engaging with the technologies.
    - ***Mobile technologies essential theme***: the theme represents the system requirements that teachers expect when interacting with the technologies.

- ***Digital platform requisite theme***: the theme represents the expected resources, services, solutions and skills anticipated when engaging with the technologies.

- Context
  - ***Environmental settings theme:*** the theme represents the school environment where the interaction takes place and the factors that may influence the use of the mobile technologies.
  - ***Digital literate and policies theme:*** the theme represents the knowledge, training requirements, and policies that influence the use of technologies at school.

Table 5.2: The revised themes and codes

Subcomponents (Factors)	Revised themes linked to codes	Generated codes
B1.1 Needs	Users prepossession	Ease of use, Improves performance in teaching and learning, Increasing efficiency
B1.2 Perception	Users prepossession	Makes teaching easy , increases efficiency, improves IQ, positive in using tablets, teachers confidence, teachers perception
B1.3 Attitude	Users prepossession	Positive attitude, older teachers are not comfortable, acceptance of the tablets, teachers comfort, younger teacher's readiness
B1.4 Experience	Users prepossession	Experience-age influence, younger teachers, not gender-based, experience required
B1.5 Expectations	Users prepossession	User friendly, meeting the expectations, reduction of workload, teachers satisfied with tablets
C1.1 Usability	Mobile device attributes	Effectiveness, reduction of paper work, ease of use, easy to apply teaching

Subcomponents (Factors)	Revised themes linked to codes	Generated codes
C1.2 Hedonic and Aesthetic attributes	Mobile device attributes	Pleasing and appealing features, enhances and transforms teaching, enjoyment of the tablets
C1.3 Functionality	Mobile device attributes	Error handling, navigate easily, Apps (Applications) not matching learning content, tablet accessible easily
C2.1 Control & Ownership	Mobile technologies essentials	Teacher requires privacy, confidentiality purpose, no need for privacy
C2.2 Flexibility	Mobile technologies essentials	Portability, flexible to work everywhere, battery life-span
C2.3 Credibility	Mobile technologies essentials	Reliability of the tablets, monitoring of tablets, information protection, self-monitoring tool
C2.4 Valuable	Mobile technologies essentials	Tablets adding value, Encourages learning and teaching, useful in teaching
C2.5 Desirable	Mobile technologies essentials	Motivating teachers and learners, attractive to use, makes learning interesting
C3.1 Technological skills	Digital platform requisite	Technical skills
C3.2 Critical thinking	Digital platform requisite	Applying the learning content, Innovative learning
C3.3 Problem solving	Digital platform requisite	Providing solutions to learning, Technical solutions
C3.4 Creativity	Digital platform requisite	Innovative learning
C3.5 Qualified teachers	Digital platform requisite	Skilled teachers, sufficient trained teachers, insufficient skilled resources, Skills requirements, unskilled teachers
D1.1 Physical context	The environmental setting	Environment for learning, availability of network, need for

Subcomponents (Factors)	Revised themes linked to codes	Generated codes
		computer labs, overcrowded class, security concerns
D1.2 Social context	The environmental setting	Involvement of stakeholders, Social factors, school culture
D1.3 Task context	The environmental setting	Tasks completion, multitasking
D1.4 Technical and information context	The environmental setting	Issues with connectivity, Electricity issues, ICT services provision at school, insufficient tablets, maintenance service required, need for smart boards
D2.1 Policy implementation	Digital literate and policies	Policy for using tablets at schools
D2.2 Training	Digital literate and policies	Proficiency in ICT, Knowledge gained, providing solutions to learning, skill development needed, skills transfer to learners, teachers support and mentoring, training facilities , training required

- Producing the report

This is the end-point of thematic analysis, a report that will assist in the interpretation of the analysed data. A clear and convincing narrative is formulated in this phase that makes an argument that supports and answers the study's research question (Braun & Clarke, 2012). The report in this study is depicted in the data analysis section, and the results were interpreted in the data interpretation sections.

5.3 Data analysis discussion

A total of 45 teachers were targeted to participate in the study. A questionnaire was distributed to the teachers after they were approached to take part in the study. Thirty teachers responded, but data from only 27 completed questionnaires was used because three of the questionnaires were spoilt. The data was transcribed in an Excel format, where 27 sheets were loaded with the

participants' transcribed data. Data was transcribed verbatim to ensure that the participant's responses were not misinterpreted. An Excel analytical tool was used to analyse keywords and frequent comments, which were then highlighted and noted prior to using the computer-based tool for analysis. Data was copied to 27 word documents and uploaded to the Atlas.ti tool as a single project, where quotations, codes. Themes were linked to the documents and produced the network diagram that is used to present the analysed data visually. In section 5.3.2 to 5.3.4, the network diagrams are categorised and presented in themes and the presented data is interpreted. Section 5.3.1 focusses on the biographical data of the participants. Section 5.3.2 focusses on the user component, section 5.3.3 focusses on the system component and section 5.3.4 focusses on the context components' data and interpretation.

5.3.1 Participants' biographical data analysis

The selected participants were part of the ICT4E programme, where they were trained to use the mobile technologies in teaching and learning in the rural schools. The study focussed on participants from three provinces: Limpopo, North West and Gauteng. Twenty-seven responses were used to analyse the data. The participants were aged between 21 to over 50. Ten of the teachers were male and 17 were female. The questionnaire had four sections, with section A recording the demographic details of the participants (see Appendix D), focussing on factors that may influence the experience of the participants when using the technologies. Some of the factors influencing UX that were identified in the literature review include age, gender, skills, experience and expectations of the user (teacher).

Figure 5.3 shows the participants' age range, which indicates that many participants were over the age of 50. This factor contributed to the UX evaluation, where the experience factor was applied to evaluate whether age does influence the use of technologies at school. Out of the 27 participants, 12 were over the age of 50, 7 were between the ages of 41 and 50, 4 were between the ages of 31 and 40, and 4 between the ages of 21 and 30. This indicates that the highest age range of the participants, who attended the training for the use of technologies at schools was 31 to over 50.

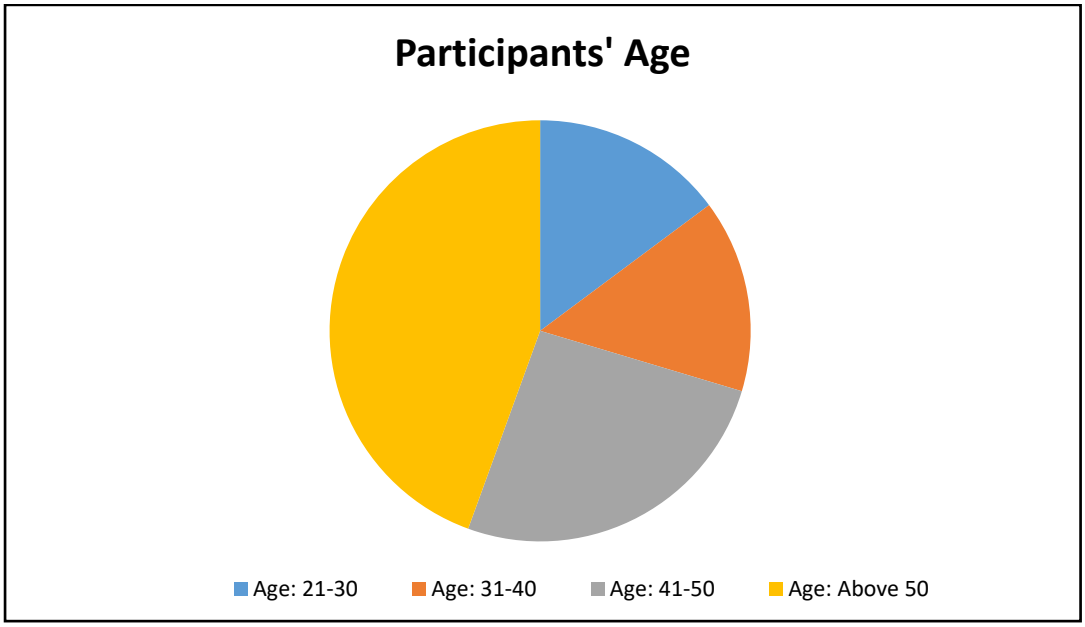


Figure 5.3: Data regarding participants' age

The participants' gender is recorded in Figure 5.4, which shows that the majority of the participants were female (17) with only 10 being male.

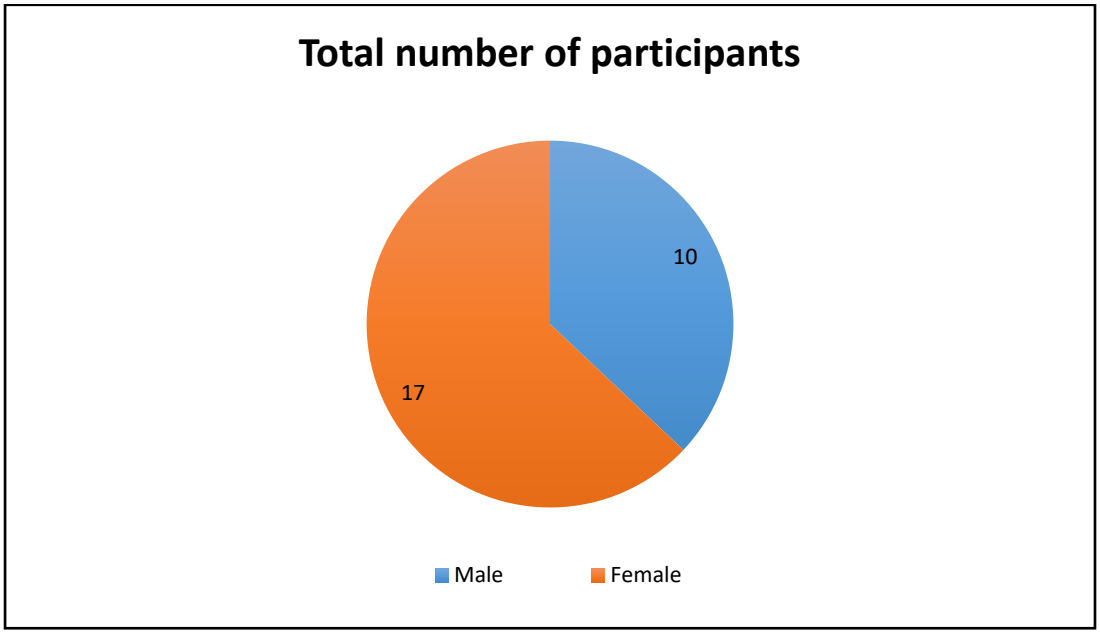


Figure 5.4: Data regarding participants' gender

The data indicated in Figure 5.5 shows how the teachers' rated their skills in using mobile technologies. Three teachers indicated that they had very high skills, 12 each indicated that they had high or average skills, while none rated themselves as novice.

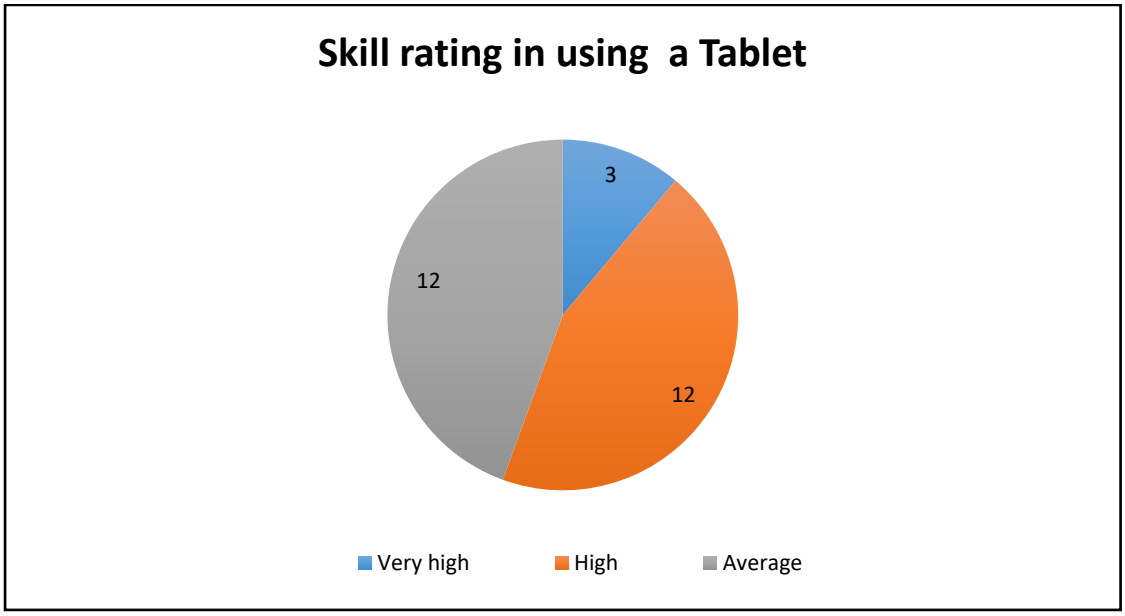


Figure 5.5: Data regarding the skills rating for participants

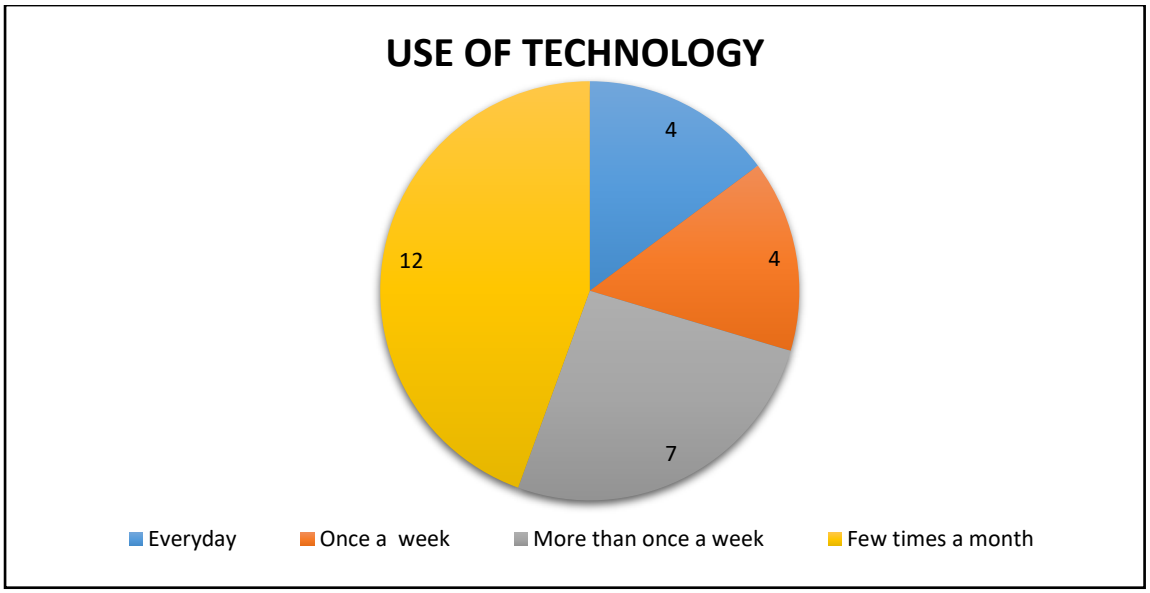


Figure 5.6: Frequency of technology use data

Teachers were expected to indicate how often they used the mobile technologies at school. The results presented in Figure 5.6 show that a high number of the teachers use the technologies "more than once a week" and "few times a month". The teachers were also asked to support their answers. It was revealed that most of the technologies had been stolen and that was why they did not often use them. Some teachers also indicated that there were not enough technologies, and they had to share the ones that were available so they did not enjoy the

benefits of the technologies. Some teachers indicated that there were not enough chargers available to charge the technologies, hence they did not often use the technologies.

In order to understand how the users received the use of mobile technologies at school, how they perceived these and their experience after they had interacted with the technologies, the teachers were required to select one or more answers from Q.8 of Section A (see Appendix D). Participants were expected to indicate their user experience when using the technologies in teaching and learning at schools. As indicated in Table 5.3, most teachers found the technologies to be "easy to use", they had confidence when using the technologies, they did enjoy teaching with the technologies, the technologies motivated them, they were able to apply their skills in teaching using the technologies, they had a positive perception about the use of technologies at schools and they had a positive experience with the use of the technologies.

Table 5.3: Participants' experience in using technologies

Participant's experience in using technologies in teaching and learning at school	Total number of participants
Q8.1 I find it easy to use the tablets in teaching and learning	24
Q8.2 I am confident about using the tablet on my own	21
Q8.3 The tablet does not meet my expectations in teaching and learning	2
Q8.4 I enjoy teaching with the tablets	22
Q8.5 I do not recommend the use of tablets at schools for teaching and learning	0
Q8.6 The tablet I am using motivates me to deliver teaching and learning	17
Q8.7 I find the interface of the tablet attractive	13
Q8.8 My mood does not affect my use of the tablet at school in teaching and learning	6
Q8.9 I am able to apply my skills quickly when using the tablet	17
Q8.10 I have a positive perception about the use of tablets at schools	17
Q8.11 I feel negative about teaching the learners using the tablets	0
Q8.12 My experience with the tablet is positive	21

The questionnaire that was used to collect data was divided into four sections. Section 5.3.1 focussed on Section A, which collected the biographical information of the participants. Section 5.3.2 discusses the data collected from Section B of the questionnaire. Section 5.3.3 concerns data collected from Section C and section 5.3.4 discusses data collected from Section

D of the questionnaire. When answering the questions in Sections B, C and D teachers were requested to select an option from the answers provided in a five-point Likert scale (1=Strongly agree, 2=Agree, 3=Not sure, 4=Disagree, and 5=Strongly disagree), and support the selected answer with a comment. In testing the validity and consistency of the participants' responses, each factor in the questionnaire was tested using two to five questions connected to the same factor. See the questionnaire in Appendix D for how the questions were structured.

The data is presented in tabular format, using colours to differentiate the components: User (**Orange**), System **(Blue)** and Context (**Green**). For the purposes of presenting the data, the following notation will be used for the segmented tables presenting data except for the summary tables (Table 5.4, Table 5.10 and Table 5.24). The segmented tables are presented in section 5.3.2 (User component), section 5.3.3 (System component) and section 5.3.4 (Context component) and structured in the following way:

The first column in the tables represents the subcomponents (factors) identified in the literature study, which were then used in the data collection instrument. The second column presents the codes presented in the network diagram. Section 5.2.2 explained how the codes were generated and how they were linked to the theme and user's feedback (questionnaires). The third column presents the responses from the teachers, corresponding to the questions presented in the questionnaire (see Appendix D). All the questions in the questionnaire were linked (referenced) to the literature review of this study and are accessible through the presented conceptual framework in section 3.5. The teachers' responses showed whether they agreed with the material in the literature review or if there was new evidence or knowledge that could contribute to the study. In qualitative study the feedback or comments of the participants are usually valuable because the research needs to gain insight into the perceptions of the participants.

5.3.2 User component: Teachers data analysis

This section will focus on the User component, which appears in the questionnaire in Section B. In the literature review User is identified as a component of the UX, and this study adopted the definition proposed by Kuniavsky (2010) and Scapin et al., (2012), which states that subcomponents (factors) such as perception, emotions, attitude, behaviour and expectations are incorporated when users (teacher) interact with the system. These factors with their *characteristics* were used to collect data through a questionnaire, and were used to analyse the collected data in this section.

In the questionnaire teachers were expected to reflect on their user experience when using mobile technology in teaching and learning. Table 5.4 shows the responses from the teachers indicating the factors that may influence their user experience when using the mobile technologies at schools in resource constrained environments. These factors specifically concerned the **User component**. The first column shows the factors' characteristics interconnected with the subcomponents that were used to compile the questionnaire. The next five columns show the responses from the teachers, indicating whether they agreed or disagreed that the factors influenced their user experience when using the mobile technologies at schools. The value of ***N*** represents the number of teachers who either agreed or disagreed with the identified components and factors. As indicated in section 5.2.2, 27 documents (teachers' responses) were used to analyse the data. *To get a percentage = Number of responses (Multiply by) * 100 (divide by) / total number of teachers i.e.: Percentage = 7*100/27 = 25.9%.* The highest number of responses will represent the majority of the teachers' feedback or responses.

Table 5.4: Summary of the teachers' feedback on User component and factors

Factors (characteristics) that may have an influence on the UX for teachers	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
B1.1.1 Teacher needs to be satisfied with the use of the tablet at school.	**(N=7)**	**(N=19)**	**(N=0)**	**(N=1)**	**(N=0)**
B1.1.2 Teacher needs the tablet to be user friendly — ease of use.	**(N=10)**	**(N=15)**	**(N=2)**	**(N=0)**	**(N=0)**
B1.1.3 Teacher needs to accept the use of tablet at school.	**(N=10)**	**(N=14)**	**(N=3)**	**(N=0)**	**(N=0)**
B1.1.4 The teacher should be able to perform tasks using the tablets effectively.	**(N=11)**	**(N=14)**	**(N=2)**	**(N=0)**	**(N=0)**
B1.1.5 Teacher needs to be encouraged when engaging with the tablet.	**(N=11)**	**(N=16)**	**(N=0)**	**(N=0)**	**(N=0)**
B1.2.1 The perception of teachers about the use of the tablet is very important.	**(N=12)**	**(N=12)**	**(N=2)**	**(N=1)**	**(N=0)**
B1.2.2 As a teacher I have a positive perception of the use of tablets at schools.	**(N=7)**	**(N=17)**	**(N=3)**	**(N=0)**	**(N=0)**
B1.2.3 Teachers perceive tablets as beneficial (helpful) to teaching and learning.	**(N=10)**	**(N=15)**	**(N=1)**	**(N=0)**	**(N=1)**
B1.2.4 Teachers perceive the tablets as easy to use.	**(N=6)**	**(N=15)**	**(N=4)**	**(N=1)**	**(N=1)**

Factors (characteristics) that may have an influence on the UX for teachers	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
B1.2.5 The tablet is perceived as a useful tool in teaching and learning.	**(N=10)**	**(N=15)**	**(N=2)**	**(N=0)**	**(N=0)**
B1.3.1 The teacher's attitude towards the use of the tablet is very important.	**(N=10)**	**(N=16)**	**(N=1)**	**(N=0)**	**(N=0)**
B1.3.2 As a teacher I have a positive attitude when it comes to use of tablets in teaching and learning at schools.	**(N=9)**	**(N=16)**	**(N=0)**	**(N=0)**	**(N=2)**
B1.3.3 As a teacher I am comfortable with the use of tablets for teaching and learning at schools.	**(N=6)**	**(N=18)**	**(N=1)**	**(N=1)**	**(N=1)**
B1.3.4 Teacher's attitude is an important factor in accepting or rejecting the use of tablets in schools.	**(N=10)**	**(N=14)**	**(N=0)**	**(N=3)**	**(N=0)**
B1.4.1 The experience of teachers when using the tablet is very important.	**(N=12)**	**(N=14)**	**(N=0)**	**(N=1)**	**(N=0)**
B1.4.2 Teachers require skills to have a good experience with tablets at school.	**(N=13)**	**(N=12)**	**(N=0)**	**(N=2)**	**(N=0)**
B1.4.3 Gender may influence the teacher's experience of the use of tablets in schools.	**(N=0)**	**(N=5)**	**(N=3)**	**(N=11)**	**(N=8)**
B1.4.4 Age may influence the teacher's experience of using tablets at schools.	**(N= 4)**	**(N= 3)**	**(N=3)**	**(N= 16)**	**(N= 1)**
B1.5.1 The tablets meet our expectations of supporting teaching and learning at our school.	**(N= 4)**	**(N=13)**	**(N=5)**	**(N= 5)**	**(N= 0)**
B1.5.2 Teachers expect the use of the tablet to meet the functionality requirements of teaching and learning.	**(N=5)**	**(N=12)**	**(N=1)**	**(N=5)**	**(N=4)**
B1.5.3 Teachers expect the use of the tablet to meet the non-functionality requirements such as performance, reliability.	**(N= 8)**	**(N= 6)**	**(N=1)**	**(N= 1)**	**(N= 1)**

The discussion of the results shown in Table 5.4 can be found in section 5.3.2.1 where tables are segmented per factor, which contributes to the presentation of the data analysis.

In section 5.2.2 there was a discussion of how a network view diagram would be presented in the data analysis section. Network view diagrams were used to present the analysed data. The Atlas.ti tool was used to analyse the subcomponents such as needs, expectations, experience, perception and attitude from the Users prepossession theme which is illustrated in Figure 5.7 as a network view diagram. The network diagram in Figure 5.7 presents the theme and codes produced in Table 5.2 as discussed in section 5.2.2. In this instance User prepossession is the theme and the codes are presented in a ♦ diamond in the network diagram. To present the

relations that connect the questionnaire to data analysis: Users prepossession theme links to -> **B1. Users**

5.3.2.1 Response on User component — User prepossession theme

Literature evidence: The subcomponents (factors) that are used to determine the UX of the user include: emotions, attitude, perceptions and user's expectations (Alhussayen, Alrashed & Mansor, 2015), as explained in section 1.1. Roto (2007) believes that the experience of the user involves the user's mental state and includes: attitudes, expectation, knowledge, motivation as indicated in section 2.2.2. As indicated in section 3.3.2, "[t]eachers who hold positive attitudes towards using a new technology in teaching are more likely to use the technology in their classrooms" (Chiu & Churchill, 2015, p.6). Roto (2006) argued that user's earlier experiences and expectations affect the UX of the user, and these components can be used as a starting point for the system (technologies) evaluation. For the purposes of this study, needs, expectations, attitude, experience and perception were used to evaluate the factors that influence the UX of the user for the user component.

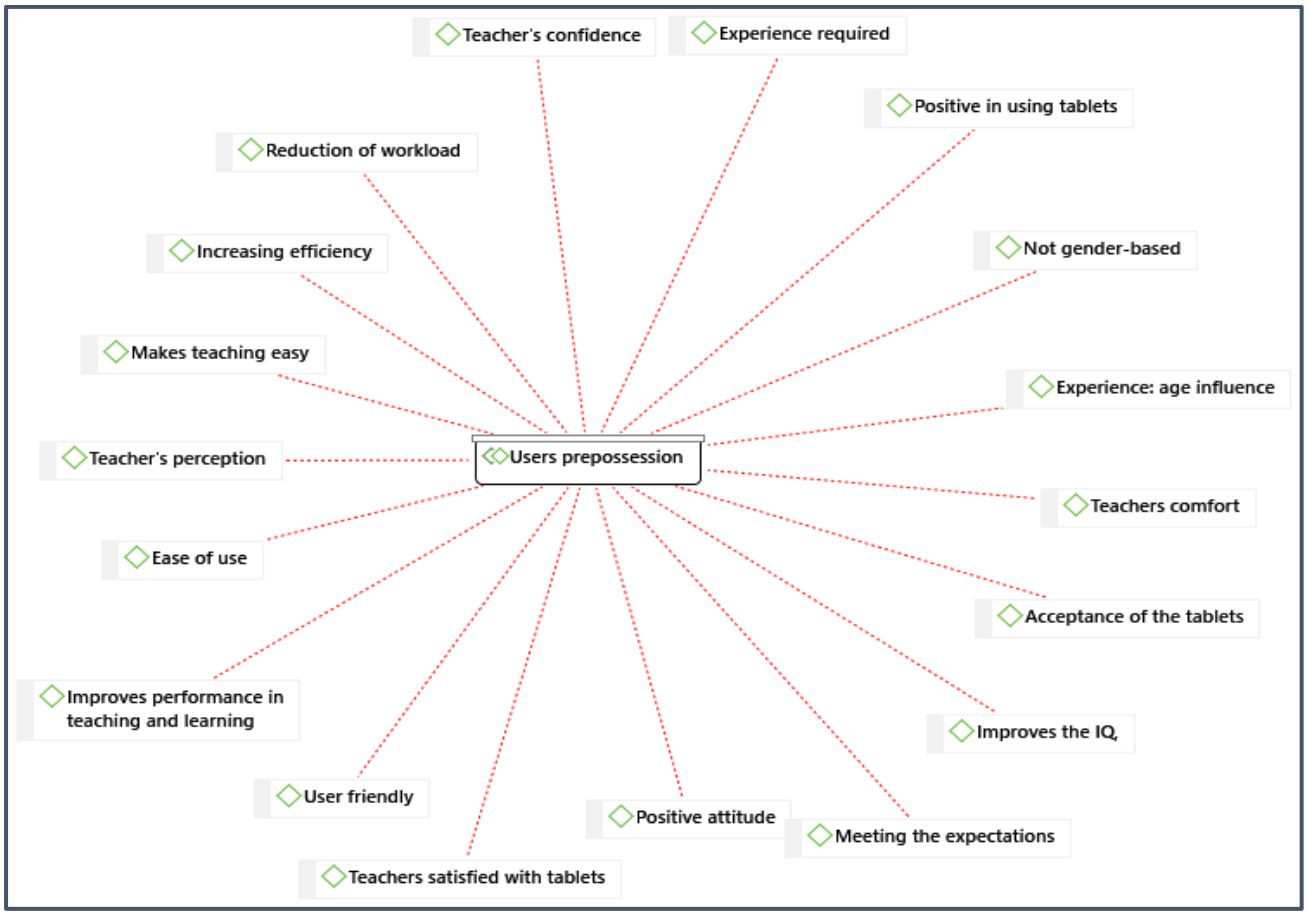


Figure 5.7: Network diagram — Users prepossession theme and codes

The data presented in tables in this section represents the response from the teachers in relation to the User component under the theme: User prepossession. In this section the factors are segmented into different tables (Table 5.5-Table 5.9) related to the user component, with the aim of presenting data per factor in the discussion of the questionnaire results.

Table 5.5: User Component — Factor Needs

Subcomponent (Factors)	Codes linked to: User prepossession theme	Teachers' feedback
B1.1 Needs	Ease of use, Improves performance in teaching and learning, Increasing efficiency	"Ease of use to teachers is very important to improve learners' skills." "It's easy to use without any struggle." "the use of tablets is efficient because everything required is on the tablets." "We learn fast and it improves performance."

Table 5.5 presents the factor Needs. Based on the Likert scale's summary feedback presented in Table 5.4 out of twenty-seven teachers, about ninety-six percent (96%) (->) either strongly agreed (7) or agreed (19) that teachers need to be satisfied with the use of the technologies. Ninety-two percent (92%) (->) either strongly agreed (10) or agreed (15) that technologies need to be user-friendly (ease of use). One hundred percent (100%) (->) either strongly agreed (11) or agreed (16) that teachers need to be encouraged when engaging with technologies.

Teachers' feedback: Teachers do agree that they need the system to be easy to use. ***Teacher-2*** indicated that *"ease of use to teachers is very important to improve learners' skills"*. The feedback also showed that teachers are encouraged and satisfied with the use of the technologies. ***Teacher-14*** indicated that *"we learn fast and it improves performance"*. The results align with the literature where Mashapa (2013) argued that satisfaction is a need for the user using the system (technologies), Portugal (2014) argued that users need to be encouraged, and Chan and Johansson (2016) emphasised that ease of use is needed when using the technologies. Based on teacher's feedback, the results indicate that teachers perceive the factor ***Needs*** to have an influence on the use of mobile technologies at schools.

Table 5.6: User Component — Factor Perception

Subcomponent (Factor)	Codes linked to: User prepossession theme	Teachers' feedback
B1.2 Perception	Makes teaching easy, Increases efficiency, improves IQ, Positive in using tablets, teachers' confidence, teachers' perception	"Tablets save time, no more chalk boards." "Makes learners to learn quicker than before." "I like what I do with the tablets." "Positive perception will build confidence in the teacher." "Perception of teachers towards the tablet is very important."

Table 5.6 presents the factor Perception, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.4, out of twenty-seven teachers, approximately eighty-nine percent (89%) (->) either strongly agreed (12) or agreed

(12) that the perception of teachers regarding the use of the technologies is very important. Eighty-nine percent (89%) (->) either strongly agreed (7) or agreed (17) that they have a positive perception about the use of mobile technologies at schools. Ninety-two percent (92%) (->) either strongly agreed (10) or agreed (15) that they perceive technologies as useful in teaching and learning.

Teachers' feedback: Based on the teacher's feedback, teachers' perception about the technologies is positive. ***Teacher-23*** agrees that *"[p]ositive perception will build confidence in the teacher".* ***Teacher-25*** also supports that *"[p]erception of teachers towards the tablet is very important"*. The feedback aligns with the literature review. According to Roto et al. (2011), the perception of the user about the system (mobile technologies) does have an influence on the UX, and Maguire (2013) argued that users need to perceive the system as useful. Therefore, it can be concluded that the factor ***Perception*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.7: User Component — Factor Attitude

Subcomponent (Factor)	Codes linked to: User prepossession theme	Teachers' feedback
B1.3 Attitude	Positive attitude, Acceptance of the tablets, Teachers comfort, Younger teacher's readiness	"Once the teacher is positive also the learners will have a positive attitude." Positive attitude will yield positive outcomes." "As the forth industrial revolution is fast knocking at our doorsteps, teachers need to accept the use of tablets." "If teachers don't accept it, learners will not accept it." "I am comfortable because the tablet has made things easier."

Table 5.7 presents the factor Attitude, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.4, out of twenty-seven teachers, approximately ninety-six percent (96%) (->) either strongly agreed (10) or agreed (16) that the attitude of the teacher towards the use of the technologies is very important. Ninety-two percent (92%) (->) either strongly agreed (9) or agreed (16) to having a positive attitude towards the

use of technologies in teaching and learning. Eighty-nine percent (89%) (->) either strongly agreed (10) or agreed (14) that the attitude of the teachers has an impact on the acceptance of the technology at schools; they are of the view that if teachers have a positive attitude so will the learners.

Teachers' feedback: The results show that teachers' attitude towards the use of mobile technologies has an impact on the use of mobile technologies at schools. ***Teacher-7*** said that *"[o]nce the teacher is positive also the learners will have a positive attitude".* While ***Teacher-24*** indicated that a *"[p]ositive attitude will yield positive outcomes".* In the literature review, Langenhoven (2016) stated that a positive attitude is associated with good UX. ChanLin (2017) also argued that the attitude of the user influences the UX. Therefore, it is evident that the factor ***Attitude*** as indicated in the literature review does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.8: User Component — Factor Experience

Subcomponent (Factor)	Codes linked to: User prepossession theme	Teachers' comparable feedback
B1.4 Experience	Experience-age influence, younger teachers, not gender-based, experience required	"Experienced teachers will be able to work fast and efficiency." "we cannot be biased about gender with the use of technology." "No gender equity in technology." "If no experience the will be no change, old method that waste time will be used." "Age is not an aspect to influence usage of tablets."

Table 5.8 presents the factor Experience, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.4, out of twenty-seven teachers about ninety-six percent (96%) (->) either strongly agreed (12) or agreed (14) that the experience of teachers when using the technologies at school is very important. Seventy percent (70%) (->) either disagreed (11) or strongly disagreed (8) that gender influences the experience of teachers when using the mobile technologies at school. Sixty-three percent (63%) (->) either disagreed (16) or strongly disagreed (1) that age influenced the use of technologies at school.

Teachers' feedback: Most teachers agreed that the experience of the teacher in the use of technologies is very important. *"Experienced teachers will be able to work fast and efficiency".* In the literature, Langenhoven (2016) and Roto (2006) emphasised that experience has a significant impact on the UX of the user. However, the majority of participants did not think characteristics of factor ***Experience***, such as ***Age***, and ***Gender*** influenced the experience of the teachers when using technology. ***Teacher-8*** said that, *"No gender equity in technology"* and ***Teacher-20*** stated that, *"Age is not an aspect to influence usage of tablets".* Based on the results it can be concluded that the factor ***Experience*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.9: User Component — Factor Expectation

Subcomponent (Factor)	Codes linked to: User prepossession theme	Teachers' feedback
B1.5 Expectation	User friendly, meeting the expectations, reduction of workload, teachers' satisfaction with tablets	"The tablets meet our expectations in learning and teaching." "The use of tablets must meet the functionality requirements of teaching and learning." "Reduce the workload."

Table 5.9 presents the factor Expectation, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.4, out of twenty-seven teachers, approximately sixty-three percent (63%) (->) either strongly agreed (4) or agreed (13) that they expect the use of technologies to support their teaching needs. Sixty-three percent (63%) (->) either strongly agreed (5) or agreed (12) that they expect the use of technologies to meet requirements such as performance and reliability in teaching. Eighty-nine percent (89%) (->) either strongly agreed (8) or agreed (16) that the use of technologies should meet the functionality requirements in teaching.

Teachers' feedback: According to the results, teachers agreed that they expect the technologies to meet their needs and technologies should meet both functional and non-functional requirements. ***Teacher-11*** also agreed that "*the use of tablets must meet the functionality requirements of teaching and learning"* and ***Teacher-23*** expected the technologies to *"reduce the workload".* In the literature review, Tan (2009) stated that a system meets the user's

expectation by conforming to the standards of meeting both functional and non-functional requirements. Botha and Herselman (2017) argued that teachers expect the technologies to support their teaching needs. Therefore, it can be concluded that the factor ***Expectation*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.8.

Figure 5.8: User component outcome

Based on the feedback from the participants, the teachers mentioned that factors such as needs, perception, expectations, experience and attitude may have an influence on the use of the technologies at school. Teachers indicated that they want the technologies to be easy to use, and that their perception towards the technologies is positive. According to teachers, the

technologies increase efficiency and make teaching and learning easy. The attitude of the teachers towards the use of technology at school is positive and teachers accept the use of technologies at schools as they feel these bring confidence to the teachers. Teachers acknowledge that the experience of the teachers in using the technologies is very important, hence they suggested that teachers be trained to use the technologies. Teachers think the experience of teachers using the technologies is a necessity, and that the age and gender of the teacher does not matter. If there is a lack of experience in using the technologies, there will be resistance to accepting the use of technologies at school. Teachers expect the technologies to be user-friendly, and that they will reduce the workload. They also agree that the technologies they are using at schools do meet their expectations. There is an impression that older teachers still prefer the traditional method of teaching more than the younger teachers. Nonetheless, teachers do acknowledge that they need to be ready for change as the fourth industrial revolution is already taking place.

The following section focusses on data analysis for the System component.

5.3.3 System component: Mobile technologies

This section will focus on the System component, Section C of the questionnaire (see Appendix D) and as highlighted in section 5.3.1. Table 5.10 shows the responses from the teachers indicating the factors that may have an influence on their user experience when using the mobile technologies at schools in resource constrained environments. These factors are specifically related to the **System component**. The first column shows the factor's characteristics interconnected with the subcomponents which were used to compile the questionnaire. The next four columns show the responses from the teachers, indicating whether they agree or disagree that the factors may have an influence on their user experience, when using the mobile technologies at schools. The value of ***N*** represents the number of teachers who either agree or disagree with the identified components and factors. The highest number of responses represents the majority of the teachers' feedback or responses. This section focusses only on the System component.

Table 5.10: Summary of the teachers' feedback on System component and factors

Factors (characteristics) that may have an influence on the UX for teachers	**Strongly Agree**	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
C1.1.1 Teachers find the use of the tablet to be *efficient — quick* to learn.	***(N=10)***	***(N=13)***	***(N=0)***	***(N=2)***	***(N=2)***
C1.1.2 Teachers expect the tablet to be *easy to use*.	***(N=8)***	***(N=18)***	***(N=0)***	***(N=1)***	***(N=0)***
C1.1.3 Teachers find it *easy to navigate* their way to certain functionality using the tablets.	***(N=7)***	***(N=15)***	***(N=3)***	***(N=1)***	***(N=1)***
C1.1.4 I *am satisfied* with using the tablet to perform my daily task as a teacher.	***(N=8)***	***(N=11)***	***(N=3)***	***(N=5)***	***(N=0)***
C1.1.5 The *errors encountered* when using the tablets do *influence* my experience of using the tablet.	***(N=3)***	***(N=16)***	***(N=5)***	***(N=3)***	***(N=0)***
C1.2.1 The *visualisation* or the *appearance* of the tablet *does influence* my experience of using the tablet.	***(N=4)***	***(N=18)***	***(N=2)***	***(N=3)***	***(N=0)***
C1.2.2 The *features* of a tablet *motivate* teachers in their teachings.	***(N=8)***	***(N=13)***	***(N=5)***	***(N=1)***	***(N=0)***
C1.2.3 The tablets we received have proper *visualisation, they are attractive* to use.	***(N=9)***	***(N=14)***	***(N=2)***	***(N=2)***	***(N=0)***
C1.2.4 Teachers perceive *the appearance* of the tablets as pleasing.	***(N=4)***	***(N=15)***	***(N=4)***	***(N=4)***	***(N=0)***
C1.2.5 The tablet is *perceived as a useful tool* in teaching and learning.	***(N=8)***	***(N=16)***	***(N=3)***	***(N=0)***	***(N=0)***
C1.3.1 *Functionality* of the tablet enables teachers to *navigate* the tablet without any constraints.	***(N=8)***	***(N=13)***	***(N=3)***	***(N=2)***	***(N=1)***
C1.3.2 The functionality of the tablet is *easily accessible*.	***(N=6)***	***(N=13)***	***(N=3)***	***(N=3)***	***(N=2)***
C1.3.3 I am *satisfied with the functionalities* of the tablets I use for teaching and learning.	***(N=7)***	***(N=16)***	***(N=2)***	***(N=2)***	***(N=0)***
C2.1.1 Having *control and ownership* on the tablet motivates the user to *navigate* the tablet *freely*.	***(N=9)***	***(N=15)***	***(N=1)***	***(N=2)***	***(N=0)***
C2.1.2 I do not *feel safe* about sharing my tablet with other teachers.	***(N=4)***	***(N=7)***	***(N=4)***	***(N=10)***	***(N=2)***
C2.1.3 The administration functionalities of the tablet require *confidentiality*.	***(N=6)***	***(N=15)***	***(N=2)***	***(N=3)***	***(N=1)***
C2.1.4 The work of the teachers on the tablets needs to be *protected*.	***(N=12)***	***(N=12)***	***(N=2)***	***(N=1)***	***(N=0)***
C2.2.1 *Flexibility* of the tablets gives teachers freedom to *work anywhere*.	***(N=10)***	***(N=16)***	***(N=1)***	***(N=0)***	***(N=0)***
C2.2.2 The tablets we received at our school give us *flexibility to move around* while teaching.	***(N=11)***	***(N=10)***	***(N=1)***	***(N=2)***	***(N=3)***
C2.2.3 *Flexibility motivates* the user as there is no limitation to teaching and learning while physically moving.	***(N=8)***	***(N=16)***	***(N=1)***	***(N=2)***	***(N=0)***
C2.3.1 Tablets need to be *reliable*.	***(N=12)***	***(N=15)***	***(N=0)***	***(N=0)***	***(N=0)***

Factors (characteristics) that may have an influence on the UX for teachers	**Strongly Agree**	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
C2.3.2 The tablets should be *monitored*, to ensure that they are used for learning and teaching purposes only.	***(N=10)***	***(N=14)***	***(N=1)***	***(N=2)***	***(N=0)***
C2.3.3 The tablets need to work *consistently*.	***(N=11)***	***(N=16)***	***(N=0)***	***(N=0)***	***(N=0)***
C2.4.1 The tablet enables me to *perform* my daily tasks.	***(N=5)***	***(N=17)***	***(N=4)***	***(N=1)***	***(N=0)***
C2.4.2 The tablet enables me to *add value* to the learners teaching and learning experience.	***(N=12)***	***(N=12)***	***(N=2)***	***(N=1)***	***(N=0)***
C2.4.3 Tablet is a *helpful tool* without it the task of teaching is much more difficult.	***(N=9)***	***(N=11)***	***(N=1)***	***(N=4)***	***(N=2)***
C2.4.4 The use of tablets *add value* to the education system in South Africa.	***(N=13)***	***(N=12)***	***(N=2)***	***(N=0)***	***(N=0)***
C2.5.1 The tablet should be *(desirable) pleasing* to interact with.	***(N=9)***	***(N=15)***	***(N=1)***	***(N=2)***	***(N=0)***
C2.5.2 The tablets that we use in our school are *motivating*.	***(N=10)***	***(N=14)***	***(N=2)***	***(N1)***	***(N=0)***
C2.5.3 The *aspect (physical features)* of the tablet should be appealing to the teachers.	***(N=10)***	***(N=13)***	***(N=2)***	***(N=2)***	***(N=0)***
C3.1.1 Teachers need to know how to *operate* the tablet for teaching and learning purposes.	***(N=10)***	***(N=16)***	***(N=1)***	***(N=0)***	***(N=0)***
C3.1.2 The issue of *technophobic (fear of technology)* teachers needs to be addressed.	***(N=11)***	***(N=16)***	***(N=0)***	***(N=0)***	***(N=0)***
C3.1.3 Teachers need to *know how to operate* the tablet for administration and research purposes.	***(N=16)***	***(N=9)***	***(N=2)***	***(N=0)***	***(N=0)***
C3.2.1 Teachers require *critical thinking skills* to engage with the tablet and its content.	***(N=12)***	***(N=13)***	***(N=2)***	***(N=0)***	***(N=0)***
C3.2.2 Teachers are expected *to understand how the tablets operate*.	***(N=17)***	***(N=10)***	***(N=0)***	***(N=0)***	***(N=0)***
C3.2.3 Teachers are expected to *transfer skills* to the learners.	***(N=12)***	***(N=14)***	***(N=1)***	***(N=0)***	***(N=0)***
C3.3.1 Teachers require some level of *problem-solving skills* in order to learn to use the tablet.	***(N=9)***	***(N=12)***	***(N=3)***	***(N=3)***	***(N=0)***
C3.3.2 Teachers are expected to come up *with solutions* should the tablets be dysfunctional.	***(N=10)***	***(N=10)***	***(N=5)***	***(N=1)***	***(N=1)***
C3.3.3 Teachers require *problem-solving skills* to learn to work on technical tasks in teaching.	***(N=5)***	***(N=7)***	***(N=0)***	***(N=15)***	***(N=0)***
C3.4.1 Teachers are required to *think creatively* in order to apply knowledge when using the tablets.	***(N=8)***	***(N=19)***	***(N=0)***	***(N=0)***	***(N=0)***
C3.4.2 Teachers are required *to be innovative* when using the tablet.	***(N=5)***	***(N=20)***	***(N=1)***	***(N=1)***	***(N=0)***
C3.5.1 There are an *inadequate number of teachers* at schools to teach learners using the tablets.	***(N=10)***	***(N=14)***	***(N=0)***	***(N=3)***	***(N=0)***
C3.5.2 Unskilled teachers *require training* to enhance teaching and learning at schools using tablets.	***(N=13)***	***(N=12)***	***(N=1)***	***(N=1)***	***(N=0)***

Factors (characteristics) that may have an influence on the UX for teachers	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
C3.5.3 Teachers' *professional development* is important to accelerate the use of tablets at schools.	***(N=10)***	***(N=17)***	***(N=0)***	***(N=0)***	***(N=0)***

The results in Table 5.10 are discussed in sections 5.3.3.1 to 5.3.3.3 where tables are segmented per factor, and a data analysis is presented.

Three themes were generated to present the System component; these themes were then used to develop the network diagrams. Section 2.2.2 elaborated on how the themes, network diagrams and codes were formulated in this study. Three network diagrams, namely, Mobile device attribute theme, Mobile technologies essential theme, and Digital platform requisite theme, as well as codes were developed using the Atlas.ti tool, as discussed in section 5.2.2. This section will present and analyse the data connected to the three themes. Figure 5.9 presents the mobile device attributes theme, Figure 5.11 presents the mobile technology essential theme, and Figure 5.13 presents the digital platform requisite with the intention of assessing factors of the system component that may influence the use of mobile technologies in rural schools. The following present the relations that connect the questionnaire to data analysis:

- Mobile device attribute theme links to -> **C1. Features of the device**;
- Mobile technologies essential theme links to -> **C2. Users expectations**; and
- Digital platform requisite theme links to -> **C3. Digital skills**.

5.3.3.1 Response on System component — Mobile device attribute theme

Literature evidence: The use of mobile technologies including technologies at schools is beneficial to teachers not only in teaching and learning, but also for administration work because it saves time when planning, sharing documents, storing learners' data and developing training skills (Becta, 2010). Figure 5.9 presents the network diagram Mobile device attributes and codes. The codes are presented in a ♦ diamond in the network diagram. The UX involves the characteristics of the system, which includes functionality, the complexity of the system, its purpose and usability (Hassenzahl & Tractinsky, 2006). As the users interact with the system (technologies) they need to be satisfied with the system, their perception about the system includes how good the results of the system are (efficiency), how fast the system is (effectiveness), how good it feels to use (satisfaction), and the quality of the system

(Kuniavsky, 2010). Pragmatic and hedonic qualities fulfil the human needs when interacting with the system (Hassenzahl, 2008). Bidin and Ziden (2013) identified factors such as usability, effectively, flexible, pragmatic, hedonic as factors that may have an influence when a teacher interacts with the technologies. As presented in Table 5.2 in section 5.2.2, factors such as usability, hedonic and aesthetic, and functionality form the Mobile device attributes theme.

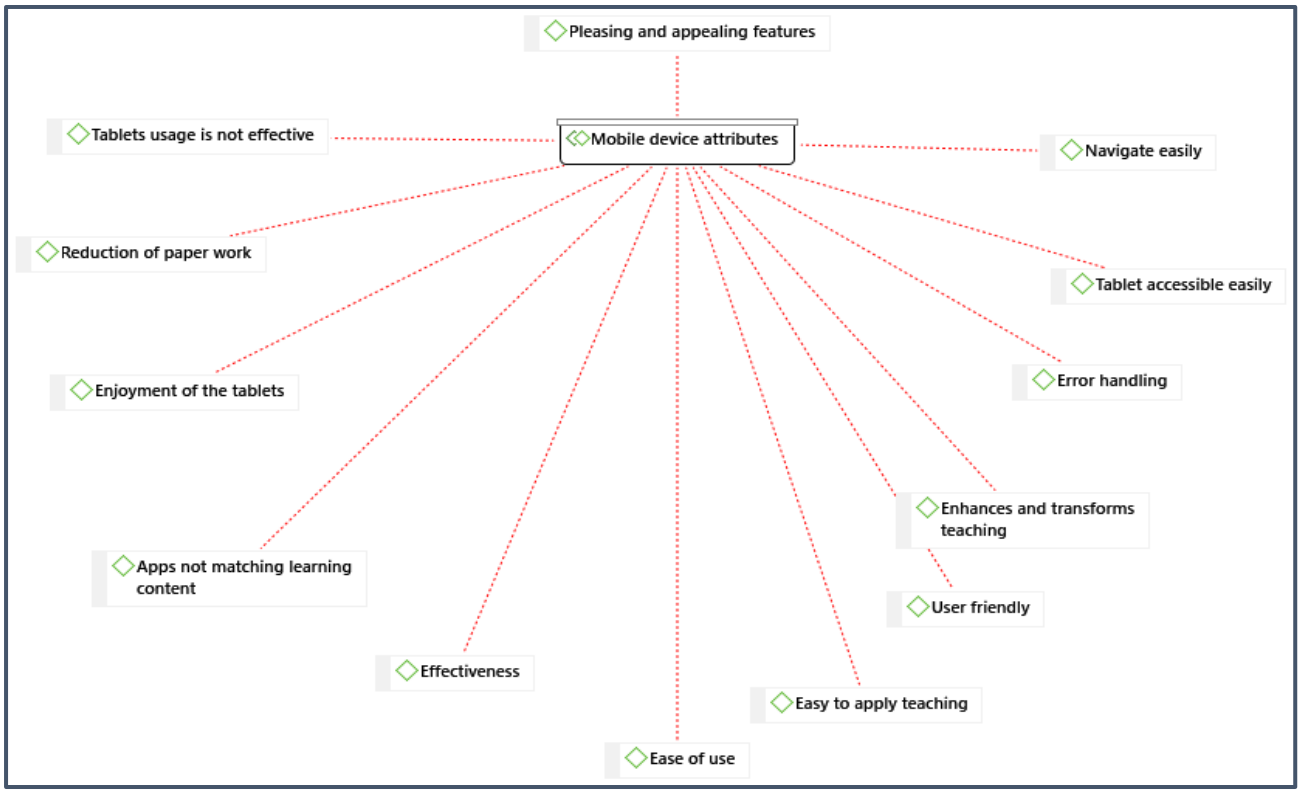


Figure 5.9: Network diagram — Mobile device attributes theme and codes

The data presented in the tables in this section reflects the responses from the teachers regarding the System component under the theme: Mobile device attribute theme. In this section the factors are segmented into different tables (Table 5.11-Table 5.13) related to the system component Mobile device attribute theme, with the aim to present data per factor in the discussion of the questionnaire results.

Table 5.11: System Component — Factor Usability

Subcomponents (Factors)	Codes linked to: Mobile device attribute theme	Teachers' feedback
C1.1 Usability	Effectiveness, reduction of paper work, ease of use, easy to apply teaching	"Makes teaching effective". "Makes lesson to go quick all the time." "Making teaching easy to present subject professionally to learners." "I'm able to google and research." "The easier the tablet, the more efficiently they can be used." "Easy for my task to be done"

Table 5.11 presents the factor Usability, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers approximately eighty-five percent (85%) (->) either strongly agreed (10) or agreed (13) that they find the use of technologies efficient. Ninety-six percent (96%) (->) either strongly agreed (8) or agreed (18) that they expect the mobile technologies to be easy to use. Eighty-one percent (81%) (->) either strongly agreed (7) or agreed (15) that it is easy for them to navigate to the certain functions using the technologies. Seventy percent (70%) (->) either strongly agreed (3) or agreed (16) that errors encountered in the technologies have an impact on the use of the technologies at school.

Teachers' feedback: *"The easier the tablet, the more efficiently they can be used."* The teacher's feedback indicated that teachers agreed that they find the technologies to be easy to use, which makes teaching effective. For example, ***Teacher-27*** indicated that mobile technology *"[m]akes teaching effective" and "making teaching easy to present subject professionally to learners"*. Teachers expect the technologies to be easy to use and that errors encountered do disturb their experiences. The results align with the literature review, specifically with work done by Chan and Johansson (2016) who argue that characteristics such as effectiveness and the ease of use of the system should be considered. The usability of the system (technologies) can be influenced by the errors encountered (Bevan, 2009).

From the results it can be concluded that the factor ***Usability*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.12: System Component — Factors Hedonic and Aesthetic

Subcomponents (Factors)	Codes linked to: Mobile device attribute theme	Teachers' feedback
C1.2 Hedonic and Aesthetic	Pleasing and appealing features, enhances and transforms teaching, enjoyment of the tablets	"The appearance and features influences the use of technology." "They should be attractive to use." "Visualization and appearance enrich experience." "It improves my approach or method of teaching." "They have more Apps that enhance learners to learn." "I enjoy using it." "Makes teaching to be fun as well."

Table 5.12 presents the factors Hedonic and Aesthetic, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers approximately eighty-one percent (81%) (->) either strongly agreed (4) or agreed (18) that the visual attributes of the technologies do have an influence on the user experience of the teachers. Seventy-seven percent (77%) (->) either strongly agreed (8) or agreed (13) that the features of the technologies motivate them in their teaching. Seventy percent (70%) (->) either strongly agreed (4) or agreed (15) that they perceive the technologies as pleasing to use. Eighty-five percent (85%) (->) either strongly agreed (9) or agreed (14) that the technologies have proper visualisation and that they are attractive to use.

Teachers' feedback: ***Teacher-14*** indicated that the appearance influences their use of the technology: "*the appearance and features influences the use of technology*". ***Teacher-25*** agreed with ***Teacher-14*** and said that "*visualization and appearance enrich the experience*". Based on the results, teachers are motivated by the visualisation of the technologies, the features of the technologies make them enjoyable for the teachers to use. According to Gentner et al. (2013), the system (technologies) is perceived through pleasure achieved from the attributes of the system, which evokes the cognitive response of the user when engaging with the system. As a result, it is evident that the factor ***Hedonic and Aesthetic*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.13: System Component — Factor Functionality

Subcomponent (Factors)	Codes linked to: Mobile device attribute theme	Teachers' feedback
C1.3 Functionality	Navigate easily, Tablet accessible easily, Apps not matching learning content, Error handling	"All Apps are clear and easily accessible." "Im very satisfied with the functions of the tablets." "Is easy to navigate and get used to functioning of the tablet." "Not many relevant Apps for all the subjects." "Content should match with the syllabus." "Most of the errors are making it difficult for me to enjoy the use of the tablets."

Table 5.13 presents the factor Functionality, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about seventy-seven percent (77%) (->) either strongly agreed (8) or agreed (13) that the functionality of the technologies enables teachers to navigate without challenges. Eighty-five percent (85%) (->) either strongly agreed (7) or agreed (16) that they are satisfied with the functionalities of the technologies they use. Seventy percent (70%) (->) either strongly agreed (6) or agreed (13) that functionalities are supposed to be easily accessible.

Teachers' feedback: The majority of teachers concurred that they were not experiencing challenges with navigating the features of the technologies, and that they were satisfied with the functionalities. For example, ***Teacher-7*** indicated: *"Im very satisfied with the functions of the tablets."* ***Teacher-16*** indicated that: "*All Apps are clear and easily accessible."* In the literature review, Bidin and Ziden (2013) stated that the functionality of the mobile technology should allow the user to use it without any constraints, regardless of where the interaction is taking place. However, a few concerns were expressed by the teachers, which will be discussed in section 5.4. Based on the results, it can be concluded that the factor ***Functionality*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.10.

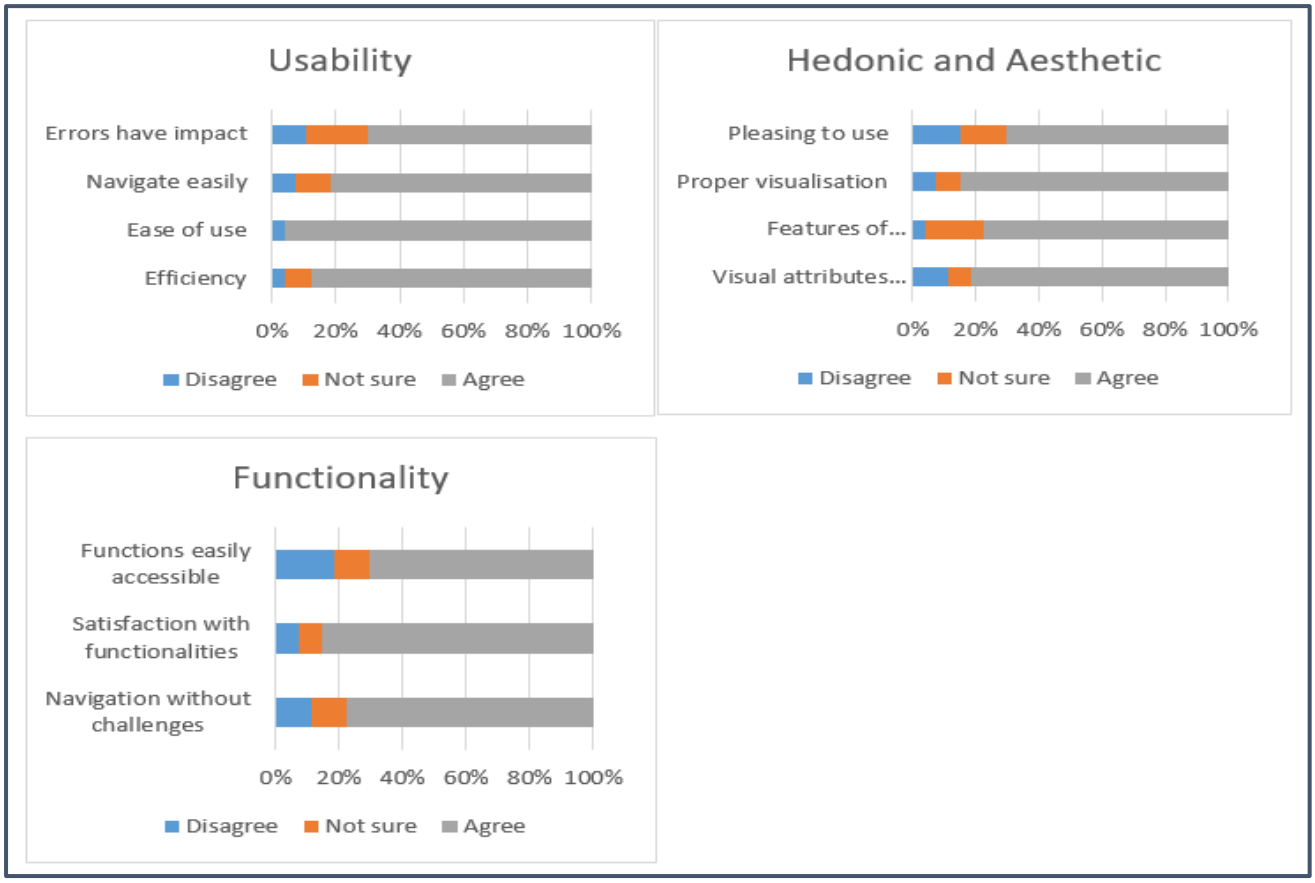


Figure 5.10: System component outcome (1)

Teachers found the technologies to be effective and easy to use, which made teaching easier. Lessons were easy to present to the learners and the technologies reduced paperwork. Teachers enjoyed using the technologies, and found the visual attributes and features attractive, user-friendly, and that they enhanced education. Teachers also expressed their frustrations and challenges about functionalities and Apps that were difficult to use, the errors encountered on the technologies, and the irrelevant Apps that do not match the learning content. The following section focusses on the second part of the data analysis for the System component.

5.3.3.2 Response on System component — Mobile technology essentials theme

Literature evidence: In section 3.3.3 privacy, flexibility, control and ownership were identified as factors influencing the use of mobile technologies at school (Bidin and Ziden, 2013). For a system to deliver a positive UX, system aspects such as credibility, valuable and desirable should be considered (Morville, 2004) as they may influence the UX of teachers when using the technologies as indicated in section 2.2.3.1.1. Therefore, factors such as Control and

Ownership, Flexibility, Credibility, Valuable and Desirable form the Mobile technologies essentials theme illustrated in Figure 5.11.

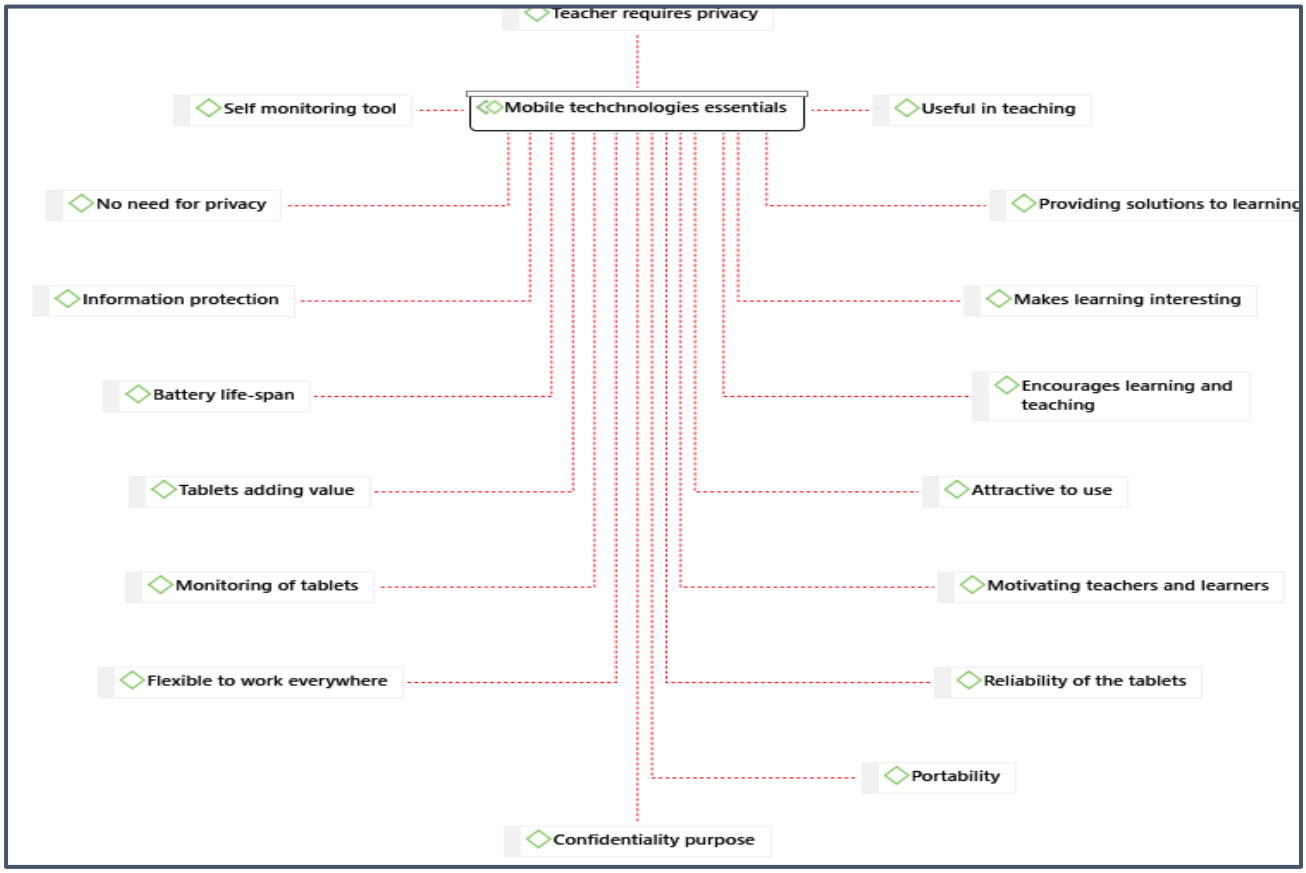


Figure 5.11: Network diagram — Mobile technologies essentials theme and codes

The data presented in tables in this section represents the responses from the teachers, in relation to the System component under the theme: Mobile technologies essentials theme. In this section the factors are segmented into different tables (Table 5.14 - Table 5.18) related to system component Mobile technologies essentials theme, with the aim of presenting data per factor in the discussion of the questionnaire results.

Table 5.14: System Component — Factor Control and Ownership

Subcomponents (Factors)	Codes linked to: Mobile technologies essential theme	Teachers' feedback
C2.1 Control and Ownership	Teacher requires privacy, confidentiality purpose, no need for privacy	"Ownership makes it possible for your information to be safe and protected." "Some of the documents are confidentially." "I don't feel safe to share it with other teachers." "Password should be known by the user only; information is confidential."

Table 5.14 presents the factor Control and Ownership, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about eighty-nine percent (89%) (->) either strongly agreed (9) or agreed (15) that having control and ownership motivates the teachers to navigate the technologies freely. Seventy-seven percent (77%) (->) either strongly agreed (6) or agreed (15) that administration functionalities require confidentiality. Eighty-nine percent (89%) (->) either strongly agreed (12) or agreed (12) that the teacher's work loaded onto the technologies needs to be protected.

Teachers' feedback: The results show that teachers feel that ownership on the tablets is important. For example, ***Teacher-17*** said that *"[o]wnership makes it possible for your information to be safe and protected"* and ***Teacher-2*** felt that their *"information is confidential".* Teachers feel that ownership motivates them to use the technologies freely, and they do agree that their information is confidential and needs to be protected. According to Bidin and Ziden (2013), having control over the device is important for the user. Based on the results it is evident that the factor ***Control and Ownership*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.15: System Component — Factor Flexibility

Subcomponents (Factors)	Codes linked to: Mobile technologies essential theme	Teachers' feedback
C2.2 Flexibility	Portability, flexible to work everywhere, battery life-span	"Portable tablet can be used in or outside the classroom." "Works everywhere doesn't keep the teacher at hostage." "The teacher is able to move around checking learners' activities and engaging with them." "We have a shortage of USB cables, it's very difficult to charge." "Other tablets become flat in the middle of the lesson."

Table 5.15 presents the factor Flexibility, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about ninety-six percent (96%) (->) either strongly agreed (10) or agreed (16) that the flexibility of the technologies gives them the ability to work anywhere. Eighty-nine percent (89%) (->) either strongly agreed (8) or agreed (16) that flexibility in the technologies motivates them in their teaching since they are not limited in movement. Seventy-seven percent (77%) (->) either strongly agreed (11) or agreed (10) that the technologies they are using at school enable them to move around while teaching.

Teachers' feedback: Teachers do agree that the technologies give them freedom to teach while moving around. For example, ***Teacher-4*** said that "*portable tablet can be used in or outside the classroom*", ***Teacher-7*** reported that the technology "*works everywhere doesn't keep the teacher at hostage*" and ***Teacher-20*** explained that teachers are "*able to move around checking learner's activities and engaging with them*". The freedom to teach while moving around motivates teachers in their teaching as they can reach out to learners and assist them with their activities. The findings agree with Brown and Mbati's (2015) claim that flexibility gives users freedom to work anywhere, which motivates the user as there are no limitations. However, there were a few concerns that were expressed by the teachers, which will be discussed in

section 5.4. Based on the results it is evident that the factor ***Flexibility*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.16: System Component — Factor Credibility

Subcomponents (Factors)	Codes linked to: Mobile technologies essential theme	Teachers' feedback
C2.3 Credibility	Reliability of the tablets, monitoring of tablets, information protection, self-monitoring tool	"Results produced by tablets must be valid." "Tablets should be monitored." "To ensure that they are only used for educational purpose." "Reliability is very important." "The tablets needs self-monitoring tool."

Table 5.16 presents the factor Credibility, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers one hundred percent (100%) (->) either strongly agreed (12) or agreed (15) that the technologies should be reliable. Eighty-nine percent (89%) (->) either strongly agreed (10) or agreed (14) that the technologies should be monitored to ensure that they are used for teaching and learning purposes. One hundred percent (100%) (->) either strongly agreed (11) or agreed (16) that the technologies need to work constantly.

Teachers' feedback: Teachers want the mobile technologies to be reliable, and to operate constantly. This aligns with the findings of the literature review. Morville (2004) argued that the credibility of the system is important in the experience of the user. Comments from the teachers confirm Morville's (2004) statement. For example, ***Teacher-23*** said that *"results produced by the tablets must be valid"*, ***Teacher-16*** felt that *"tablets should be monitored, to ensure that they are only used for educational purposes"*. Based on the feedback it can be concluded that the factor ***Credibility*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.17: System Component — Factor Valuable

Subcomponents (Factors)	Codes linked to: Mobile technologies essential theme	Teachers' feedback
C2.4 Valuable	Tablets adding value, Encourages learning and teaching, useful in teaching	"Tablets add value to my lessons, they are valuable." "Found using tablet more helpful and very informative." "They encourage learners to learn and improve their progress." "The tablets are useful in teaching and learning." "It will increase the pass rate of the learners."

Table 5.17 presents the factor Valuable, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about eighty-nine percent (89%) (->) either strongly agreed (12) or agreed (12) that the use of technologies adds value to teaching and learning. Seventy-four percent (74%) (->) either strongly agreed (9) or agreed (11) that technologies are a helpful tool in teaching and learning. Ninety-two percent (92%) (->) either strongly agreed (13) or agreed (12) that the use of technologies does add value to South Africa's education system.

Teachers' feedback: Teachers found the technologies to be useful, adding value to teaching and learning (***Teacher-9***: "*tablets add value to my lesson, they are valuable*"), and to the South African education system by helping improve the pass rate of the learners. For example, ***Teacher-14*** claimed that "*they encourage learners to learn and improve their progress*". This aligns with the findings of the literature review. Morville (2004) argued that teachers will find the system (mobile technologies) valuable because it meets the needs of the user. Based on the feedback, it is evident that the factor ***Value*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.18: System Component — Factor Desirable

Subcomponents (Factors)	Codes linked to: Mobile technologies essential theme	Teachers' feedback
C2.5 Desirable	Attractive to use, Motivating teachers and learners, Makes learning interesting	"If its attractive to use, they'll be enjoyable to use them." Tablets are motivating especially to learners." "Tablets should always be pleasing to work with." "They are very helpful and make learning interesting."

Table 5.18 presents the factor Desirable, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about eighty-nine percent (89%) (->) either strongly agreed (9) or agreed (15) that the technologies should be pleasing to interact with. Ten teachers strongly agreed and thirteen agreed that the aspects of the technologies should be appealing. Eighty-five percent (85%) (->) either strongly agreed (10) or agreed (14) that the technologies they are using motivate them.

Teachers' feedback: Teachers enjoy working with a pleasing system (technologies). ***Teacher-14*** supported this by saying *"[i]f its attractive to use, they'll be enjoyable to use them"* and they want the technologies to be appealing to work with because this motivates them. This aligns with the findings in the literature review. Morville (2004) emphasised that an attractive system motivates the user. Based on the results it can be concluded that the factor ***Desirable*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.12

Figure 5.12: System components outcome (2)

Teachers indicated that privacy in the technologies is crucial, they want passwords on the technologies to be able to hide their confidential information, which includes their administration and research work. Flexibility of the technologies is important for the teachers; they want to move freely when teaching. They have issues with the short life-span of the batteries. They expect the batteries to last longer because they do not want to disrupt a lesson to charge the technologies.

Teachers expect their information to be reliably protected. They expect the technologies to have a self-monitoring tool to ensure that they are only used for teaching and learning purposes. Teachers believe that the technologies add value to the education system and they expect to find them pleasing to work with.

The following section focusses on the data analysis for the third part of the System components.

5.3.3.3 Response on System component – Digital platform requisite theme

Literature evidence: The world revolves around technology, therefore technological skills are essential (Mbebe, 2017). Hlagala (2015) stated that mobile technologies require the user to have technological skills such as critical thinking and problem-solving skills (section 3.3.4). Payton and Hauge (2010) recommended that users have technological skills such as creativity, which brings innovation to learning and critical thinking (section 3.3.4). There is a necessity for qualified teachers to be able to use the mobile technologies in teaching and learning (Mabila, 2017). Factors such as Technological skills, Problem solving, Creativity, Critical thinking and qualified teachers form the Digital platform requisite theme.

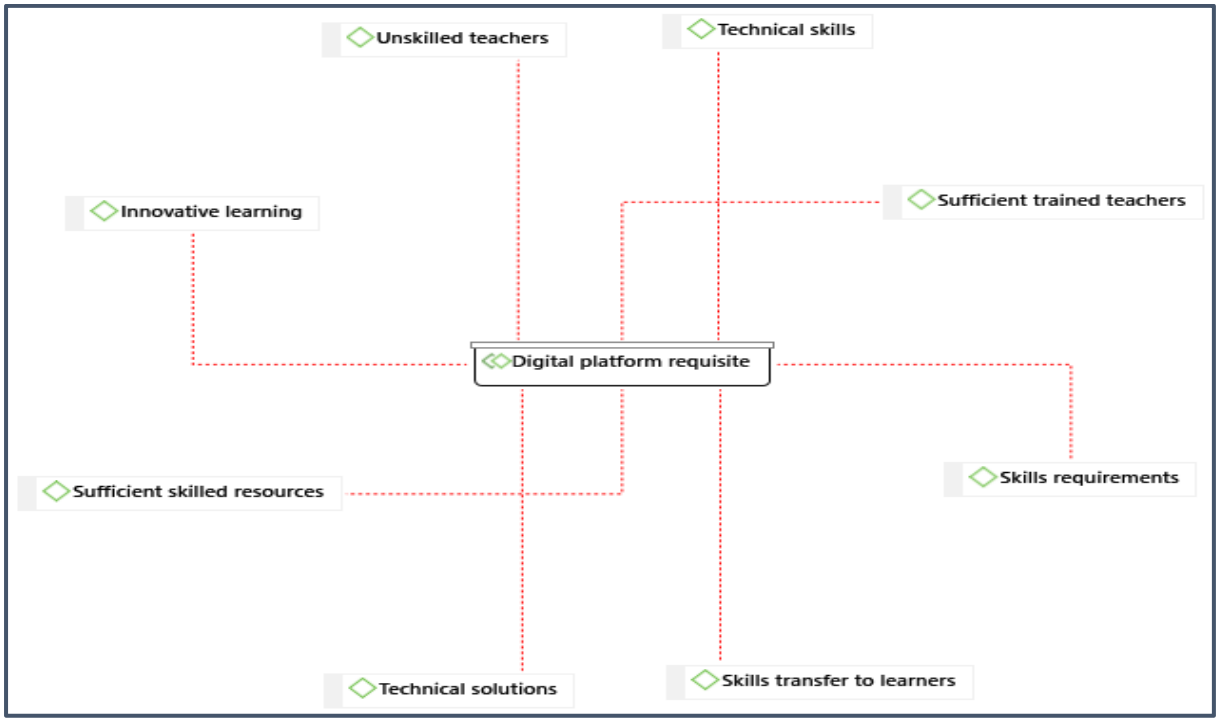


Figure 5.13: Network diagram — Digital platform requisite theme and codes

The data presented in the tables in this section represent the responses from the teachers in relation to the System component under the Digital platform requisite theme. In this section the factors are segmented into different tables (Table 5.19 - Table 5.23) related to system component Digital platform requisite theme, with the aim of presenting data per factor in the discussion of the questionnaire results.

Table 5.19: System Component — Factor Technological skills

Subcomponents (Factors)	Codes linked to: Digital platform theme	Teachers' feedback
C3.1 Technological skills	Technical skills	"4th Industrial revolution technology is on the way, more training for all the teachers is required." "Teachers must be free and have no fear of technology." "They should know the basic principle of using the tablet." "If I have a technical problem I should log a call for it." "Any technical issues must be referred."

Table 5.19 presents the factor Technological skills, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers approximately ninety-six percent (96%) (->) either strongly agreed (10) or agreed (16) that teachers should know how to operate the technologies for teaching and learning purposes. One hundred percent (100%) (->) either strongly agreed (11) or agreed (16) that the issue of technophobia needs to be addressed. Ninety-two percent (92%) (->) either strongly agreed (16) or agreed (9) that teachers need to know how to operate the technologies for administration and research purposes.

Teachers' feedback: Teachers agreed that technological skills are required to operate the technologies in their teaching, administration and research activities. This aligned with the findings in the literature review. Mbebe (2017) argued that to be relevant to the current generation, the world of technology and technological skills are essential. Teachers in resource constrained environments are eager to use technologies in the classrooms for teaching and learning, but they lack technological skills (Botha & Herselman, 2016). ***Teacher-4*** agrees with Botha and Herselman's (2016) statement saying that *"4th Industrial revolution technology is on the way, more training for all the teachers is required"*. Based on the results, it can be concluded that the factor ***Technological skills*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.20: System Component — Factor Critical thinking

Subcomponents (Factors)	Codes linked to: Digital platform theme	Teachers' feedback
C3.2 Critical thinking	Innovative learning	"Critical thinking is required." "Expected to transfer skills to the learners." "Teaching is transfer of skills, therefore it is expected."

Table 5.20 presents the factor Critical thinking, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about ninety-two percent (92%) (->) either strongly agreed (12) or agreed (13) that teachers need critical thinking skills to use the technologies. One hundred percent (100%) (->) either strongly agreed (17) or agreed (10) that teachers are expected to understand how the technologies operate. Ninety-six percent (96%) (->) either strongly agreed (12) or agreed (14) that teachers are expected to transfer the technologies skills to learners.

Teachers' feedback: Teacher-24 agreed that *"[c]ritical thinking is required".* Teachers agree that they require critical thinking skills, and that they should be able to transfer technological skills to learners. This aligns with the findings in the literature review. According to Mabila, Herselman and Van Biljon, 2016 (2016), teachers are required to assist learners with becoming competent in the use of technology and are expected to transfer skills such as critical thinking skills to learners. Based on the results, it is evident that the factor ***Critical thinking*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.21: System Component — Factor Problem solving

Subcomponents (Factors)	Codes linked to: Digital platform theme	Teachers' feedback
C3.3 Problem solving	Providing solutions to learning, Technical solutions	"Teachers need skills to learn to work on technical tasks in teaching." "Problem solving skills in maths, to add etc." "Teachers need training not problem-solving skills." "Teachers are not technician." "CSIR and the university should fix it." "They must be given technician contacts."

Table 5.21 presents the factor Problem solving, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers about seventy-eight percent (78%) (->) either strongly agreed (9) or agreed (12) that they should have problem-solving skills in order to use the technologies. Seventy-five percent (75%) either strongly agreed (10) or agreed (10) that teachers should have solutions if the technologies become dysfunctional. Fifty-six percent (56%) (->) disagreed (15) that they should have problem-solving skills to work on technical tasks in teaching.

Teachers' feedback: The findings align with the literature review. Hlagala (2015) argued that mobile technologies skills comprise demanding skills such as problem-solving skills, and teachers are expected to have problem-solving skills (Mabila, Herselman & Van Biljon, 2016). Although teachers agreed that problem-solving skills are a necessity, they had a different opinion on who should provide technical solutions for the technologies. ***Teacher-9*** was of the strong opinion that *"[t]eachers are not technicians"* and ***Teacher-6*** suggested that *"[t]hey must be given technician contacts"* in case they encounter technical glitches. Based on the feedback it is evident that the factor ***Problem solving*** is a requirement but does not have an influence on the technical aspects of the technologies, as teachers felt other departments should handle the technical issues.

Table 5.22: System Component — Factor Creativity

Subcomponents (Factors)	Codes linked to: Digital platform theme	Teachers' feedback
C3.4 Creativity	Innovative learning	"Teachers must be creative when using tablets." "Required to think creative in order to apply knowledge." "They should be creative and have innovative solutions."

Table 5.22 presents the factor Creativity**,** codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers one hundred percent (100%) (->) either strongly agreed (8) or agreed (19) that creative skills are required to apply knowledge when using technologies. Ninety-two percent (92%) (->) either strongly agreed (5) or agreed (20) that teachers need to be innovative when using the technologies.

Teachers' feedback: According to Payton and Hauge (2010), technological skills such as creativity enable one to think creatively and innovatively about technology. ***Teacher-19*** agreed with Payton and Hauge's (2010) claim, saying that *"[t]eachers must be creative when using tablets"*. ***Teacher-15*** also agreed that teachers are *"[r]equired to think creative in order to apply knowledge"*, while ***Teacher-7*** took this further and indicated that instead of just being creative teachers should also have *"[i]nnovative solutions"*. Based on the feedback it can be concluded that the factor ***Creativity*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.23: System Component — Factor Qualified teachers

Subcomponents (Factors)	Codes linked to: Digital platform theme	Teachers' feedback
C3.5 Qualified teachers	Sufficient trained teachers, Insufficient skilled resources, Skills requirements, Unskilled teachers	"Teachers require training; development is important to accelerate the use of tablets." "Few educators trained." "Inadequate number of teachers to teach learners using tablets." "Many unskilled teachers." "Without knowledge or skills you cannot deliver an effective lesson."

Table 5.23 presents the factor Qualified teachers**,** codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.10, out of twenty-seven teachers approximately eighty-nine percent (89%) (->) either strongly agreed (10) or agreed (14) that there are not enough teachers to teach learners using technologies. Ninety-two percent (92%) (->) either strongly agreed (13) or agreed (12) that teachers require training to use technologies in teaching and learning at school. One hundred percent (100%) (->) either strongly agreed (10) or agreed (17) that teachers' professional development is important to accelerate the use of technologies at schools.

Teachers' feedback: Teacher-1 said that *"[d]evelopment is important to accelerate the use of tablets".* The results align with the findings in the literature review. According to Mabila (2017), there is a shortage of qualified and experienced teachers trained to conduct teaching using technology. South Africa's education system faces challenges in developing skilled and qualified teachers (Chisholm, 2011). ***Teacher-13*** agreed with Chisholm's (2011) statement

saying that there are *"[m]any unskilled teachers"*. Based on the feedback it can be concluded that the factor ***Qualified teachers*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.14.

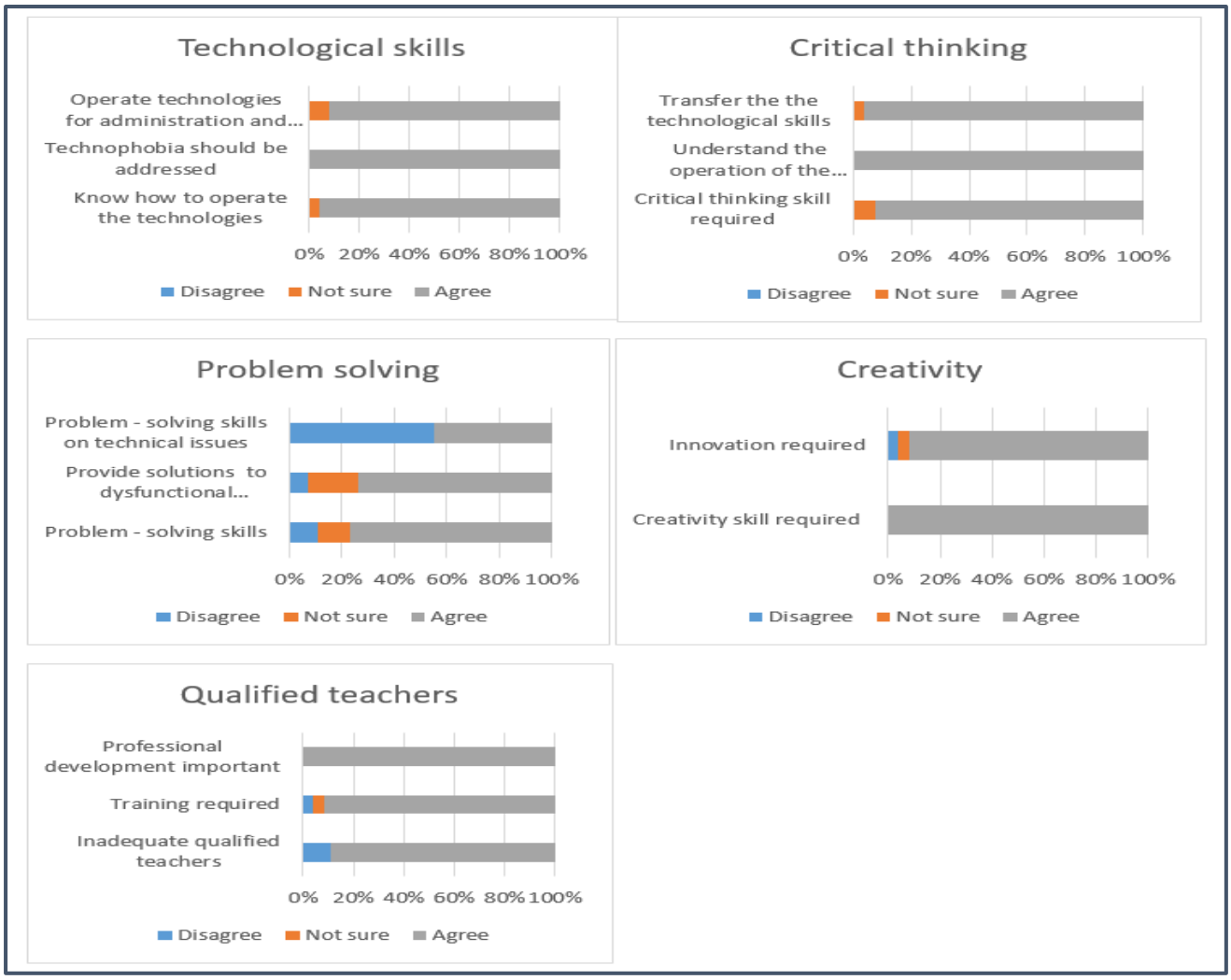


Figure 5.14: System component outcome (3)

Teachers need to have the technological skills for administration and research purposes. Issues of technophobia need to be addressed, and most teachers acknowledged that they do know how to operate the technologies. Critical thinking and creative skills are necessary and will assist with transferring skills to the learners. It is also clear that a level of innovative skill is also necessary when using mobile technologies. Although problem-solving skills are good to have in teaching, teachers felt that these are not a necessity when it comes to resolving technical

issues. Teachers expect the ICT personnel or support team to take care of any technical glitches experienced with the technologies and do not think teachers need to have the problem-solving skills to resolve technical problems. There is an inadequate number of teachers who are qualified to use the technologies at schools. More skilled teachers are required.

The following section focusses on the data analysis for the Context component.

5.3.4 Context component: School

This section focusses on the Context component, which is presented in the questionnaire in Section D as highlighted in section 5.3.1. Table 5.24 shows the responses from the teachers indicating the factors that may have an influence on their user experience when using the mobile technologies at schools in resource constrained environments. These factors specifically concern the **Context component**. The first column shows the factors' characteristics interconnected with the subcomponents which were used to compile the questionnaire. The next four columns show the responses from the teachers, indicating whether they agreed or disagreed that the factors may have an influence on their user experience when using the mobile technologies at schools. The value of ***N*** represents the number of teachers, who either agreed or disagreed with the identified components and factors. The highest number of responses represents the majority of the teachers' feedback or responses.

Table 5.24: Summary of the teachers' feedback on Context component and factors

Factors (characteristics) that may have an influence on the UX for teachers	**Strongly Agree**	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
D1.1.1. The *environment where the teaching and learning takes place* might have an influence on the teachers' experience of using the tablets.	**(*N=12*)**	**(*N=10*)**	**(*N=3*)**	**(*N=1*)**	**(*N=1*)**
D1.1.2 *Availability of technology support is important* in resource constrained environments (rural schools).	**(*N=17*)**	**(*N=8*)**	**(*N=1*)**	**(*N=1*)**	**(*N=0*)**
D1.1.3 We *do not experience any problems* when using the tablets in our school**.**	**(*N=2*)**	**(*N=3*)**	**(*N=2*)**	**(*N=15*)**	**(*N=5*)**
D1.1.4 *Poor environment* may result in poor experience when using tablets at schools.	**(*N=9*)**	**(*N=10*)**	**(*N=1*)**	**(*N=6*)**	**(*N=1*)**
D1.1.5 *The environment* where teaching and learning is happening is important.	**(*N=15*)**	**(*N=10*)**	**(*N=1*)**	**(*N=1*)**	**(*N=0*)**
D1.2.1 The *opinion of other teachers* on how their colleagues (teachers) should operate the tablets may influence the experience of the teacher.	**(*N=4*)**	**(*N=15*)**	**(*N=6*)**	**(*N=1*)**	**(*N=1*)**

Factors (characteristics) that may have an influence on the UX for teachers	**Strongly Agree**	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
D1.2.2 I operate the tablet freely without the *intervention* of my colleagues.	***(N=7)***	***(N=15)***	***(N=2)***	***(N=2)***	***(N=1)***
D1.2.3 The *instructions* from school governing body or principal on how the tablets should be used by the teachers may influence the teacher's experience of using the tablet.	***(N=9)***	***(N=11)***	***(N=3)***	***(N=4)***	***(N=0)***
D1.2.4 The *beliefs* of other teachers about the tablets do not influence my experience with the tablet.	***(N=10)***	***(N=12)***	***(N=2)***	***(N=2)***	***(N=1)***
D1.2.5 Our *school culture* does influence the use of tablets in teaching and learning in my school.	***(N=7)***	***(N=12)***	***(N=4)***	***(N=4)***	***(N=0)***
D1.3.1 *Multitasking* when using a tablet may affect the concentration of the teachers.	***(N=2)***	***(N=8)***	***(N=1)***	***(N=14)***	***(N=2)***
D1.3.2 Lack of educational resources such as instructions on how to *perform a task* using a tablet, may influence the teachers' experience.	***(N=8)***	***(N=13)***	***(N=1)***	***(N=5)***	***(N=0)***
D1.3.3 The *focus* of the teacher when giving tasks using the tablet is important.	***(N=9)***	***(N=17)***	***(N=0)***	***(N=1)***	***(N=0)***
D1.4.1 The *availability* of Information Communication Technology (ICT) *services* at schools is important when using tablets.	***(N=11)***	***(N=15)***	***(N=1)***	***(N=0)***	***(N=0)***
D1.4.2 Teachers at my school are *able to connect* to the Internet anytime using the tablets.	***(N=4)***	***(N=10)***	***(N=2)***	***(N=8)***	***(N=3)***
D1.4.3 The tablets *operate well* at our schools.	***(N=6)***	***(N=18)***	***(N=1)***	***(N=1)***	***(N=1)***
D1.4.4 *Availability of network coverage* at schools is important when using the tablets.	***(N=13)***	***(N=12)***	***(N=1)***	***(N=1)***	***(N=0)***
D2.1.1 The lack of *policy implementation* may have an influence on the use of tablets (technologies) at schools.	***(N=7)***	***(N=13)***	***(N=1)***	***(N=3)***	***(N=3)***
D2.1.2 There are *proper policies* that govern the use of tablets at our school.	***(N=5)***	***(N=14)***	***(N=3)***	***(N=3)***	***(N=2)***
D2.1.3 *Improper implementation* of the Information Communication Technology (ICT) frameworks may have an impact on the adoption of mobile technologies at schools.	***(N=11)***	***(N=13)***	***(N=1)***	***(N=1)***	***(N=1)***
D2.2.1 The *skills of teachers* in ICT are important to bring transformation and use of tablets at schools.	***(N=11)***	***(N=13)***	***(N=0)***	***(N=2)***	***(N=1)***
D2.2.2 We have *enough trained* teachers to support teaching and learning using tablets in my school.	***(N=6)***	***(N=11)***	***(N=2)***	***(N=6)***	***(N=2)***
D2.2.3 *Training is required* to ensure the adoption and implementation of tablets at schools.	***(N=9)***	***(N=17)***	***(N=0)***	***(N=1)***	***(N=0)***
D2.2.4 Teacher's *readiness to adopt* the use of tablets at school may influence the use of tablets at schools.	***(N=10)***	***(N=15)***	***(N=2)***	***(N=0)***	***(N=0)***

Factors (characteristics) that may have an influence on the UX for teachers	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
D2.2.5 Teacher's *competence* in ICT skills is imperative when using tablets for teaching and learning.	***(N=6)***	***(N=20)***	***(N=1)***	***(N=0)***	***(N=0)***

The data analysis and results presented in Table 5.24 are discussed in sections 5.3.4.1 and 5.3.4.2, where tables are segmented per factor. For the purposes of analysis it must be noted that two themes were generated to present the Context component data. These are the themes that were used to develop the network diagrams. Section 2.2.2 discussed how the themes, network diagrams and codes were formulated in this study. Two network diagrams, Environmental settings theme and Digital literate and policies theme and their codes were developed using the Atlas.ti tool, as discussed in section 5.2.2. This section will present and analyse the data of the two themes. Figure 5.15 presents the Environmental settings theme and Figure 5.17 presents the Digital literate and policies theme with the intention of assessing the factors of the Context component that may influence the use of mobile technologies in rural schools. To present the relations that connect the questionnaire to the data analysis the Environmental settings theme links to -> **D1. Context** and Digital literate and policies theme links to -> **D2. ICT integration at schools.**

5.3.4.1 Response on Context component – Environmental settings theme

Literature evidence: There is an assumption that the environment in which the interaction between the user (teacher) and the system (technologies) takes place is very important. Deegan and Rothwell (2010) emphasised that the deepest concern when the user interacts with the system is the context where the interaction is happening. It was stated in the literature review that the context where the interaction takes place is very important and may have an influence on the UX of the user. Jumisko-Pyykkö and Vainio (2010) identified different contexts of use, namely: physical, social, task and technical context (section 3.2.3). Factors such as physical context, social context, task context and technical context form the environmental setting theme.

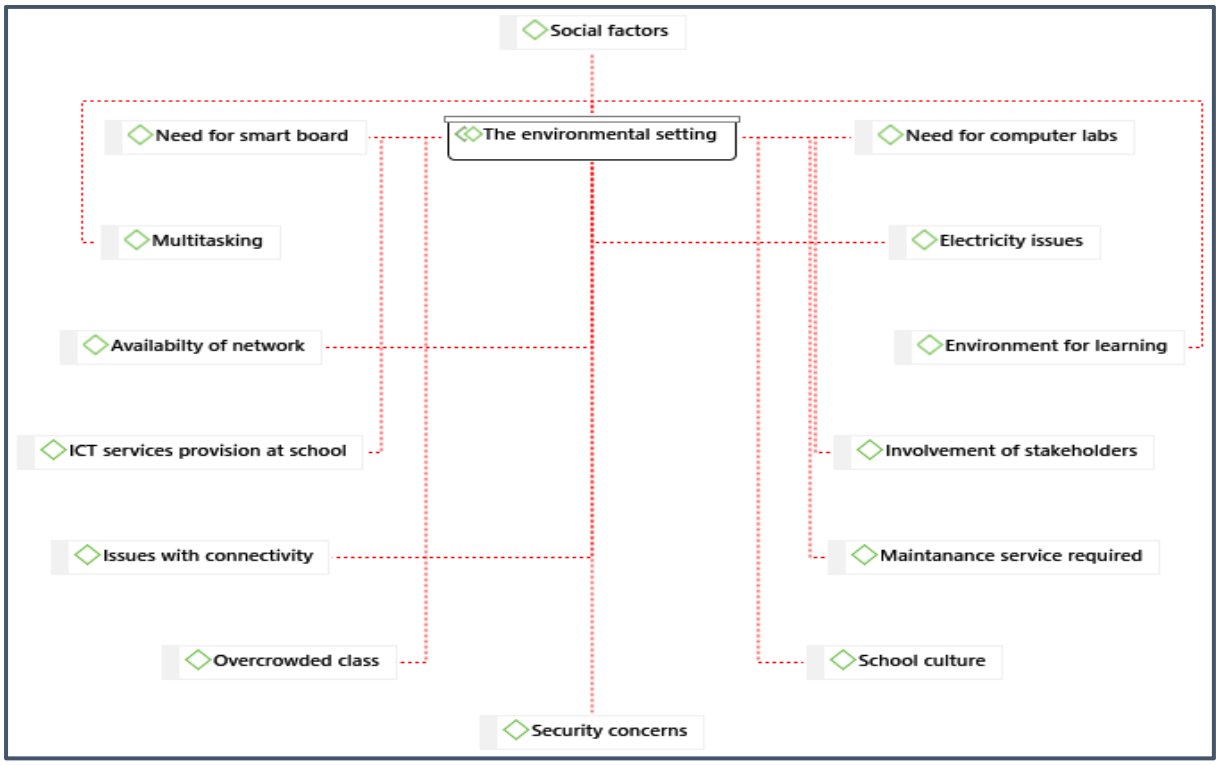


Figure 5.15: Network diagram — Environmental settings theme and codes

The data in the tables presented in this section represents the responses from the teachers in relation to the Context component under the theme: Environmental settings theme. In this section the factors are segmented into different tables (Table 5.25 - Table 5.28) related to the Context component: Environmental settings theme, with the aim of presenting data per factor in the discussion of the questionnaire results.

Table 5.25: Context component — Factor Physical context

Subcomponents (Factors)	Codes linked to: Environmental settings theme	Teachers' feedback
D1.1 Physical context	Environmental learning, Availability of network, Needs for computer labs, Overcrowded class, Security concerns	"Poor environment result in poor experience in using the tablets at schools." "Environment should be well established for technology." "Network is not enough." "We don't have rooms or labs to use the

Subcomponents (Factors)	Codes linked to: Environmental settings theme	Teachers' feedback
		tablets." "Overcrowding is a challenge." "Crime is problem." "The problem is our tablets were stolen."

Table 5.25 presents the factor Physical context, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers about eight-one percent (81%) (->) either strongly agreed (12) or agreed (10) that the environment where learning and teaching using the technologies took place had an influence on the teachers' experience. Seventy percent (70%) (->) either strongly agreed (9) or agreed (10) that poor environment may result in poor experience in the use of technologies at schools. Ninety-two percent (92%) (->) either strongly agreed (15) or agreed (10) that the environment where teaching and learning is happening is important.

Teachers' feedback: According to the results, there is evidence that environment is an important factor. ***Teacher-19*** said that *"[p]oor environment result in poor experience in using the tablets at schools",* and ***Teacher-26*** added that *"[e]nvironment should be well established for technology".* This aligned with the findings in the literature review. Mashapa (2013) argued that physical context has an influence on the UX. Ouma (2013) describes physical context as the constraints within the environment where the mobile technologies are operating. Other limitations include the weather and noise where the interaction occurs. There were other concerns that teachers raised in their comments, which will be discussed extensively in the data interpretation in section 5.4. Nonetheless, the feedback shows that the factor ***Physical context*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.26: Context component — Factor Social context

Subcomponent (Factors)	Codes linked to: Environmental settings theme	Teachers' feedback
D1.2 Social context	Involvement of stakeholders, Social factors, school culture	"The opinion and instructions from all stake holders' influence teachers experience." "Their opinions may affect how we should work at school." "Instructions must be done in a right way not to discourage teachers and learners." "Beliefs of other teachers about the tablets influence my experience." "School culture influences the use of tablets."

Table 5.26 presents the factor Social context, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers about seventy percent (70%) (->) either strongly agreed (4) or agreed (15) that the opinion of others (colleagues) on how to use the technologies had an influence on their experiences. Seventy-four percent (74%) (->) either strongly agreed (9) or agreed (11) that instructions from the school governing body and/or principals on how the technologies should be used may influence their experience in the use of the technologies. Seventy percent (70%) (->) either strongly agreed (7) or agreed (12) that the culture of their schools does have an influence on the use of technologies.

Teachers' feedback: The teacher's feedback aligned with Arhippainen's (2009) study that showed that the presence of other people and their opinions during the interaction has an impact on how the user responds to the system and can influence the UX. For example, ***Teacher-19*** indicated that *"[t]he opinion and instructions from all stakeholders' influence teachers experience"*. The involvement of school principals and/or the school governing body on the use of technologies, culture of the school and the attitude of the school towards the use of mobile technologies in teaching and learning has an impact on the UX (De Kock, 2017; Ouma, 2013). Based on the feedback it can be concluded that the factor ***Social context*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.27: Context component — Factor Task context

Subcomponent (Factors)	Codes linked to: Environmental settings theme	Teachers' feedback
D1.3 Task context	Tasks performance, multitasking, Tasks instructions	"Many apps can be offered at once, one can assess and prepare lesson at ease." "Instructions are important to for effectively using and assist not to waste time." "Teachers trained to multitask" "teachers may not know how to do a task, which will lead to ineffective learning" "Teacher should be able to deal with multiple tasks."

Table 5.27 presents the factor Task context, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers approximately fifty-nine (59%) (->) either disagreed (14) or strongly disagreed (2) that multitasking has an influence and may negatively affect concentration. Teachers believed that they are capable of multitasking, and do not think that the characteristic of Task context: ***Multitasking*** has an influence. Ninety-six percent (96%) (->) either strongly agreed (9) or agreed (17) that the focus of the teacher when giving tasks using the technologies is important.

Teachers' feedback: According to ***Teacher-23,*** *"[t]eacher should be able to deal with multiple tasks".* The results show that ***Multitasking*** does not interrupt their tasks, as they are used to multitasking in their teaching. For example, ***Teacher-13*** said that *"teachers trained to multitask"*. In the literature review Jumisko-Pyykkö and Vainio (2010) refer to other tasks that the user may be involved in, which in relation to the task of interacting with the mobile technologies, results in multitasking, interruption and task domain. The results show that the focus of the teacher when giving tasks using the technologies is important. This aligns with Ouma's (2013) study, cited in the literature review, which argued that the focus is on the task that the user performs and the targeted goals involved when finishing the task. Based on the feedback it can be concluded that the characteristic of factor ***Task context: Multitasking*** does not have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.28: Context component — Factor Technical and information context

Subcomponent (Factors)	Codes linked to: Environmental settings theme	Teachers' feedback
D1.4 Technical and information context	Issues with connectivity, Electricity issues, ICT services provision at school, Insufficient tablets, Maintenance service required, Needs for smart boards	"Very difficult to connect to the internet, poor network." "Some gadgets need other things, e.g. electricity." "Sometimes there's no network, very difficult to connect to the internet." "ICT must provide with service." "There should be technician for tablets." "Tablets are not enough at school." "Sometimes it needs full maintenance." "The school should also have smartboard."

Table 5.28 presents the factor Technical and information context, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers approximately ninety-six percent (96%) (->) either strongly agreed (11) or agreed (15) that the availability of ICT services at schools using technologies is important. Ninety-two percent (92%) (->) either strongly agreed (13) or agreed (12) that the coverage of networks at schools using technologies is important. Eighty-nine percent (89%) (->) either strongly agreed (6) or agreed (18) that the technologies they have at their schools are operating well.

Teachers' feedback: The results show that teachers agreed that the availability of ICT resources had an impact, which aligns with the findings in the literature review. According to Ouma (2013), the school's infrastructure including the availability of services, hardware, software and network at all times is vital, especially in the ICT environment as users rely on all the related factors. For example, ***Teacher-27*** specified that "*ICT must provide with service*" and ***Teacher-22*** asked for "... *smartboards*". However, there were concerns that the technologies are not enough. Issues were raised concerning connectivity and technologies

maintenance, which will be discussed in section 5.4. Based on the feedback it can be concluded that the factor ***Technical and information context*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.16.

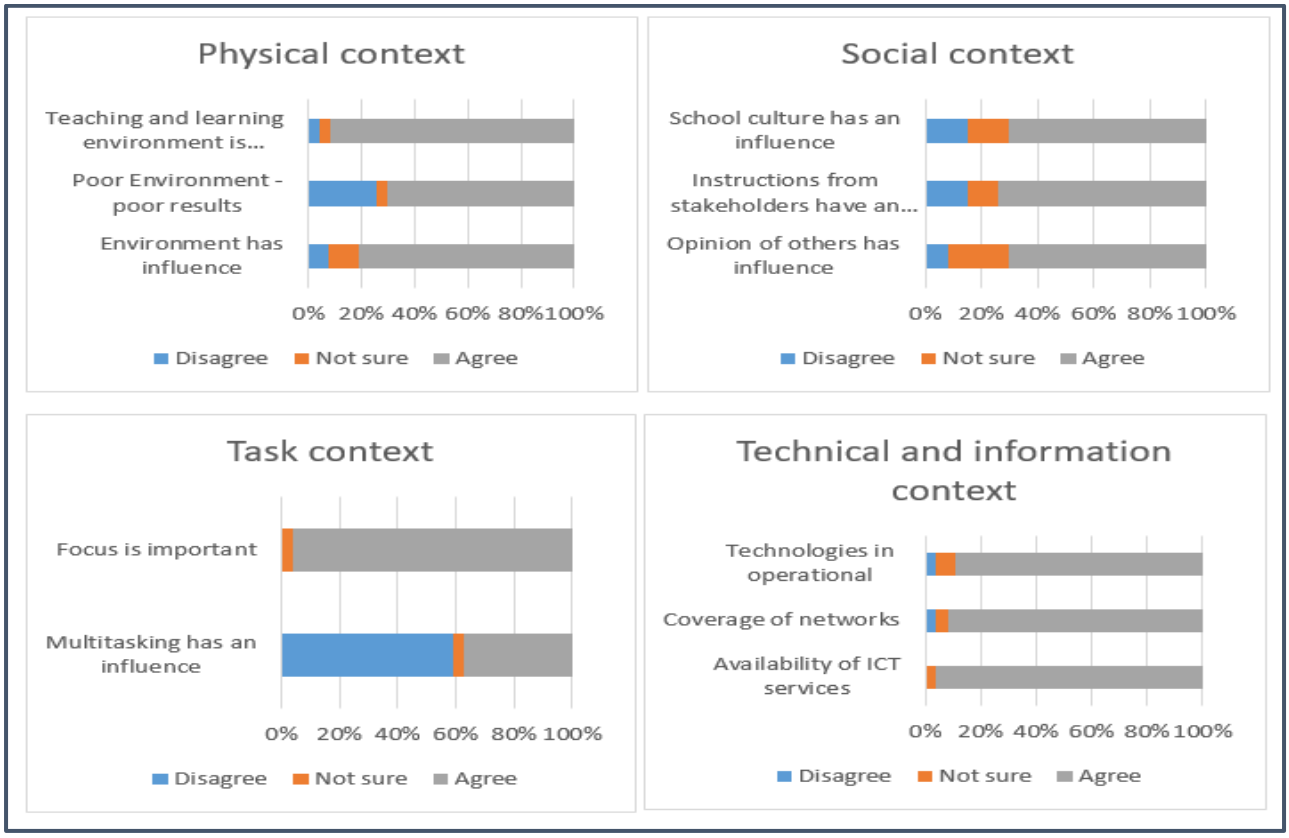


Figure 5.16: Context component outcome (1)

Teachers require a proper environment to deliver teaching and learning using the technologies, and they think computer labs should be provided. Poor connectivity at schools is the biggest challenge in all three of the provinces, as well as the large number of learners in each classroom. The involvement of principals, the school governing body and colleagues affects the experience of teachers. School culture was also identified as contributing to the use of technologies at schools. Teachers can multitask without influencing the use of mobile technologies, yet focus is very important when using the technologies. Teachers expressed their frustration with the inadequate technologies at school, and the lack of support from ICT with the overall ICT infrastructure.

The following section focusses on the data analysis for the second part of the Context component.

5.3.4.2 Response on Context component — Digital literate and policies theme

Literature evidence: Although mobile technologies are not a primary tool used to conduct teaching and learning, they should be used to support (education) teaching and learning (Meyer & Gent, 2016). It is, therefore, important that educational policies be put in place where part of the implementation includes training for educators, and ICT adoption and integration at schools (Donohue & Bornman, 2014). If the use of technology is to be achieved in rural environments, teachers need to be trained and have the skills to be able to use the technologies in teaching and learning at schools. There is, however, a shortage of skilled teachers who can deliver teaching using technology (Mabila, 2017). Factors such as Policy Implementation and Training form the Digital literate and policies theme.

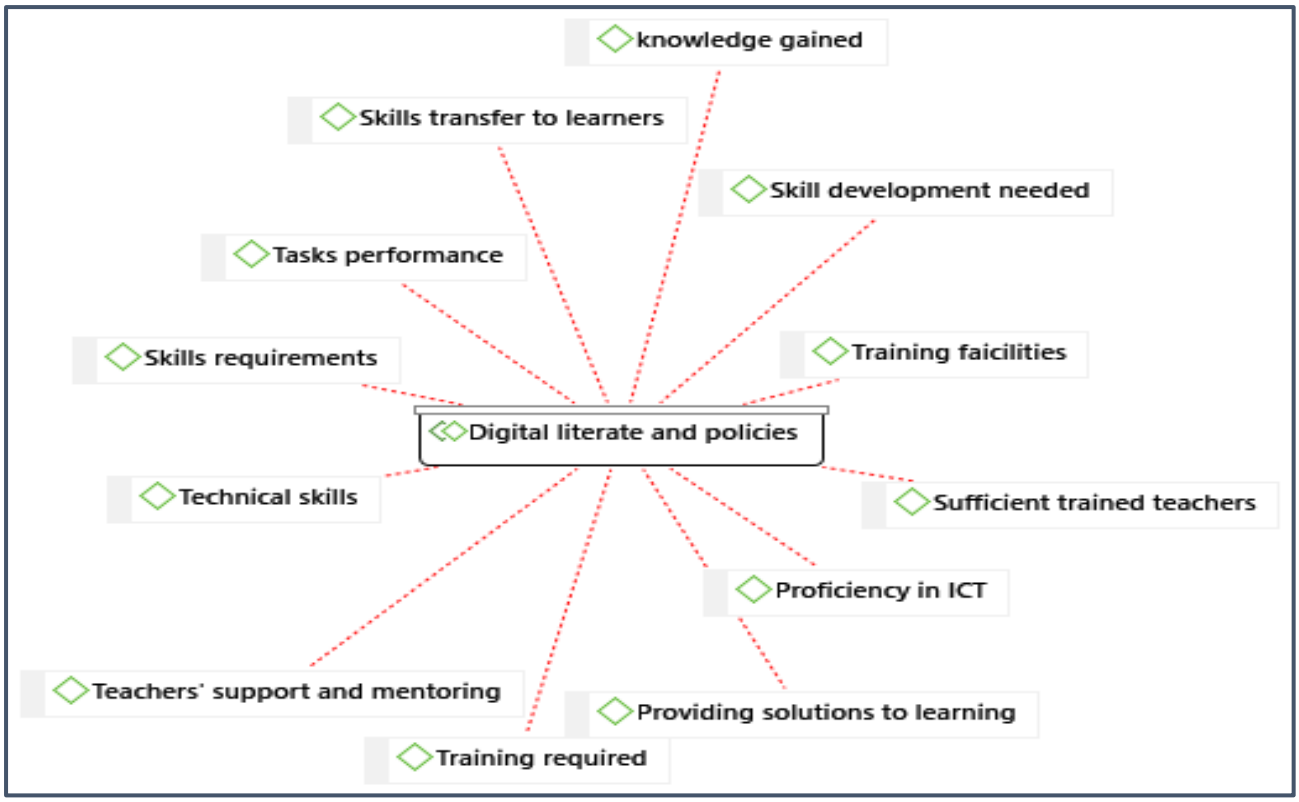


Figure 5.17: Network diagram — Digital literate and policies theme and codes

The data presented in the tables in this section represents the responses from the teachers in relation to the Context component under the theme: Digital literate and policies theme. In this section the factors are segmented into different tables (Table 5.29 - Table 5.30) related to Context component Digital literate and policies theme, with the aim of presenting data per factor in the discussion of the questionnaire results.

Table 5.29: Context component — Factor Policy implementation

Subcomponents (Factors)	Codes linked to: Digital literate and policies theme	Teachers' feedback
D2.1 Policy implementation	Policy for using tablets at schools	"Improper implementation of ICT may influence adoption and usage of technology." "Most people are not informed about such policies." "Policy needs to be reviewed; they need to be amended." "Some policies work against tablets."

Table 5.29 presents the factor Policy implementation, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers approximately seventy-four percent (74%) (->) either strongly agreed (7) or agreed (13) that a lack of policies may influence the experience of the use of technologies at schools. Eighty-nine percent (89%) (->) either strongly agreed (11) or agreed (13) that improper implementation of ICT frameworks may influence the experience of the use of technologies in school.

Teachers' feedback: According to Donohue and Bornman (2014), most countries are failing to put educational policies into practice. Part of the implementation of these policies is the training of educators, and ICT adoption and integration at schools (Mamba & Isabirye, 2015). ***Teacher-12*** agreed with Mamba and Isabirye (2015) saying that "*[s]ome policies work against tablets*". Based on the feedback it can be concluded that the factor ***Policy implementation*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

Table 5.30: Context component — Factor Training

Subcomponents (Factors)	Codes linked to: Digital literate and policies theme	Teachers' feedback
D2.2 Training	Training required, Proficiency in ICT, Knowledge gained, providing solutions to learning, Skill development needed, Skills transfer	"It must be introduced at the colleges or universities level so that when starting teaching they are already equipped with skills." "in

Subcomponents (Factors)	Codes linked to: Digital literate and policies theme	Teachers' feedback
	to learners, teachers support and mentoring, Training facilities.	order to use the gadgets more effectively." "Teachers' competence ICT skill is imperative" "Improving training facilities and ensuring and make sure there's proper mentoring."

Table 5.30 presents the factor Training, codes linked to the theme and teachers' feedback. Based on the Likert scale's summary feedback presented in Table 5.24, out of twenty-seven teachers approximately eighty-nine percent (89%) (->) either strongly agreed (11) or agreed (13) that the skills of teachers in ICT are important. Ninety-six percent (96%) (->) either strongly agreed (9) or agreed (17) that training for teachers using the tablet is required. Ten (10) teachers strongly agreed and (15) agreed that the readiness of the teachers to use the technologies may have an influence. Ninety-six percent (96%) (->) either strongly agreed (6) or agreed (20) that the competence of the teachers in ICT is important for the use of the technologies in schools.

Teachers' feedback: Training is required ("*in order to use the gadgets more effectively*", ***Teacher-4***). The results align with the literature review. Nkula and Krauss (2014) argued that the shortage of adequate skills in using technology at rural schools impacts the delivery of proper teaching and learning using the technologies. Teachers' ICT skills and competence are imperative in ensuring the use of technologies in the classroom (Mabila, 2017). ***Teacher-17*** agrees with Mabila (2017) saying that training "*[m]ust be introduced at the colleges or universities level so that when starting teaching they are already equipped with skills*". Based on the feedback it can be concluded that the factor ***Training*** does have an influence on the use of mobile technologies at schools in resource constrained environments.

The data presented in this section are summarised in Figure 5.18.

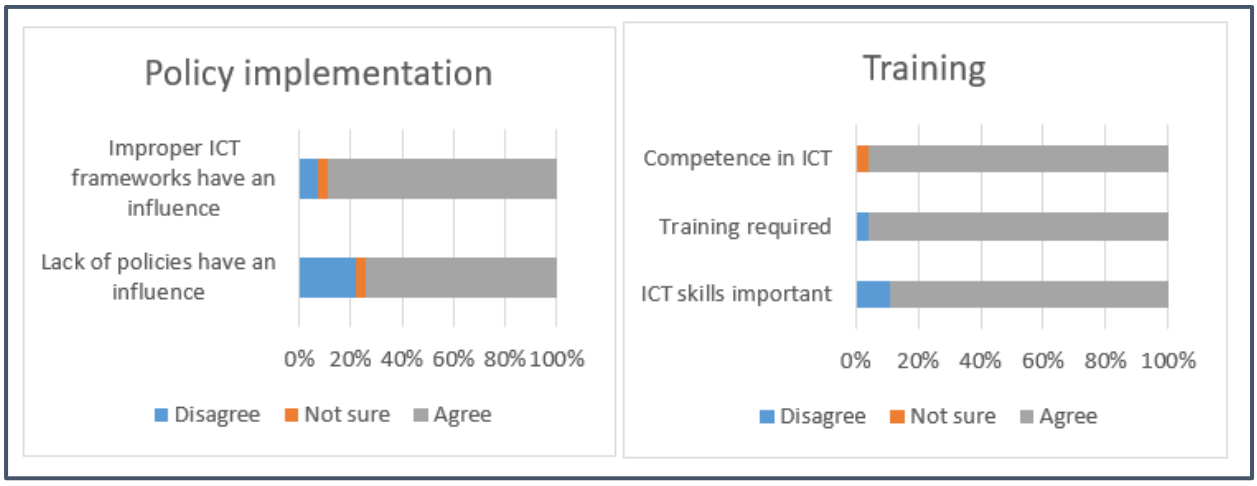


Figure 5.18: Context component outcome (2)

Improper implementation of policies and frameworks do affect the adoption and use of technologies at schools. Most teachers agreed that there needs to be training to fast tract the use of technologies at schools, and that unskilled teachers may influence the use of technologies at schools. Teachers proposed training facilities, and some indicated that the training should begin at the training colleges or universities. In other words, training should be added as a module to the teachers' training. The education department, school governing body and researchers should find solutions to problems associated with the use of the technologies at schools.

The following section discusses the findings of the data analysed in this chapter, the teachers' feedback is summarised, and possible solutions suggested by the teachers are outlined.

5.4 Findings of the study

The study made use of thematic data analysis, where themes and codes were compiled using a computer-based tool called Atlas.ti to analyse the collected data using functionalities such as memos, documents, codes, themes and network grouping. Network diagrams, generated using the tool, were presented, illustrating the links between the themes and codes extracted from the collected data. The network diagrams, the Likert scale data (grouped into components: User, System and Context) and the teachers' responses (segmented per component, per factor) were used to analyse data as presented in sections 5.3.2 to 5.3.4. Table 5.31 summarises the analysed data, showing the teachers reflections. Section 5.4.1 presents the teachers' proposed possible solutions and contributions to the study.

Table 5.31: Teachers' reflections

Components	Factors	Reflection from the teachers
B. User component User	B1.1 Needs	• Teachers need the technologies to be easy to use • Teachers need the technologies to improve performance in teaching • Teachers need the technologies to increase efficiency
	B1.2 Perception	• Teachers have a positive perception about the use of the technologies in schools • The technologies make teaching easy for teachers and increase efficiency • Technologies improve the IQ of the learners • Technologies bring confidence to teachers
	B1.3 Attitude	• Teachers have a positive attitude towards the use the technologies • Teachers have a positive attitude towards the acceptance of technologies at schools • Teachers are ready and comfortable with the use of technologies • Some of the elderly teachers are still comfortable with the old method of teaching and learning
	B1.4 Experience	• The experience of the teacher is important in the use of technologies at school • Age should not be used to decide whether to use technologies at school • Gender does not influence the use of technologies in teaching and learning • Teachers are required to obtain skills to use the technologies in teaching and learning
	B1.5 Expectations	• Teachers expect the mobile technologies to be user-friendly • Teachers expect the technologies to meet their expectations in teaching and learning • Teachers expect the technologies to reduce the workload • Teachers are satisfied with use of technologies at schools

Components	Factors	Reflection from the teachers
C. System component: Mobile technology	C1.1 Usability	• The technologies at school increase effectiveness, making teaching easy to present to the learners. • The use of technologies reduced the use of paper at schools, making learning easier • Teachers and learners find it easy to use the technologies • Some teachers find it difficult to use the technologies
	C1.2 Hedonic and Aesthetic attributes	• The appearance, visualisation and features of the technologies are important to the teachers • The technologies transform teaching, they have Apps that enhance learning • Teachers enjoy using the technologies
	C1.3 Functionality	• The Apps on the technologies are easily accessible • It is easy to navigate through the functions of the technologies • Errors encountered on the technologies make it difficult for teachers to enjoy using the technologies • The Apps on the technologies do not match the learning content, some are not relevant
	C2.1 Control and Ownership	• Teachers require privacy from the technologies • Teachers want to have individual passwords for confidentiality purposes • Teachers do not feel safe about sharing their technologies with their colleagues • A few of the teachers feel safe about sharing the technologies
	C2.2 Flexibility	• Teachers expect the technologies to be flexible, enabling them to work anywhere • Teachers expect the technologies to allow them to send homework via WhatsApp, or instant messaging tools • Teachers require technologies to have a long battery life-span • Teachers want portable technologies to be able to carry the technology around
	C2.3 Credibility	• Teachers expect the technologies to produce reliable information • Teachers require a self-monitoring tool

Components	Factors	Reflection from the teachers
		• Teachers want their information to be protected
	C2.4 Valuable	• Teachers feel that the technologies are adding value to the education system • Teachers feel that technologies encourage them to teach • Technologies are useful in teaching
	C2.5 Desirable	• Technologies should be attractive to use • Technologies are motivating, especially to learners • Technologies make learning interesting
	C3.1 Technological skills	• Teachers feel that if the technologies can be used daily, it would be easy to navigate through • Teachers feel they need to have the technological skills to operate the technologies • Any technical problems with the technologies should be referred to a technologies support department
	C3.2 Critical thinking	• Teachers think there is a need to have critical thinking skills to use the technologies • Teachers feel they need to be innovative to help learners grasp the concept
	C3.3 Problem solving	• Teachers think problem-solving skills are good to have but not a necessity to have when using technologies • Teachers expect the technologies to provide solutions to teaching • Teachers are not technicians, technical issues should be resolved by relevant personnel
	C3.4 Creativity	• Teachers need to be creative when using the technologies
	C3.5 Qualified teachers	• There is a shortage of skilled teachers using technologies in teaching and learning • Teachers require skills to have a good experience when using technologies at school
D. Context: School	D1.1 Physical context	• The environment where learning and teaching is taking place is very important • Poor environment will result in poor experience in using the technologies • The availability of networks at schools is important

Components	Factors	Reflection from the teachers
		• There is an issue with security, crime is a serious concern • Most classes are overcrowded making it difficult to conduct the lessons with learners • Teachers need to have computer labs, where they can use the technologies freely
	D1.2 Social context	• The opinion and beliefs of others about the use of technologies influence the experience of the other teachers • Involvement of stakeholders affects how the teachers should work • School culture influences the use of technologies • Principals, the school's governing body, departments and researchers need to come together and come up with solutions for the use of technologies at schools
	D1.3 Task context	• The focus of tasks does influence the use of the technologies • Teachers should perform tasks using the technologies • Teachers should be able to multitask while teaching, multitasking does not affect the use of technologies
	D1.4 Technical and information context	• There are insufficient technologies to use at schools • Connectivity is the biggest challenge in the use of technologies • Technicians are required to service and maintain the technologies • There is a need for smart boards at schools
	D2.1 Policy implementation	• Improper implementation policies and frameworks affect the adoption and use of technologies at schools • Teachers need to be informed of the policies that are in place
	D2.2 Training	• Training and training facilities are required to upskill the teachers • Skills development is required for teachers to transfer skills to learners • Teacher support and mentoring from the Department of Education is needed • The schools need proficient teachers to speed up the adoption of technologies at schools

Based on the analysis of the qualitative data collected from the teachers, it can be concluded that factors such as ***age*** and ***gender***, which were factors that were identified in the literature review, do not influence the user experience of the teachers. The ***problem-solving*** skill factor identified in the literature review is necessary to have, but does not have an influence on resolving the technical issues experienced with the technologies. Technical issues should be handled by the relevant department. The ***task context*** characteristic such as focus, which was identified in the literature review, is important to have but a characteristic such as ***multitasking*** does not affect the use of technologies in teaching and learning. Teachers believe that they are capable of multitasking without interrupting their teaching.

Factors such as ***desirable*** and ***creativity*** were considered to be duplicates. It emerged during the data analysis that the factors share the same characteristics with factors such as ***hedonic*** and ***critical thinking***. The hedonic factor inherited the characteristics pleasing and attractive from desirable, which was also incorporated into hedonic, and critical thinking inherited the characteristic innovative from creativity, which was also incorporated into critical thinking. As a result, desirable and creativity were discarded from the list of factors.

In the responses teachers included suggestions and possible solutions to some of the identified factors. The following section outlines the possible solutions and suggestions from the teachers.

Teacher's possible solutions and suggestions

Functionality factor: Teachers do enjoy working with mobile technologies, but they find some of the functions difficult to use. They expected the technologies to reduce their workload, not add to it. Teachers had concerns regarding the errors that they encountered when using the mobile technologies. They felt that it would be better if the mobile technologies had an error handling functionality. There were also concerns regarding the Apps that were loaded onto the mobile technologies. Teachers indicated that most of the Apps did not match the learning content, they found them to be irrelevant. The technical errors made it difficult for teachers to enjoy using the technologies.

Control and Ownership factor: Due to the inadequate number of technologies at schools, teachers are sharing the technologies. Therefore, teachers suggested that it would be useful to have their own username and password to access the technologies. This would prevent other colleagues invading their privacy. Teachers do not feel safe about sharing the technologies with their colleagues, as they want to save confidential information such as marks, research, and learners' confidential details onto the mobile devices.

Flexibility factor: For technology to be effective at schools, teachers indicated a need for technologies that will enable them to communicate with the learners while they are at home, using Apps similar to WhatsApp to communicate with them in a group. Teachers have a problem with the short life-span of the batteries in the mobile technologies. They stated that they need batteries that will operate long enough to avoid having to charge batteries in the middle of the lessons.

Credibility factor: Teachers expect to use mobile technologies that have reliable information uploaded onto them so that they do not teach invalid and/or irrelevant information to learners. They suggested that relevant content be loaded onto the technologies. As a result of the large number of learners in one classroom, teachers found it difficult to monitor whether their learners were opening the learning tasks. Teachers suggested that the technologies have a self-monitoring tool that will detect wrongful actions from learners using the mobile technologies in the classrooms. Teachers need to see what the leaners re doing.

Technological skills factor: According to teachers, they need to have the technological skills to operate the technologies. They suggested that the technologies should be used daily, which would help them navigate through the functions more easily and use it effectively.

Problem-solving skills factor: Teachers do not think that it is necessary for them to be involved in technical issues concerning the technologies. Should there be any issues with the technologies, these should be attended to by the support department where the issues can be fixed.

Physical context factor: Teachers raised concerns about crime at schools, and suggested that the technologies would be much safer if security could be prioritised before mobile technologies are delivered to schools. Most of the technologies in most of the schools were stolen, and replacing the technologies is a challenge for most schools. The overcrowding in the classrooms is also a concern as it makes it difficult for teachers to move around while teaching. Teachers suggested that computer labs should be made available where teachers will be able to move freely and be able to give attention to learners who are struggling to use the technologies.

Social context factor: The involvement of stakeholders affects the use of mobile technologies at schools. Teachers suggested that all the stakeholders including principals, the school's

governing body, departments and researchers need to come together and come up with solutions regarding the use of technologies at schools.

Technical and information context: There is concern about the limited number of mobile technologies that were delivered to schools. According to teachers, for mobile technologies to be used effectively at schools more technologies need to be made available so that they can be used daily. Teachers also suggested that smart boards should be introduced in the classrooms.

Training factor: Teachers are concerned about the low number of teachers who are trained in using the mobile technologies. They suggested that training and skills development programmes need to be put in place as part of planning for the use of technologies at schools. Teachers also suggested that there is a need for support and mentorship from the Department of Education.

Table 5.32 provides a summary of the suggested factors (characteristics) of UX. No new components or subcomponents (factors) were suggested by the participants (teachers).

Table 5.32: Summary of suggested UX factors

Factors	Suggested factors (characteristics) of UX
Functionality	• Technologies should have *error handling* functionality
	• The mobile technologies should have *relevant Apps* to match the learning content
Control and Ownership	• Technologies should enable *distinct credentials* for confidentiality purposes
Flexibility	• Technologies should have *instant messaging Apps*, to work from home • Technologies should have batteries that last longer (*battery's life-span*)
Credibility	• Technologies should have *self-monitoring Apps*
Physical context	• Schools require tight *security* to avoid theft of technologies • Schools should have *computer labs*
Social context	• Schools require the *involvement* of researchers, school governing body, departments to support the use of mobile technologies
Technological context	• Schools require *more tablets* (mobile technologies) • Schools require *technical support* • Schools need to have *smart boards*
Training	• Teachers require *support and mentorship* from DoE • *Training facilities* and *training programmes* should be provided

5.5 Summary of the chapter

This study used a qualitative method to collect data, and interpreted it using a thematic data analysis (Braun & Clarke, 2006; Clarke & Braun, 2013). The data was analysed using the computer-based tool Atlas.ti version 8.0. The data was transcribed verbatim into an Excel spreadsheet and Microsoft word document, and then uploaded to Atlas.ti where quotations, themes and codes were created to link with the data.

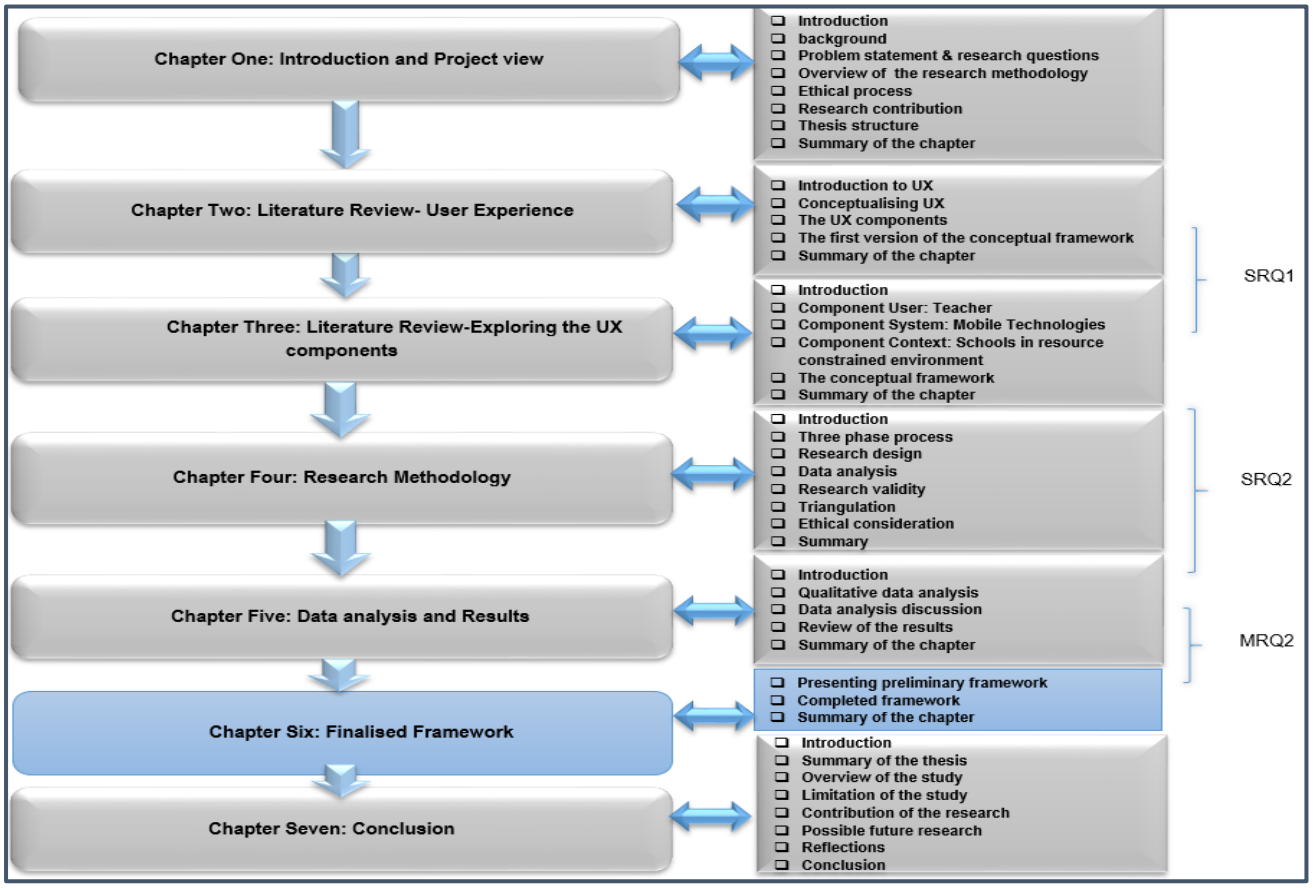
The network views were used to display the analysed data in a visual diagram, which presented the themes and codes. How the data was analysed was discussed in this chapter. Firstly, the biography of the participants was analysed. Then the data was divided into the three components — User, System and Context — and was analysed. Tables were segmented to display the comments or responses from the participants, showing a link to the factors and the codes.

Data was presented in data analysis bars to present the summary of the data, and results were interpreted. The teachers' summary reviews of the results were displayed in the form of summary tables showing the reflections of the participants, with the aim of answering research sub-question two. The findings of the study were discussed in this chapter along with the teachers' proposed solutions and suggestions. Factors and characteristics of factors that were identified as not having an influence were outlined in this chapter. The new characteristics of factors suggested by participants were discussed in the chapter and summarised in a table.

Based on the feedback from the teachers, it can be concluded that factors such as age and gender do not influence the user experience of the teachers. The problem-solving skills factor is necessary to have, but does not have an influence on resolving the technical issues experienced with the technologies. The task context characteristic focus is important to have, but characteristics such as multitasking do not affect the use of technologies in teaching and learning.

Factors such as critical thinking, and creativity shared the same characteristic: Innovative. Since critical thinking has other characteristics that influence the use of technology it inherited the innovative characteristic and creativity was removed. Factors such as desirable and hedonic share the same characteristics, including pleasing and attractive. Since hedonic has other characteristics that influence the use of technology it inherited the pleasing and attractive characteristics and the desirable factor was removed. The following chapter provides the review and the finalised framework.

6. CHAPTER SIX: FINALISED FRAMEWORK



6.1 Presenting initial framework

Section 3.5 discussed the construction of the conceptual framework for the User Experience of Teachers using Mobile Technologies in Resource Constrained Environments (UXFTMTR), which was derived from the literature review presented in Chapter Two and Chapter Three. It was specified in section 3.4 that the study adopted Arhippainen's (2003) framework, which demonstrated the Product-User-Interaction where the ***user*** interacts with the product ***(system)*** in a specific ***context***. Arhippainen's (2003) framework was adopted because it directly relates to the focus of this study, which is on *user's (teacher)* interaction with the *mobile technology* in the school *context*. Therefore, the conceptual framework and Arhippainen's (2003) framework were incorporated to form a preliminary framework depicted in Figure 6.1. The preliminary framework contributed to the development of the final framework for this study, which is discussed in section 6.2.

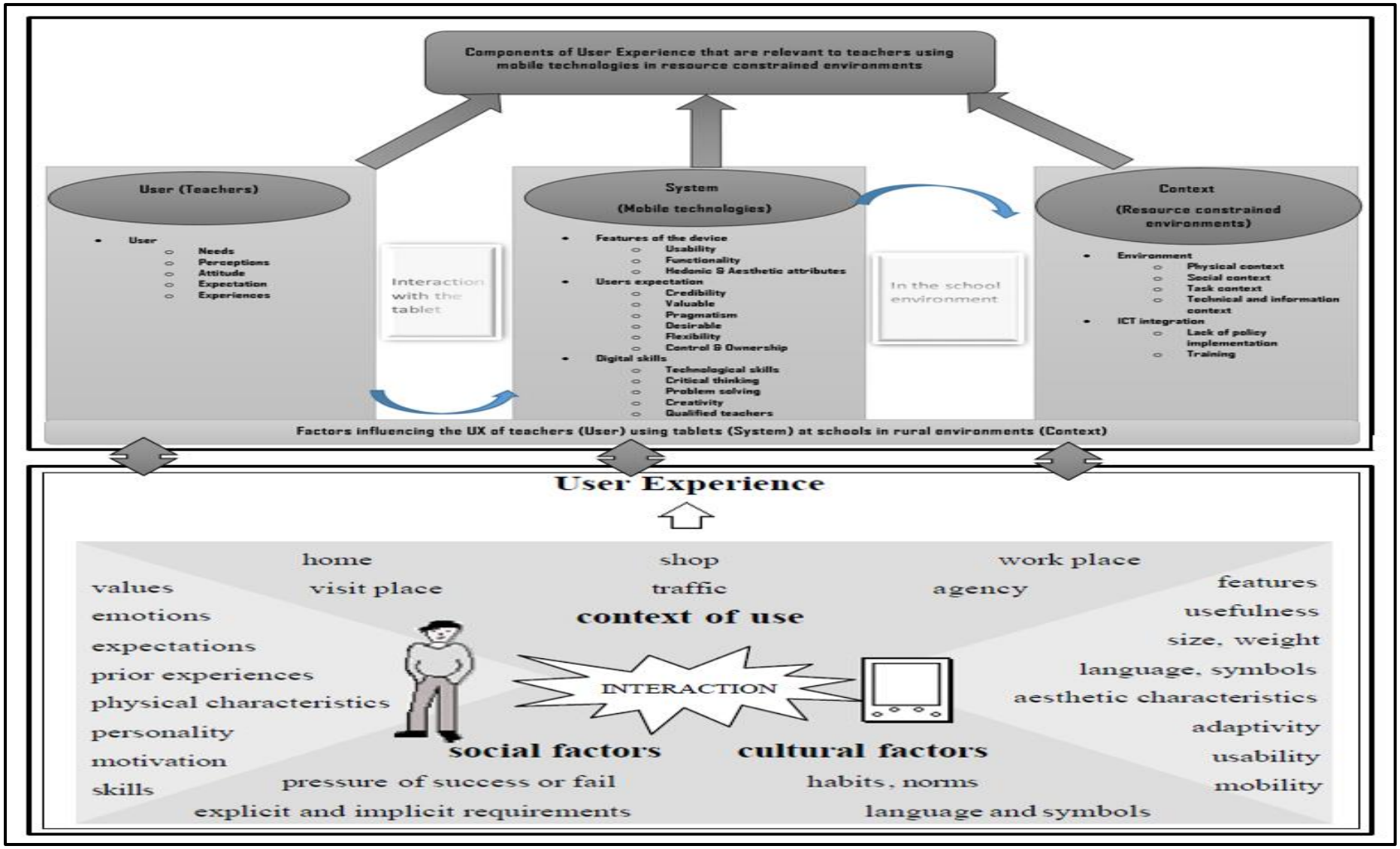


Figure 6.1: UXFTMTR preliminary framework

The UXFTMTR preliminary framework was formed using the conceptual framework, presented in section 3.5, with the aim of answering research sub-question one.

- **What are the components and factors of user experience that are relevant for teachers using mobile technologies in resource constrained environments?**

The conceptual framework was used to develop a qualitative questionnaire that was used to collect data with the aim of answering research sub-question two.

- **How is the user experience of the teacher reflected in the use of mobile technology for teaching in resource constrained environments?**

Research sub-question one presented three components: User, System and Context. For this study the components were expanded into:

- User: The teachers
- System: Mobile technologies
- Context: The rural schools

Table 6.1 shows the inclusion and exclusion of components and factors in the conceptual framework and the final framework, where symbol (X) indicates inclusion and symbol (-) indicates exclusion. The factors that are indicated as having been excluded on the table were not included in the final framework presented in section 6.2. These are factors that teachers felt were unnecessary because they did not have an influence on the UX of teachers using mobile technologies in resource constrained environments. Examples include problem-solving skills and Task context. Factors that were also excluded in the final framework include desirable and creativity. These factors were considered to be duplicates, as they are perceived to share the same characteristics with factors such as hedonic and critical thinking. The hedonic factor inherited the characteristics pleasing and attractive from desirable, which was also incorporated into hedonic, and critical thinking inherited the characteristic innovative from creativity, which was also incorporated into critical thinking. As a result, desirable and creativity were excluded from the final framework.

None of the components were excluded from the final framework, although some of the characteristics belonging to the factors were considered not to have an influence on the UX of teachers, and are, therefore, not discussed in this section. However, the participants did suggest new characteristics for the factors, which were presented in Table 5.32, and are discussed in section 6.2.

Table 6.1: Inclusion (X) and exclusion (-) of identified factors

Components	Subcomponents (Factors)	References and Literature Section	Factors Included/Excluded in Conceptual Framework	Factors Included/Excluded in Final Framework
User: Teachers	B1. User's prepossession • Needs • Perceptions • Attitude • Expectation • Experiences	(Mashapa, 2013) **3.2.1**; (Chan & Johansson, 2016) **3.3.3**; (Mashapa, 2013) **3.2.1**; (Mahlke, 2008) **2.2.3**; (Portugal, 2014) **3.2.1**	X	X
		(Roto et al. (2011) **2.2.3.2**; Maguire (2013) **2.2.3.2**; (Morville, 2004) **2.2.3.1.1**	X	X
		(Langenhoven, 2016) **2.2.2**; (ChanLin, 2017) **3.2.4**; (Chiu & Churchill, 2015) **3.3.2**	X	X
		(Botha & Herselman, 2017) **3.4.3**; Gentner et al. (2013) **2.2.3.2**; Tan (2009) **2.2.1**	X	X
		(Roto, 2006**) 1.2**; (Langenhoven, 2016) **1.2**; (Gentner et al., 2013) **2.2.3.2**	X	X
System: Mobile technologies	C1. Features of the device • Usability • Hedonic • Functionality-Efficiency	(Pretorius & Calitz, 2014) **2.2.2.1**; (Chan & Johansson, 2016) **3.2.2.1.2**; (Bidin & Ziden, 2013) **3.3.3**; (Bevan, 2009) **2.2.2**; (Petrie & Bevan, 2009) **2.2.2**	X	X
		(Gentner et.al, 2013) **2.2.3.2**;	X	X

Components	Subcomponents (Factors)	References and Literature Section	Factors Included/Excluded in Conceptual Framework	Factors Included/Excluded in Final Framework
		(Scapin et al., 2012) **2.2.3.2.1**		
		(Bidin & Ziden, 2013) **3.3.3**	X	X
	C2. Users expectation • Control & Ownership	(Bidin & Ziden, 2013) **3.3.3**	X	X
	• Flexibility	(Brown & Mbati, 2015) **3.2.2.1.2**	X	X
	• Credibility	(Morville , 2004) **2.2.3.1.1**	X	X
	• Valuable	(Morville , 2004) **2.2.3.1.1**	X	X
	• Desirable	(Morville , 2004) **2.2.3.**	X	—
	C3. Digital skills • Technological skills	(Mbebe, 2017) **3.3.4**; **(**Botha & Herselman, 2016) **3.4.2**	X	X
	• Critical thinking	(Mabila, Herselman & Van Biljon, 2016) **3.4.3**	X	X
	• Problem solving	(Mabila, Herselman & Van Biljon, 2016) **3.4.3**	X	—
	• Creativity	(Mabila, Herselman & Van Biljon, 2016) **3.4.3**	X	—
	• Qualified teachers	(Mabila, 2017) **3.4.3**; (Chisholm, 2011) **3.4.3.2**; (Becta, 2010) **3.3.2**	X	X
Context: Resource constrained environment	D1. Context • Physical context	(Chipangura, 2016) **3.3.3**; (Mashapa, 2013) **3.4.1**; Ouma (2013) **3.4.1**	X	X
	• Social context	(Arhippainen, 2009; Ouma,	X	X

Components	Subcomponents (Factors)	References and Literature Section	Factors Included/Excluded in Conceptual Framework	Factors Included/Excluded in Final Framework
	• Task context • Technical and information context	2013; De Kock, 2017) **3.4.1**		
		(Jumisko-Pyykkö & Vainio, 2010); **3.4.1**	X	—
		(Ouma, 2013) **3.4.1**	X	X
	D2. ICT integration • Lack of policy implementation • Training	(Mamba & Isabirye, 2015) **3.4.3.1**	X	X
		(Nkula & Krauss, 2014) **3.4.2**; (Blackboard, 2008) **3.4.3**; (Mabila, 2017) **3.4.3**; (Botha & Herselman, 2017) **3.4.3**	X	X

This section presents factors with the characteristics identified in the literature review and the new characteristics suggested by teachers in the responses discussed in section 5.4.1. These factors (characteristics) contributed towards the design of the framework.

6.1.1 **User –** the identified factors with the characteristics of the user component are as follows

- Needs: The technologies *need* to be *easy to use* in order to improve *performance* in teaching and to increase performance.
- Perception: Teachers have a *positive perception* about the use of the technologies in schools. Teachers *perceive* the technologies as a tool that *makes teaching easy* and *improves the IQ* of the learners.
- Experience: The *experience* of the teachers is *important* in the use of the technologies at school.
- Attitude: Teachers have a *positive attitude* towards the use of technology in schools. Teachers have a *positive attitude* towards *accepting* the use

of technologies at schools. Teachers are comfortable with using the technology.

- Expectations: Teachers *expec*t the technologies to be *user-friendly*, they expect the technologies to *meet* their *expectations* in teaching and learning.

6.1.2 System - the identified factors with the characteristics of the system component are as follows

- Usability: the technologies should increase the *effectiveness*, making teaching *easy* to present to learners. Mobile technologies *reduce* the need for paper work making learning more *efficient*.
- Hedonic and Aesthetics: The *appearance*, *visualisation* and *features* of the technologies are important to the teachers.
- Functionality: The Apps in the technologies should be easily *accessible*, easy to *navigate*. Technologies should be able to *handle errors* and have relevant *learning content*.
- Control and Ownership: Teachers require *privacy* and *confidentiality* in the technologies. Teachers require individual *passwords* to access the technology.
- Flexibility: Teachers expect the technologies to be *portable*, easy to carry, and *flexible,* allowing teaching to happen anywhere, with batteries that have long *life-spans*. Technologies should have *instant messaging apps (relevant)* to communicate with learners and assist with homework.
- Credibility: Teachers expect *reliability* from the technologies, ensuring that the information is *safe*. A *self-monitoring* tool needs to be included in the technologies.
- Valuable: The technologies are *useful (helpful)* in teaching. Teachers feel that the technologies *encourage* them to teach.
- Critical thinking: Teachers expect *innovative* teaching and learning to happen as a result of using the technologies. Teachers are expected to *transfer knowledge* to learners using the technologies.
- Technological skills: Teachers need to have the technological *skills* to operate the technologies.

- Qualified teachers: Teachers require *skills* to have a good experience when using the technologies in teaching and learning. Schools require an adequate number of *qualified teachers*.

6.1.3 Context - the identified factors with the characteristics of the context component are as follows

- Physical context: The *environment* and *availability of networks* where teaching and learning using technologies happens is important to teachers. The schools need to have *security* and *computer labs*.
- Social context: The *social factors*, including *schools' cultures* and the involvement of *stakeholders* in the use of tablets at schools, are essential.
- Technical and information context: The involvement of *technical assistance* and the availability of *ICT infrastructure* are important for the use of technologies at schools. The introduction of *smart boards* and an increase of *mobile technologies* at school are required.
- Policy implementation: The implementation of *policies* and *frameworks* plays a role in the adoption and use of technologies at schools.
- Training: The availability of *training facilities* and *training programmes* is important to teachers. Teachers need *support* and *mentorship*.

The final framework presented in section 6.2 intends to achieve the main objective of the study: *To design a framework for the user experience of teachers using mobile technology in resource constrained environments.* In accomplishing the main objective, the finalised framework is presented in Figure 6.2 as the User Experience of Teachers using Mobile Technology in Resource Constrained Environments (UXFTMTR) framework. The framework was constructed from the preliminary framework and teachers' feedback, reflecting the findings of the research.

The framework presents the teacher (***user***) interacting with the mobile technology (***system***) at school in a resource constraint environment (***context***) . The arrows indicate the relationship and connection between the components and the factors. As the ICT4E project will expand into other provinces, researchers and other stakeholders can use the UXFTMTR framework as a recommendation for implementing and using mobile technologies for teaching and learning in rural schools.

6.2 Completed framework

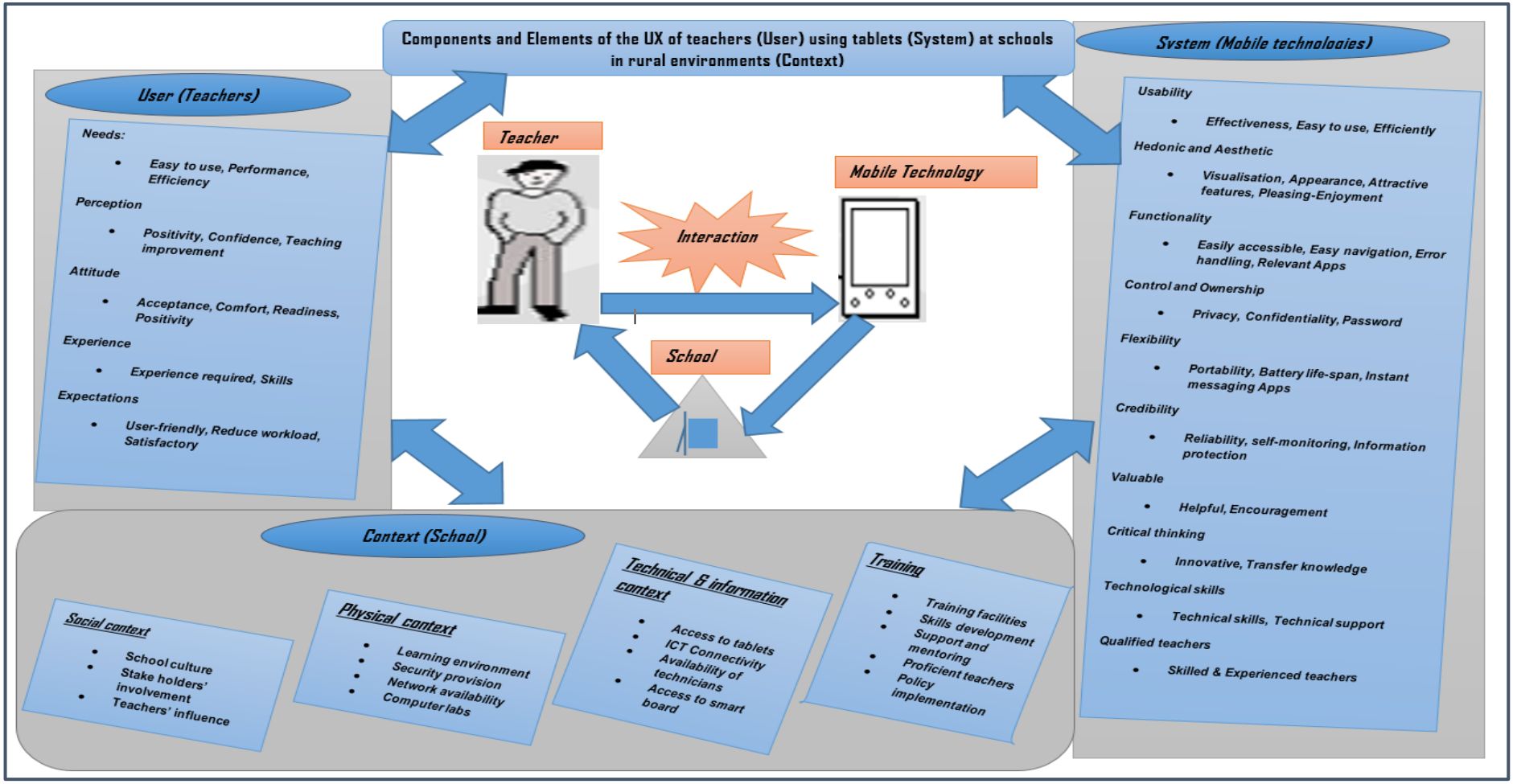


Figure 6.2: User Experience of Teachers using Mobile Technologies in Resource Constrained Environments (UXFTMTR) framework

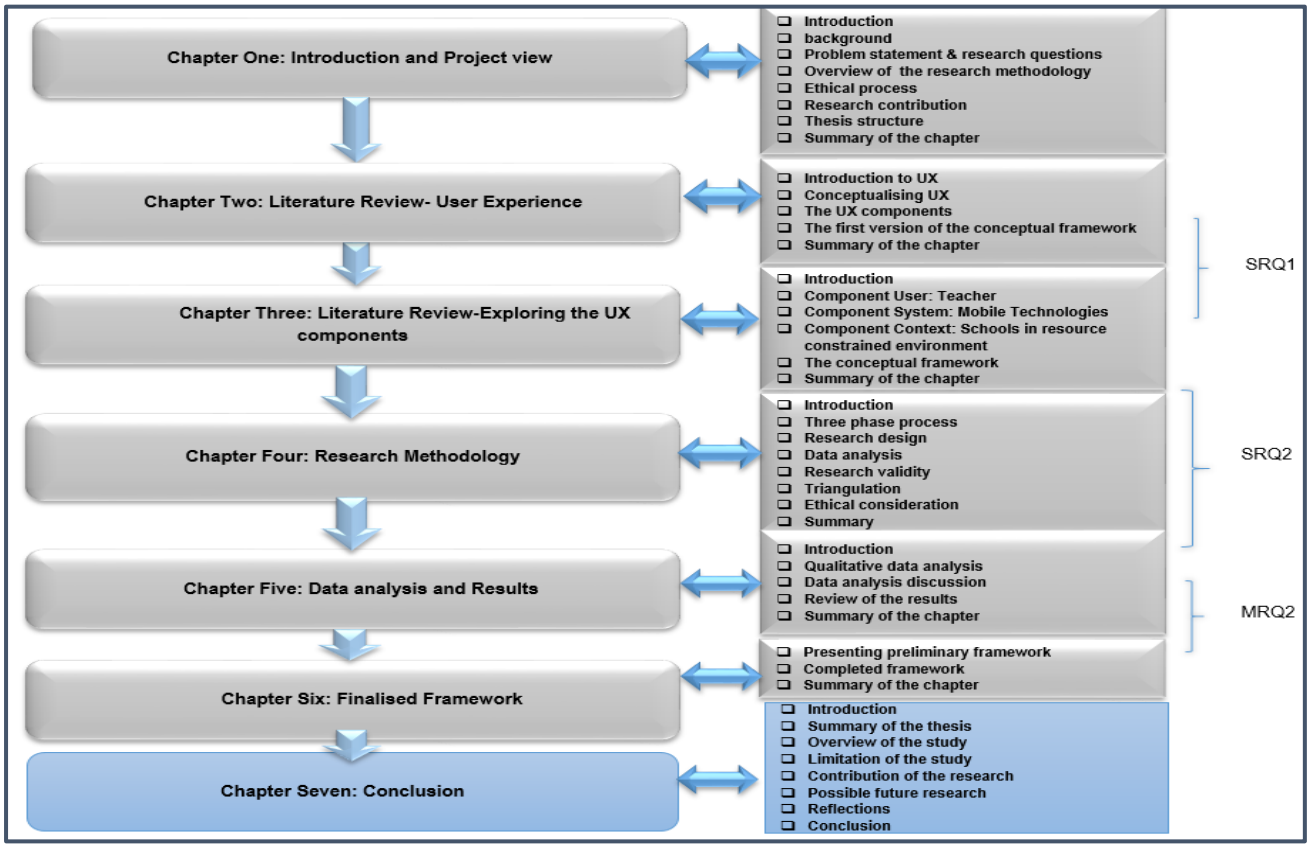
6.3 Summary of the chapter

The final framework User Experience of Teachers using Mobile Technology in Resource Constrained Environments (UXFTMTR) is presented in this chapter. This chapter also presented the conceptual framework that was produced from the literature review and the adopted framework, with an aim to illustrate how the frameworks contributed in building the final framework.

The inclusion and exclusion of factors are presented in a tabular format, indicating inclusion with symbol (X) and exclusion with symbol (-). The inclusion and exclusion table was used to indicate which of the factors that were identified in the initial framework were included or excluded in the final framework.

This chapter also presented the new characteristics of factors that were suggested or identified by teachers in the responses on the questionnaires, and the characteristics of factors that were identified in the literature review, which contributed in the design of the framework. The next chapter is the final chapter, summarising the purpose of the study, its contribution and recommendations.

7. CHAPTER SEVEN: CONCLUSION



7.1 Introduction

This chapter finalises the research and summarises the research outcomes. This research project aimed to design a framework for the user experience of teachers using mobile technologies in resource constrained environments. A summary of the dissertation, an overview of the study, limitations of the study, the research contribution and possible areas for future research are discussed in this chapter. A reflection on the research with recommendations concludes the final chapter.

7.2 Summary of the dissertation

This research was separated into seven chapters. This section provides a brief summary of all the chapters, highlighting the significant topics.

- Chapter One: Introduction

This chapter outlined the purpose of the study, the problem of the study and its objectives. The background section in this chapter gave an overview of the study and its focus.

- Chapter Two: Literature Review

This chapter was divided into three parts with the aim of conceptualising the user experience, mobile technologies and resource constrained environment. The purpose of the chapter was to present insight and arguments in relation to the study, by presenting the components and factors that contributed to building the proposed framework.

- Chapter Three: Conceptual Framework

This chapter focussed on drafting the conceptual framework, using the components User, System and Context with the factors derived from the literature review. This conceptual framework was used to construct the questions in the questionnaire that was sent to the participants, with the aim of answering research sub-question two.

- Chapter Four: Research Methodology

This chapter presented the research design that was used to conduct this research and collect data. The research paradigm, research approach, research strategy, research method, data collection method and participants were included in this chapter. The data analysis approach, research validity and ethical considerations were also outlined in this chapter.

- Chapter Five: Data Analysis and Results

In this chapter data was analysed qualitatively, following the thematic analysis process proposed by Braun and Clarke (2006); Clarke and Braun (2013). The study also used the computer-based tool called Atlas.ti to analyse and present the results using the network diagrams. This was done with the aim of answering research sub-question two and the main research question.

- Chapter Six: Finalised Framework

The chapter presented the end product of the research, the final framework, which answers the main research question and achieves the objective of the research.

- Chapter Seven: Conclusion

This chapter summarises the research, gives recommendations and concludes the research.

7.3 Overview of the study

The main purpose of the study was to develop a framework that will contribute towards the use of mobile technologies at schools in rural areas. The research investigated the components and factors of the user experience of the teachers using technologies in resource constrained environments. The study was done in three provinces, Limpopo, North West and Gauteng, focussing on the teachers who participated in the ICT4E project where teachers were trained to use technologies for teaching and learning in rural schools.

The study explored the teachers' user experience when using the technologies with the aim of answering the main research question: *How can the components of a framework for the user experience of teachers using mobile technologies enhance their classroom practice in resource constrained environments?*

Two research sub-questions were used in the study:

- *What are the components and factors of user experience that are relevant for teachers using mobile technologies in resource constrained environments?*
- *How is the user experience of the teacher reflected in the use of mobile technology for teaching in resource constrained environments?*

Research sub-question one was answered in the literature review in Chapter Two, which identified the components and factors relevant to teachers using mobile technologies in resource constrained environments. A conceptual framework *Conceptual framework of the components and factors that may influence the UX of the teachers in resource constrained environments* was produced from the literature study. To answer research sub-question two, the conceptual framework was used to construct a questionnaire that was sent to teachers to gather qualitative data comprising closed-ended questions using a five-point Likert scale and open-ended (comments) questions that would collect qualitative data. The questionnaire was divided into four sections: participants' demographic information, User (Teachers) factors, System (Mobile technologies) factors and Context (School) factors. To ensure data validity, reliability and trustworthiness, each factor consisted of two to five questions correlated to the same factor. This was done to ensure that participants' feedback was not misinterpreted.

This study applied an explorative qualitative approach as the research strategy, which comprises explorative research and qualitative research. Explorative research focusses on exploring the phenomenon, and is characterised by a focus on either seeking out new insight

or the new phenomenon, where the problem is broad and not yet defined (Malhotra, 2010). Data was analysed qualitatively through a thematic analysis process using the Atlas.ti tool. Results were interpreted in Chapter Five, and in Chapter Six the User Experience of Teachers using Mobile Technologies in Resource Constrained Environments (UXFTMTR) framework was presented.

7.4 Limitations of the study

The study was limited to the teachers who participated in the ICT4E project, the purpose of which was to incorporate the use of mobile technology in teaching and learning in rural schools. The ICT4E project was implemented in 24 rural schools in seven provinces in South Africa. However, the study focussed on only three of the provinces: Limpopo, Gauteng and North West. ICT was integrated and teachers were trained to use the mobile technologies in the classroom for teaching and learning. This study was restricted to:

- Teachers in rural schools in Limpopo, Gauteng and North West
- Teachers who had participated in the ICT4E project
- Teachers who attended and finished the training course (TPD)
- Teachers who were using the technologies in the classrooms

7.5 Contribution of the research

The research contributed towards the Information Systems body of knowledge in the field of UX focussing on mobile technologies. The education system in South Africa is in a process of enhancing education by introducing the use of mobile technologies in teaching and learning to all schools. Consequently, there is a necessity for research that will support the implementation of the transformation in the education system. The produced framework will give a full understanding of what constitutes a positive user experience for teachers using mobile technologies in resource constrained environments. The developed framework identified the components and factors that are relevant to teachers using mobile technologies in resource constrained environments.

As the ICT4E project will be implemented in other provinces, the framework can be used as a guideline to implementing and using mobile technologies for teaching and learning in rural schools. The framework shows the project implementers, researchers and other stakeholders that there is a need to focus on the three components — user (teacher), system (mobile technologies), context (schools) — if the use of technologies in schools is anticipated to be a

success in South Africa. The findings of this research could serve as the basis for further research related to the user experience of teachers using mobile technologies, either in urban areas or any other countries that seek to understand the UX of the teachers or learners using mobile technologies at schools in resource constrained environment.

7.6 Possible future research

This study focussed on the teachers who participated in the ICT4E project. The study selected three provinces (Limpopo, North West and Gauteng) out of the seven provinces where the project was implemented. Once the ICT4E project is implemented nationwide further research that includes all nine provinces will be essential to assess the impact of the project. Further research could also include the urban or suburban schools or any countries that are on the verge of transforming their education systems by introducing the use of mobile technologies in schools. A comparative study could possibly provide a different perspective on this issue. This could include comparing rural schools' data with urban schools' data, or teachers who attended and passed the TPD training course with those who attended but did not pass the course or possibly teachers who did not attend the TPD course, yet the teachers use the mobile technologies in their day to day lives.

The study identified three components, and possible future research may identify more than three components. As the use of mobile technologies is integrated in many aspects of our daily lives there is so much that can be done to expand the knowledge gained from this study.

7.7 Reflections

7.7.1 Methodological contribution

This research outlines the components and factors that are relevant for teachers using mobile technologies in rural schools. The framework developed from these components and factors can be used by experts and researchers in the field of study as a basis for improving the user experience of the teachers at schools using mobile technologies in teaching and learning.

The study followed an explorative qualitative research with an intention to explore the phenomenon by applying the interpretivist approach to explore and explain the social context with the aim of creating an understanding about the phenomenon using the qualitative data analysis method. The conceptual framework was presented, as the basis of qualitative approach through the implementation of a questionnaire with an aim to produce qualitative data.

For validity and reliability of the study, four experts in the field of the study were used for the qualitative study, and the experts contributed in the design and implementation of the questionnaire for data collection and a total of 27 teachers responded to the qualitative questionnaire. The researcher interpreted the meaning of the data, and relied on a small number of participants because the purpose was not to generalise, but explore (Shah, 2015). Therefore, the selected methodology and data analysis technique were relevant for this study.

7.7.2 Personal Reflection

I personally do not regret taking up the challenge and conducting this research, as it shapes and contributes to the society we are trying to nurture as a nation. I believe that every individual deserves a better education, regardless of the region where the schools are based. Opting to research this phenomenon was the best choice, as it has not only expanded my knowledge, but enabled me to observe the gaps within the South African education system.

As a student doing this research, I learnt to be patient, disciplined and to prioritise my decisions and options, as I had to sacrifice my time and dedicate it to studying journals in support of the research argument. As I was travelling to different schools in the three provinces I learnt a lot. My standpoint and approach changed as I realised that I was not dealing with the same characters, and the participants' approach and reactions to situations taught me to be humble and patient. Moving forwards, I now know what to confront first in order to progress in the research field.

7.8 Conclusion

It is without doubt that the use of mobile technology at school is improving and transforming the learning and teaching process in education and it is embraced by both teachers and learners. However, the use of technology cannot be fully implemented and adopted in schools if the user experience of either teachers or learners is negative. The *User Experience of Teachers using Mobile Technologies in Resource Constrained Environments* (UXFTMTR) framework is significant because it will assist project implementers and experts in the field with understanding the factors that may influence the use of mobile technologies in schools from a teacher's perspective.

REFERENCES

Abawi, K. (2013). Data collection instruments (questionnaire and interview). Geneva workshop. Geneva foundation for Medical Education and Research.

https://www.gfmer.ch/SRH-Course-2012/Geneva-Workshop/pdf/Data-collection-instruments-Abawi-2013.pdf

Abbasi, M.Q., Lew, P., Rafique, I., & Li, Z. (2012). User Experience Evolution Lifecycle Framework. International Scholarly and Scientific Research & Innovation, 6(1).

https://waset.org/publications/8683/user-experience-evolution-lifecycle-framework.

Adom, D., Hussein, E., & Joe, A. (2018). Theoretical and conceptual framework: mandatory ingredients of a quality research. International Journal of Scientific Research, 7, 438-441.

Ahmad, S. (2012). Questionnaire and Types. Doi:10.13140/RG.2.1.2235.0320.

https://www.researchgate.net/publication/304607255_Questionnaire_and_Types?channel=doi&linkId=5774c1da08ae1b18a7de4973&showFulltext=true

Anderson, R. E., Anderson, R. J., Borriello, G., & Kolko, B. (2012). Designing technology for resource-constrained environments: Three approaches to a multidisciplinary capstone sequence. In Frontiers in Education Conference (FIE), 2012, 1-6. Seattle, WA: IEEE.

Alhussayen, A., Alrashed, W., & Mansor, E, I. (2015). Evaluating the user experience of playful interactive learning interface with children. 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015. Procedia Manufacturing, 2318-2324.

Ally, M., & Prieto-Blazquez, J. (2014). What is the future of mobile learning in education? Mobile learning application in Higher Education, 11, (1), 142-151.

Archer, E., Janse van Vuuren, H.H., & Van der Walt, H, D. (2017). Introduction to Atlas.ti. Basic operations, tips, and tricks of coding. 6th Edition. Research Rescue, Pretoria South Africa.

Arhippainen, L. (2003). Capturing user experience for product design. Department of the information processing science. Finland: University of Oulu.

https://robertoigarza.files.wordpress.com/2009/10/art-capturing-user-experience-for-product-design-arhippainen-2003.pdf

Arhippainen, L. (2009). Studying user experience: issues and problems of mobile services case ADAMOS: User experience (im)possible to catch. Doctoral Dissertation. Finland: University of Oulu.

Argus, W. (2019, January 13). Uncertainty over the president's tablet plan. IOL.

https://www.iol.co.za/weekend-argus/uncertainty-over-the-presidents-tablet-plan-18797887

Bateman, C. (2017, March 23). South Africa's ICT policy; less and better regulation needed-industry expert. Thought Leaders. BizNews.

https://www.biznews.com/thought-leaders/2017/03/23/ict-policy-regulation/

Barnes, J., & Herring, D. (2011). Learning Their Way: Mobile Devices in Education. In M. Koehler & P. Mishra (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference, 127-129.

Becta. (2010). 21st century teacher: Are you ready to meet the challenge. Leading next generation learning.
https://www.erte.dge.mec.pt/sites/default/files/Recursos/Estudos/21st_century_teacher.pdf

Bevan, N. (2009). What is the difference between the purpose of usability and user experience evaluation methods? Proceedings of the Workshop UXEM, Research Gate.

Bischoff, S, A. (2016). Use Experience-Aware system optimisation for mobile. Faulty of physical science and engineering, University of Southampton.

Blackboard. (2008). Teaching in the 21st Century, a Review of the Issues and Changing Models in the Teaching Profession.
https://www.blackboard.com/resources/k12/k12_teaching21st_final.pdf

Bidin, S., & Ziden, A.A (2013). Adoption and application of mobile learning in the education industry. 6th International Conference on University Learning and Teaching. Procedia - Social and Behavioral Sciences, 90, 720 – 729.

Botha, A., Herselman, M., & van Greunen, D. (2010). Mobile user experience in a mlearning environment. ACM International Conference Proceeding Series, 29-38.

Doi: 10.1145/1899503.1899507.

Botha, A., Calteaux, K., Herselman, M., Grover, A. S. & Barnard, E. (2012). Mobile User Experience for voice services: A theoretical framework. 7th Framework programme.

Botha, A., & Herselman, M. (2015a). A Teacher Tablet Toolkit to meet the challenges posed by 21st century rural teaching and learning environments. South African Journal of Education, 35(4).

Botha, A., & Herselman, M. (2015b). Supporting Teacher Professional Development to use Tablets in Resource Constrained Schools: A Case Study of Cofimvaba schools, Eastern Cape Province, South Africa. Systemic, Cybernetics and Informatics, 13(5), 20-27.

Botha, A., & Herselman, M. (2016). Rural teachers as innovative co-creators: An intentional Teacher Professional Development strategy. CONF-IRM 2016 Proceedings, 23.
http://aisel.aisnet.org/confirm2016/23

Botha, A., & Herselman, M. (2017). Teachers become cocreators through participation in a teacher professional development (TPD) course in a resource constraint environment in South Africa. The Electronic Journal of Information Systems in Developing Countries.
https://researchspace.csir.co.za/dspace/bitstream/handle/10204/9970/Botha_20061_2017.pdf?sequence=1&isAllowed=y

Botha, A., Herselman, M., Musgrave, S., & Jaeschke, G. (2017). Dimensional Evaluation of a Rural Mobile Learning Teacher Professional Development Curriculum. Conference: Unisa ISTE, Krugerpark, South Africa.

https://www.researchgate.net/publication/322640943_Dimensional_evaluation_of_a_rural_mobile_learning_teacher_professional_development_curriculum

Bornman, E. (2015). Information society and digital divide in South Africa: results of longitudinal surveys, Information, Communication & Society.
https://doi.org/10.1080/1369118X.2015.1065285

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, ISSN 1478-0887, 3 (2), 77-101. http://eprints.uwe.ac.uk/11735

Braun, V. & Clarke, V. (2012). Thematic analysis. In Cooper, H. (Ed.), The Handbook of Research Methods in Psychology. Washington, DC: American Psychological Association.

Brown, T. H, & Mbati, L. S. (2015). Mobile Learning: Moving Past the Myths and Embracing the Opportunities. International Review of Research in Open and Distributed Learning, 16 (2), 115-135.

Burgess, S. & Sievertsen, H.H. (2020, April 01). Schools, skills, and learning: The impact of COVID-19 on education. VOX. https://voxeu.org/article/impact-covid-19-education

Chan, F., & Johansson, S. (2016). Evaluation of user experience on a mobile application. KTH Royal Institute of Technology, School of Information and Communication Technology. Stockholm, Sweden.

ChanLin, L. J. (2017). Analysis of teachers' tablet teaching adoption process. Educational Sciences: Theory & Practice, 17,1935–1958. http://dx.doi.org/10.12738/estp.2017.6.0436

Chinapah, V., & Odero, J.O. (2016). Towards Inclusive, Quality ICT-Based Learning for Rural Transformation. Journal of Education and Research, 2(5).

http://dx.doi.org/10.3126/jer.v5i0.15733

Chipangura, B., Van Biljon, J., & Botha, A. (2012). The digital difference between traditional information provision and students' expectations in developing countries, IDIA2012 Conference Proceedings, 88-100.

Chipangura, B. (2016). A framework for providing mobile centric services to students at higher education institutions: the case of open distance learning. Doctoral Dissertation, Information Systems. UNISA.

Chiu, K.F., & Churchill, D. (2015). Adoption of mobile devices in teaching: changes in teacher beliefs, attitudes and anxiety. Interactive Learning Environments.
http://hdl.handle.net/10722/222576

Chisholm, L. (2011). The challenge of South African schooling: dimensions, targets and initiatives. http://transformationaudit.org/blog/wp-content/uploads/2012/02/Review-The-challenge-of-South-African-schooling.pdf

Clarke, V. & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. The Psychologist, 26(2), 120-123.

Clemmensen, T., Hertzum, M., Yang, J., & Chen, Y. (2013). Do Usability Professionals Think about User Experience in the Same Way as Users and Developers do? IFIP International Federation for Information Processing, 461-478.

Costa, C., Breda, Z., Pinho, I., Bakas, F., & Durão, M. (2016). Performing a Thematic Analysis: An Exploratory Study about Managers' Perceptions on Gender Equality. The Qualitative Report, 21(13), 34-47. https://nsuworks.nova.edu/tqr/vol21/iss13/4

Creswell, J. W. (2013). Research Design Qualitative, Quantitative and Mixed Methods Approaches, Sage Publications.

Creswell, J.W., & Plano Clark, V. L. (2011). Design and Conducting mixed methods research (2nd Ed.). London: SAGE.

Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: A step-by-step approach. British journal of nursing, Mark Allen Publishing, 17, 34-43.

Davis, R., & Wong, D. (2007). Conceptualizing and Measuring the Optimal Experience of the eLearning Environment. Decision Sciences Journal of Innovative Education, 5(1), 97-126.

DeFranzo, S.E. (2011, September, 16). What's the difference between qualitative and quantitative research? Snap surveys.

https://www.snapsurveys.com/blog/qualitative-vs-quantitative-research/

De Kock, E. (2017). User experience of academic lecturing staff in the use of a learning management system tool: a case study at an open distance learning institution in South Africa. Masters dissertation. UNISA.

http://uir.unisa.ac.za/bitstream/handle/10500/24965/dissertation_de%20kock_e.pdf?sequence=1&isAllowed=y

Deegan, R., & Rothwell, P. (2010). A Classification of M-Learning Applications from a Usability Perspective. Journal of the Research Center for Educational Technology (RCET), 6 (1).

Denscombe, M. (2010). The Good Research Guide for Small Scale Research Projects (4th ed.). Buckingham: Open University Press.

Dlamini, S., Meyer, I., Marais, M., & Ford, M. (2017). An implementation readiness framework for education systems: Integrating ICT into teaching and learning, 1-9. Doi:10.23919/ISTAFRICA.2017.8102322.

Donohue, D., & Bornman, J. (2014). The challenges of realising inclusive education in South Africa. South African Journal of Education, 34(2).

Eicker-Nel, S., & Matthee, M. (2014). The adoption of tablet based e-textbooks in South Africa private school. Proceedings of the e-skills for knowledge production and innovation conference 2014, Cape Town, South Africa, 109-123. http://proceedings.e-skillsconference.org/2014/e-skills109-123EickerMatthee715.pdf

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1-4. Doi: 10.11648/j.ajtas.20160501.11

Evers, J.C. (2016). Elaborating on Thick Analysis: About Thoroughness and Creativity in Qualitative Analysis. Forum: Qualitative Social Research, 17 (1).

Fin24. (2016, September 29). Cabinet finally approves SA ICT policy. Fin24Tech. Retrieved from: https://www.fin24.com/Tech/News/cabinet-finally-approves-sa-ict-policy-20160929

Flick, U. (2014). The SAGE handbook of qualitative data analysis. London, SAGE Publications Ltd. doi: 10.4135/9781446282243.

Fouka, G., & Mantzorou, M. (2011). What are the Major Ethical Issues in Conducting Research? Is there a Conflict between the Research Ethics and the Nature of Nursing?. Health Science Journal, 5(1). http://www.hsj.gr/medicine/what-are-the-major-ethical-issues-in-conducting-research-is-there-a-conflict-between-the-research-ethics-and-the-nature-of-nursing.pdf

Gentner, A., Bouchard, C., & Favart, C. (2013). Investigating user experience as a composition of components and influencing factors. 5th International Congress of International Association of Societies of Design Research, Tokyo.

Giannini, S. (2020, June 18). Build back better: Education must change after COVID-19 to meet the climate crisis. UNESCO. https://en.unesco.org/news/build-back-better-education-must-change-after-covid-19-meet-climate-crisis

Glanznig, M. (2012). User Experience Research: Modelling and describing the subjective. Interdisciplinary Description of Complex Systems, 10(3), 235-247.

Hancock B., Windridge K., & Ockleford E. (2009). An Introduction to Qualitative Research. National Institute for Health Research. The NIHR RDS EM / YH.

https://www.rds-yh.nihr.ac.uk/wp-content/uploads/2013/05/5_Introduction-to-qualitative-research-2009.pdf

Harpur, P. (2013). Evaluation of Usability and User Experience of an M-Learning Environment, Custom-Designed for A Tertiary Educational context. Masters dissertation, Information Science. UNISA.

Hassenzahl, M. (2008). User experience (UX): Towards an experiential perspective on product Quality. IHM, Semantic Scholar. Doi: 10.1145/1512714.1512717

Hassenzahl, M., & Tractinsky, N. (2006). User experience a research agenda. Behavior and Information Technology, 25(2), 91-97. Doi:10.1080/01449290500330331

Herselman, M., Botha, A., Mayindi, D. & Reid, E. (2018). Influences of the Ecological Systems Theory Influencing Technological Use in Rural Schools in South Africa: A Case Study. Conference: 2018 International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD), 1-8.

Herselman, M., Botha, A., Dlamini, S., Marais, M., & Mahwai, N. (2019). Findings from a mobile tablet project implementation in rural South Africa.15th International Conference Mobile Learning, 49-56. DOI: 10.33965/ml2019_201903L007.

https://www.researchgate.net/publication/333271018_FINDINGS_FROM_A_MOBILE_TABLET_PROJECT_IMPLEMENTATION_IN_RURAL_SOUTH_AFRICA

Herselman, M., Botha, A., Maremi, K. (2019). Evaluating a Mobile Tablet Project in Rural South Africa against Criteria to Comply with Being an Innovative Educational Ecosystem. ICEMT 2019: Proceedings of the 2019 3rd International Conference on Education and Multimedia Technology, 215-220. https://doi.org/10.1145/3345120.3355422

Herselman, M., Botha, A., Maremi, K., Dlamini, S. & Marais, M. (2020). Mobile technology affecting teaching and learning in rural schools. Conference: 16th International Conference on Mobile Learning 2020, 23-30.

Hlagala, A.R. (2015). Mobile educational technologies currently used as a means to enhance teaching and learning in privileged high school. Masters dissertation, Information Science. UNISA.

Hinkelmann, K. & Witschel, H.F. (2013). How to choose a research methodology? School of business, University of applied Sciences Northwestern, Switzerland. http://knut.hinkelmann.ch/lectures/project2013/p1_5_how-to-choose-a-research-methodology.pdf

Huang, G., & Tsai, C. (2011). Research trends in mobile and ubiquitous learning: a review of publications in selected journals from 2001 to 2010. British Journal of Education Technology, Research Gate, 42(4), 65-70. https://doi.org/10.1111/j.1467-8535.2011.01183.x

Hutchison, A., Beschorner, B. and Schmidt-Crawford, D. (2012) Exploring the Use of the iPad for Literacy Learning. Reading Teacher, 66, 15-23. https://doi.org/10.1002/TRTR.01090

Ihuah, P.W., & Eaton, D. (2013). The Pragmatic Research Approach: A Framework for Sustainable Management of Public Housing Estate in Nigeria. Journal of U-China Public Administration, David Publishing, 10, (10), 933-944.

Isaacs, S. (2012). Mobile learning for teachers in Africa and the Middle East: Exploring the potential of Mobile Technologies to support teachers and improve practice. UNESCO. http://unesdoc.unesco.org/images/0021/002163/216358E.pdf

Ishtaiwa, F. (2014). Mobile technology as a learning tool: Use and effects. International Journal of Information and Communication Technology Education. 10,1-15. https://doi.org/10.4018/ijicte.2014100101

ISO 9241-11:2018. (2018). Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts. https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en

Jabareen, Y. (2009). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. Int. J. Qual. Methods, 8. https://doi.org/10.1177/160940690900800406

Joshi, A., Kale, S., Chandel, S. & Pal, D. K. (2015). Likert Scale: Explored and Explained. British Journal of Applied Science & Technology, 7(4), 396-403.

Jugder, N. (2016). The thematic analysis of interview data: an approach used to examine the influence of the market on curricular provision in Mongolian higher education institutions. Hillary Place Papers, University of Leeds. https://www.semanticscholar.org/paper/The-thematic-analysis-of-interview-data-%3A-an-used-Jugder/2e0a746b717fa49b6f4a48a462ee47e602204de9

Jumisko-Pyykkö, S., & Utriainen, T. (2010). User-centred quality of experience: is mobile 3D video good enough in the actual context of use? On Video Processing and Quality Metrics. http://sp.cs.tut.fi/mobile3dtv/results/conference/53_Pyykko_et_al_Jan2010.pdf

Jumisko-Pyykkö, S., & Vainio, T. (2010). Framing the Context of Use for Mobile HCI. IJMHCI, 2, 1-28. https://doi.org/10.4018/jmhci.2010100101

Kaasinen, E., Roto, V., Hakulinen, J., Heimonen, T., Jokinen, J.P.P., Karvonen, H., …Turunen, M. (2015). Defining user experience goals to guide the design of industrial systems. Behaviour & Information Technology, 34(10), 976-991. https://doi.org/10.1080/0144929X.2015.1035335

Kawulich, B. (2004). Qualitative Data Analysis Techniques. Conference. RC33 (ISA), At Amsterdam, The Netherlands.

Keskinen, T. (2015). Evaluating the User Experience of interactive systems in challenging circumstances. Dissertation in school of Information Sciences, University of Tampere.

Kort, J., Vermeeren, A. P. O. S., & Fokker, J. E. (2007). Conceptualizing and Measuring User experience. 57-64

Kroeze, J. H. (2011). Interpretivism in Information Systems: A Postmodern Epistemology. Sprouts: Working Papers on Information Systems, 11, (171). http://sprouts.aisnet.org/11-171

Kukulska-Hulme, A. (2010). Mobile learning as a catalyst for change. Open Learning. The Journal of Open and Distance Learning, 25, (3), 181–185.

Kuniavsky, M. (2010). Smart things: Ubiquitous computing User Experience Design. London: British Library Cataloguing-in Publication Data.

Kuusinen, K., Väätäjä, H., Mikkonen, T. & Väänänen, K. (2016). Towards Understanding How Agile Teams Predict User Experience. In Integrating User-Centred Design in Agile Development, 163-189. https://www.researchgate.net/publication/308839307_Towards_Understanding_How_Agile_Teams_Predict_User_Experience

Langenhoven, C. (2016). User experience of learners in technology-facilitated learning in a resource deprived context. Masters Dissertation, University of Pretoria. https://repository.up.ac.za/bitstream/handle/2263/52939/Langenhoven_User_2016.pdf?sequence=1

Law, E.L., Roto, V., Hassenzahl, M., Vermeeren, A.P., & Kort, J. (2009). Understanding, scoping and defining user experience: a survey approach. CHI. Semantics Scholar. https://doi.org/10.1145/1518701.1518813

Law, E. L., Van Schaik, P., & Roto, V. (2013). Attitudes towards user experience (UX) measurement. International Journal of Human-Computer Studies. Elsevier, 72(6), 526-541. https://doi.org/10.1016/j.ijhcs.2013.09.006

Mabila, J., Herselman, M., & Van Biljon, J. (2016). Digital content and sustained use in integrating tablet technology into teaching in resource constrained environments in South Africa: Educators' views. University of South Africa, Council for Scientific and Industrial Research, South Africa. https://researchspace.csir.co.za/dspace/bitstream/handle/10204/9251/Mabila_17748_2016.pdf?sequence=1&isAllowed=y

Mabila, J., Van Biljon, J., & Herselman, M. (2016). A sustainability framework for mobile technology integration in schools: The case of resource constrained environments in South Africa. Research Gate, 13, 59-86.

Mabila, J. (2017). A Sustainability Framework for Mobile Technology Integration in Resource-Constrained Schools: A Case Study in South Africa. Doctoral Dissertation, Information Systems. UNISA.

Maguire, M. (2013). Using Human Factors Standards to Support User Experience and Agile Design. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-39188-0_20

Maguire, M., & Delahunt, B. (2017). Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars. AISHE-J, 3, 3351-33514. http://ojs.aishe.org/index.php/aishe-j/article/view/335

Mahlke, S., & Thüring, M. (2007). Studying Antecedents of Emotional Experiences in Interactive Contexts. CHI 2007 Proceedings, 915–918.

Mahlke, S. (2008). Visual aesthetics and the user experience. The Study of Visual Aesthetics in Human-Computer Interaction. Research Gate.

Malhotra, N. K. (2010). Marketing research: an applied orientation (6th Edition). Pearson publication.

Mamba, M.S.N., & Isabirye, N. (2015). A Framework to Guide Development through ICTs in Rural Areas in South Africa. Information Technology for Development, 21 (1), 135-150. https://doi.org/10.1080/02681102.2013.874321

Mashapa, J. (2009). An investigation into user interface factors impacting on user experience: pastel accounting study. Masters dissertation. Nelson Mandela Metropolitan University.

Mashapa, J. (2013). A model managing user experience. Doctorate dissertation. Nelson Mandela Metropolitan University.

Maxwell, J. A. (2005). Qualitative research design: An interactive approach. Sage publications, Thousand Oaks, California. 2nd Edition, 33 – 64.

Mbebe, T.M. (2017). Analysing the developmental role of ICT in the case of Bakgoma community library. Masters Dissertation, Management and Economic Sciences. Stellenbosch University.

Mehdipour, Y., & Zerehkafi, H. (2013). Mobile Learning for Education: Benefits and Challenges. International Journal of Computational Engineering Research, 3(6), 93-10.

Meyer, I. A., & Gent, P.R. (2016). The status of ICT in education in South Africa and the way forward. National Education Collaboration Trust. http://nect.org.za/publications/technical-reports/the-state-of-ict-in-education-in-south-africa/

Miao, F., West, M., So, H., & Toh, Y. (2017). Supporting teachers with mobile technology. UNESCO. http://unesdoc.unesco.org/images/0025/002515/251511e.pdf

Miki, H. (2014). User Experience Evaluation Framework for Human-Centered Design. Information and knowledge design and evaluation. Springer, Cham. https://doi.org/10.1007/978-3-07731-4_59

Moczarny, I.M. (2011). Dual-method usability evaluation of e-commerce websites: In quest of better user experience. Masters Dissertation. UNISA. http://uir.unisa.ac.za/bitstream/handle/10500/5300/dissertation_moczarny_im.pdf?sequence=1&isAllowed=y

Moczarny, I. M., De Villiers, M. R., & Van Biljon, J. A. (2012). How can usability contribute to user experience? A study in the domain of e-commerce. SAICSIT, 216-225.

Morville, P. (2004, June 21). User Experience Design. Semantic Studios. http://semanticstudios.com/publications/semantics/000029.php

Murphy, A., Farley, H., Lane, M., Hafeez-Baig, A., & Carter, B. (2014). Mobile Learning Anytime, anywhere: What are our students doing? Australasian Journal of Information Systems, 3(18).

Nakamura, W.T., De Oliveira, E.H.T., & Conte, T. (2019). Negative Emotions, Positive Experience: What Are We Doing Wrong When Evaluating the UX. Glasgow, Scotland, UK. 1-6. https://doi.org/10.1145/3290607.3313000

Nicholls, D. (2009). Qualitative Research: Part Two – Methodology. International Journal of Therapy and Rehabilitation, 16 (11). https://doi.org/10.12968/ijtr.2009.16.11.44939

Nkula, K. & Krauss, K. (2014). The integration of ICTs in marginalized schools in South Africa: Considerations for understanding the perceptions of in-service teachers and the role of training. Conference: 8th IDIA Conference at: Port Elizabeth, South Africa.

Oates, B. J. (2006). Researching information systems and computing. London: SAGE Publications.

Opertti, R. (2017). Curriculum in the Education 2030 Agenda: Latin America and the Caribbean. UNESCO, International Bureau of Education.

Ouma, S. (2013). M-health User Experience Framework for the public healthcare sector. Doctorate Dissertation. Nelson Mandela Metropolitan University NMMU.

Padayachee, I. (2013). A model representing the factors that influence virtual learning system usage in higher education. Doctorate dissertation. UNISA. http://uir.unisa.ac.za/bitstream/handle/10500/13060/thesis_Padayachee_I.pdf?sequence=1&isAllowed=y

Page, T. (2014). Application-based mobile devices in design education. International Journal of Mobile Learning and Organisation, ACM, Digital Library, 8 (2), 96- 111.

Paul, L. G. (2004). Research Methodology explained for Everyday People.

Parsons, D. (2014). The future of mobile learning and implications for education and training. In Ally, M. & Tsinakos, A., Editors, Perspectives on Open and Distance Learning: Increasing access through mlearning. Published by the Commonwealth of Learning and Athabasca University, Vancouver, Canada.

Patrinos, H.A. & Shmis, T. (2020, March 23). Can technology help mitigate the impact of COVID-19 on education systems in Europe and Central Asia. *World Bank Group*.

https://blogs.worldbank.org/europeandcentralasia/can-technology-help-mitigate-impact-covid-19-education-systems-europe-and

Payton, S., & Hauge, C. (2010). Digital literacy in practice: case studies of primary and secondary classrooms. FutureLab innovation in education. https://www.nfer.ac.uk/publications/FUTL06/FUTL06casestudies.pdf

Peersman, G. (2014). Overview: Data Collection and Analysis Methods in Impact Evaluation, Methodological Briefs: Impact Evaluation, UNICEF Office of Research, Florence, 10.

Petrie, H., & Bevan, N. (2009). The evaluation of accessibility, usability and user experience. The universal handbook. C Stepanidis (Ed), CRC Press.

Photongsunan, S. (2010). Interpretive paradigm in educational research. http://www.aulibrary.au.edu/multim1/ABAC_Pub/Galaxy-The-English-Department-Journal/v2-n1-1-oct-10.pdf

Pietrzyk, C., Semich, G., Graham, J. & Cellante, D. (2011). Mobile Technology in Education. In M. Koehler & P. Mishra (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2011 Chesapeake, VA: Association for the Advancement of Computing in Education (AACE), 640-650.

Portugal C. (2014). Design, User-Experience and Teaching-Learning. In: Marcus A. (Eds.) Design, User Experience, and Usability. User Experience Design for Everyday Life Applications and Services. DUXU 2014. Lecture Notes in Computer Science. Springer, Cham, (8519).

Pretorius, M., & Calitz, A. (2014) A Methodology to Institutionalise User Experience in Provincial Government. South African Computer Journal, 55. Doi:10.18489/sacj. v55iO.227

Radhakrishna, R., Tobin, D., Brennan, M., & Thomson, J. (2012). Ensuring Data Quality in Extension Research and Evaluation Studies. Journal of Extension, 55(3). https://www.joe.org/joe/2012june/pdf/JOE_v50_3tt1.pdf

Research methodology. (2019). Ethical considerations. https://research-methodology.net/research-methodology/ethical-considerations/

Rocco, T., & Plakhotnik, M. (2009). Literature Reviews, Conceptual Frameworks, and Theoretical Frameworks: Terms, Functions, and Distinctions. Human Resource Development Review, 8, 120-130. SAGE. https://doi.org/10.1177/1534484309332617

Roto, V. (2006). User Experience Building Blocks. Retrieved from: https://www.researchgate.net/publication/228415863_User_Experience_Building_Blocks

Roto, V. (2007). User Experience from Product Creation Perspective. Nokia Research Center. Research Gate.

https://www.researchgate.net/profile/Gavin_Macarthur/publication/257048076_Making_User_Experience_a_Business_Strategy/links/02e7e52441da6bbdcc000000.pdf#page=37

Roto, V., & Rautava, M. (2008). User experience elements and brand promise. http://www.academia.edu/16090594/User_experience_elements_and_brand_promise

Roto, V., Law, E., Vermeeren, A., & Hoonhout, J. (2011). User Experience white paper, bringing clarity to the concept of user experience. http://www.allaboutux.org/files/UX-WhitePaper.pdf

Roto, V., Obrist, M., Vaananen-Vainio-Mattila, K. (2009). User Experience Evaluation Methods in Academic and Industrial Contexts. https://static.googleusercontent.com/media/research.google.com/en//pubs/archive/37660.pdf

Saariluoma, P., & Jokinen, J. (2014). Emotional Dimensions of User Experience? A User Psychological Analysis. International Journal of Human-Computer Interaction, 30 (4), 303-320. doi:10.1080/10447318.2013.858460

Saavedra, A.R., & Opfer, V. D. (2012). Teaching and learning 21st century skills: Lessons from the Learning Sciences. Rand Corporation. https://asiasociety.org/files/rand-1012report.pdf

SAINFO. (2013, July 23). Teaching with tablets piloted in E Cape. Brand South Africa. https://www.brandsouthafrica.com/governance/education/ict4red-230713

Santosa, P.I. (2016). Measuring User Experience During a Web-based Survey: A Case of Back-to-Back Online Surveys. International journal on Advance Science Engineering Information Technology, 2(6), 339-344.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students. Fifth edition. Pearson Education.

Saunders, M., Lewis, P. & Thornhill, A. (2012) "Research Methods for Business Students" 6th edition, Pearson Education Limited.

Saunders, M., Lewis, P. and Thornhill, A. (2016). Research Methods for Business Students (7th edition). Harlow: Pearson Education Limited.

Scapin, D.L., Senach, B., Trousse, B., & Pallot, M. (2012). User Experience: Buzzword or New Paradigm? ACHI 2012 - 5th International Conference on Advances in Computer-Human Interactions. 336-341.

Shah, M. A. (2015). In the Labyrinth of Research: Critiquing Research Studies Conducted in Contrasting Paradigms. Journal of Language Teaching and Research, 6, 956-962. https://www.researchgate.net/publication/281633833_In_the_Labyrinth_of_Research_Critiquing_Research_Studies_Conducted_in_Contrasting_Paradigms

Shannon-Baker, P. (2016). Making paradigms meaningful in mixed methods research. Journal of mixed methods research, 10, (4), 319-334.

Shenoy, V., Mahendra, S., & Vijay, N. (2020). COVID 19 Lockdown Technology Adaption, Teaching, Learning, Students Engagement and Faculty Experience. Mukt Shabd Journal, 9, (4), 698-702. https://www.researchgate.net/publication/340609688_COVID_19_Lockdown_Technology_Adaption_Teaching_Learning_Students_Engagement_and_Faculty_Experience/citations

Simuja, C., Krauss, k., & Conger, S. (2016). Achieving inclusive and transformative ICT education practices in rural schools in marginalized communities. International Conference on Information Resources Management (CONF-IRM). Association for Information Systems AIS Electronic Library (AISeL).

Smit, B. (2002). Atlas.ti for qualitative data analysis. Perspective in Education, 20, (3).

Survey monkey (2019). Closed-ended vs open-ended questions. https://www.surveymonkey.com/mp/comparing-closed-ended-and-open-ended-questions/

Swanson, A.C. (2015). Exploratory research. Research gate.

Tan, J. 2009. FOUUX-A Framework for usability & User Experience. Master's Thesis. Blekinge Institute of Technology, Sweden. https://www.diva-portal.org/smash/get/diva2:829950/FULLTEXT01.pdf

Tan, J., Gencel, C., & Rönkkö, K. (2013). A Framework for Software Usability & User Experience Measurement in Mobile Industry. Doi: 10.1109/IWSM-Mensura.2013.31.

https://www.researchgate.net/publication/258705485_A_Framework_for_Software_Usability_User_Experience_Measurement_in_Mobile_Industry

TechTarget (2015, February). Framework. https://whatis.techtarget.com/definition/framework

Thomas, D., Thomas, A., & Fluck, A. (2014). Enhancing Pedagogy with mLearning. Information Science Reference, IGI Global, 350-363. Doi: 10.4018/978-1-4666-4502-8.ch020

Tian, X., Hou, W. & Yuan, K. (2008). A Study on the Method of Satisfaction Measurement Based on Emotion Space. Proceedings of CAID/CD 2008, 9th International Conference on Computer-Aided Industrial Design and Conceptual Design, Kunming, China, 39–43.

Toko, G. R. (2017). Closing the digital gap: handheld computing, adult first-time users, and a user experience metric model. Doctorate dissertation. UNISA. https://pdfs.semanticscholar.org/2148/82b4d2a0d3ded22d04944ed10b1a411c3048.pdf

Tokarova, L., & Weideman, M. (2013). Understanding the process of learning touch-screen mobile applications. SIGDOC, 157-164. https://doi.org/10.1145/2507065.2507066

Traxler, J. (2005). Defining mobile learning. IADIS International Conference Mobile Learning 2005, Research Gate, 261-266

Traxler, J. (2009). Learning in the mobile age. International Journal of Mobile and Blended learning, 1(1), 1-12.

Traxler, J. (2015, April 24). A digital 'Arab Spring' for higher education. University world news, the global window on higher education. http://www.universityworldnews.com/article.php?story=20150422065437831.

Trialogue. (2016, June, 02). Delivering a richer learning experience through ICT. http://trialogue.co.za/delivering-richer-learning-experience-ict/

Tullis, T., & Albert, B. (2013). Measuring the user experience, collecting, analysing and presenting usability metrics (2nd edition). Morgan Kaufmann Publishers Inc. San Francisco, CA, USA.

Vaishnavi, V. & Kuechler, B. (2013). Design Science Research in Information Systems Overview of Design Science Research. AIS. http://www.desrit.org/design-research-in -information-systems/

Van Biljon, J., & Dembeskey, E. (2011). Learning tools in resource constrained environments: Learning from e-learning in the time of m-learning. School of Computing, University of South Africa, Pretoria, Gauteng, South Africa.

Van Schaik, P. & Aranyi, G. (2014). Research White Paper Model-Based User Experience Engineering. Teesside University.

Van Staden, C. J., Van Biljon, J. A., & Kroeze, J.H. (2015). eModeration: Towards a user experience evaluation framework. SAICSIT. http://dx.doi.org/10.1145/2815782.2815821.

Van Staden, C.J., Van Biljon, J.A., Kroeze, J.H. (2017). Using a user experience evaluation framework for eModeration. 2017 Conference on Information Communications Technology and Society, 1–6.

Van Staden, C. J. (2017). User experience evaluation of electronic moderation systems: a case study at a private higher education institution in South Africa. Doctorate dissertation. UNISA.

http://uir.unisa.ac.za/bitstream/handle/10500/23586/thesis_van%20staden_cj.pdf?sequence=1&isAllowed=y

Van Wyk, B. (2012). Research design and methods part1. Post-graduate enrolment and throughput. University of the Western cape.

https://www.uwc.ac.za/Students/Postgraduate/Documents/Research_and_Design_I.pdf

Vavoula, G., & Karagiannidis, C. (2005). Designing mobile learning experiences, Education technology. https://www2.leicester.ac.uk/Members/gv18/downloads/publicationpreprints/conference-proceedings/VavoulaKaragiannidis-PCI2005.pdf

Venktess, k. (2017, January 26). Why SA's new ICT policy could break the industry. Fin24Tech. https://www.fin24.com/Tech/News/why-sas-new-ict-policy-could-break-the-industry-20170126

Vosloo, J.J (2014). Chapter 5: Research design and Methodology 5.1 Introduction. http://www.dspace.nwu.ac.za/vosloo_jj_chapter5

Walliman, N. (2011). Research methods: the basics. Taylor & Francis, Routledge publisher.

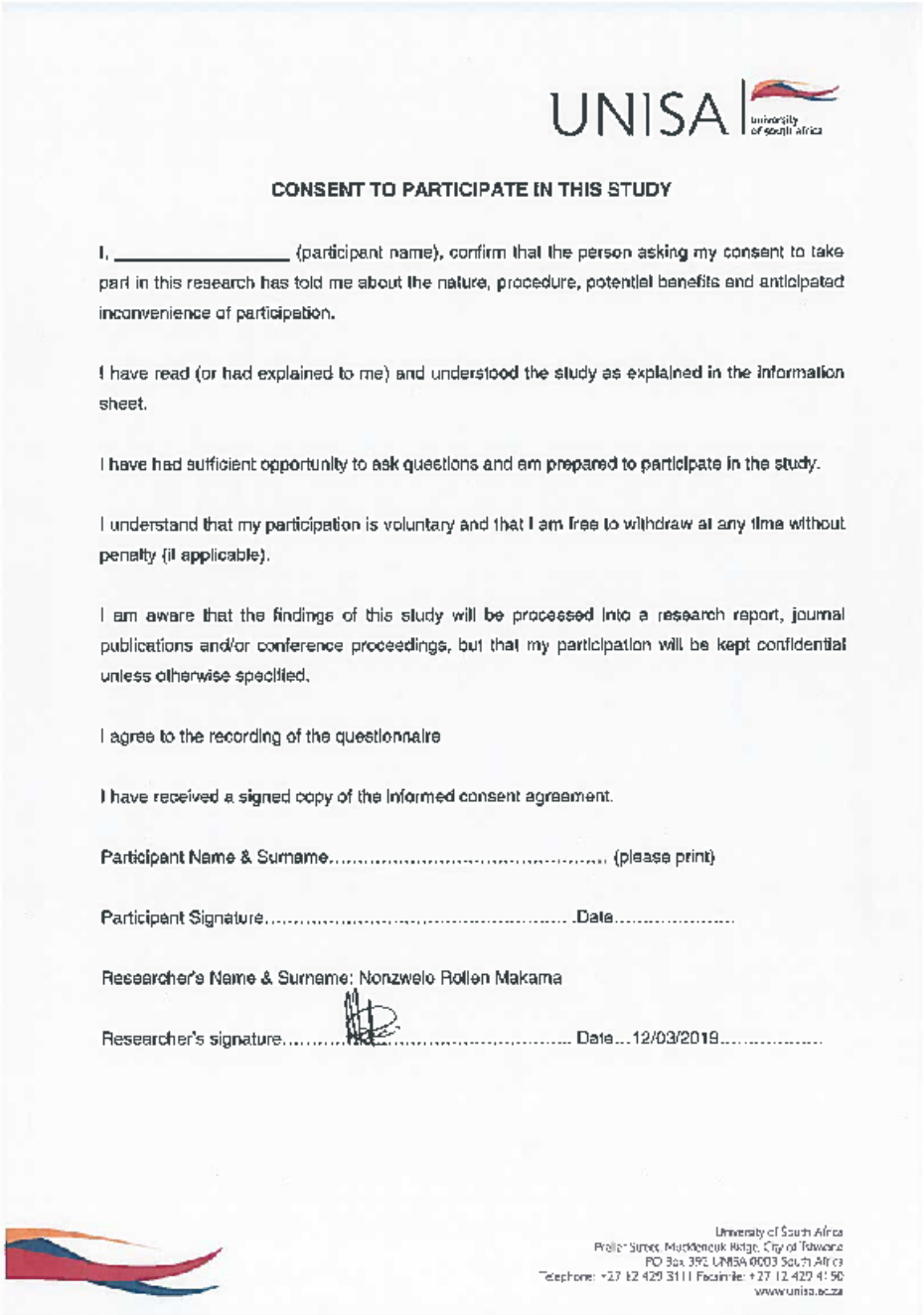
Wan, J., Zhu, Y., & Hou, J. (2013). Researcher on user experience quality assessment model of smart mobile phone. Scientific research, Technology and Investment, 4, 107-112. https://file.scirp.org/pdf/TI_2013052417545258.pdf

Wan, K. (2009). A brief history of context. IJCSI International Journal of Computer Science, 6, (2), 33-42. https://arxiv.org/ftp/arxiv/papers/0912/0912.1838.pdf

WDSglobal. (2010). Mass adoption of smartphones eroding carrier profitability http://www.wdsglobal.com/news/archive/2010/20100420/smartphones-eroding-carrier-profitability.pdf

Young, B., & Hren, D. (2006). Introduction to qualitative research methods. Methods in Research on Research (MiRoR). http://miror-ejd.eu/wp-content/uploads/sites/34/2017/03/Introduction-to-qualitative-research-methods.compressed.pdf

Appendix A: Consent to participate in the study



UNISA

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the questionnaire

I have received a signed copy of the informed consent agreement.

Participant Name & Surname..... (please print)

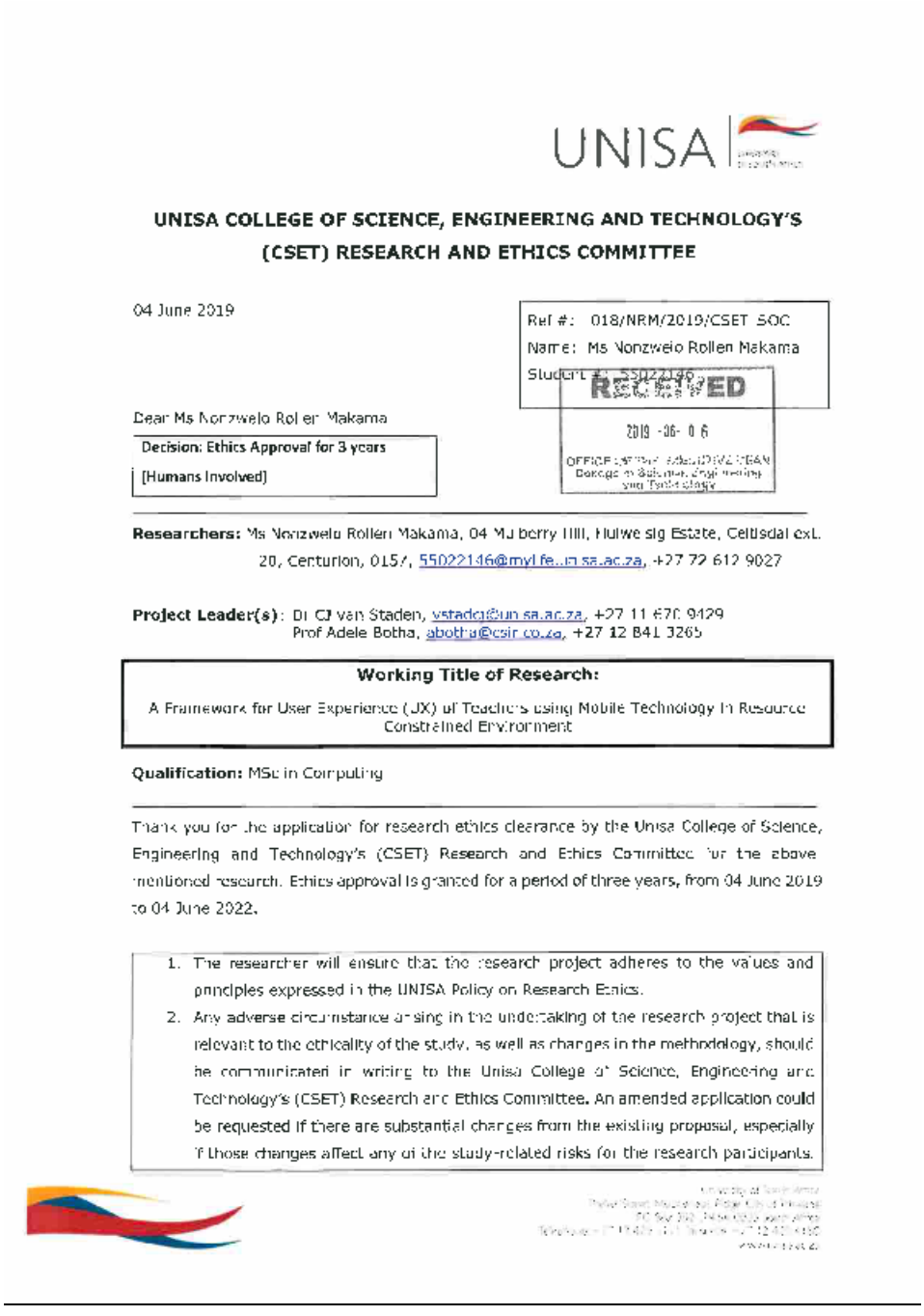
Participant Signature..... .Date.....

Researcher's Name & Surname: Nonzwelo Rollen Makama

Researcher's signature..... Date...12/03/2019.....

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392, UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Appendix B: UNISA Ethical clearance



UNISA

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) RESEARCH AND ETHICS COMMITTEE

04 June 2019

Ref #: 018/NRM/2019/CSET_SOC
Name: Ms Nonzwelo Rollen Makama
Student #: 55022146

RECEIVED
2019 -06- 06

Dear Ms Nonzwelo Rollen Makama

Decision: Ethics Approval for 3 years
[Humans Involved]

Researchers: Ms Nonzwelo Rollen Makama, 04 Mulberry Hill, Hulwe sig Estate, Celtisdal ext. 20, Centurion, 0157, 55022146@mylife.unisa.ac.za, +27 72 612 9027

Project Leader(s): Dr CJ van Staden, vstadcj@unisa.ac.za, +27 11 670 9429
Prof Adele Botha, abotha@csir.co.za, +27 12 841 3265

Working Title of Research:

A Framework for User Experience (UX) of Teachers using Mobile Technology in Resource Constrained Environment

Qualification: MSc in Computing

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee for the above mentioned research. Ethics approval is granted for a period of three years, from 04 June 2019 to 04 June 2022.

1. The researcher will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.

Appendix C: CSIR Ethical clearance

CSIR Meraka
PO Box 395 Pretoria 0001 South Africa
Tel: +27 12 841 2911
Fax: +27 12 349 1153
Email: Enquiries@csir.co.za

May 2019

Ms N Makama

It gives me great pleasure to reaffirm, on behalf of the Department of Land Reform and Rural Development approval for your research study: *A framework for user experience of teachers using mobile technology in resource constrained environment*, in the ICT 4 Education initiative.

The ICT4E DRDLR initiative was initiated by the department through a Departmental agreement between the Department of Education and DRDLR. This agreement extended to a number of other initiatives and is not in the public domain due to its sensitive nature. The CSIR is appointed the implementing agency and the initiative was operationalized by the University of the Free State.

Following due process, and with the needed government department agreements at managerial level, the CSIR obtained ethical clearance (research project is REF: 194/2016) to proceed with the initiative. Please find attached a copy of the approval.

Your study is now considered ex-post as the initiative ended in March 2019. As such your interaction is not IN schools but rather with teachers that have taken part in their personal capacity.

Regards

Prof Marlien Herselman
Chief researcher
Integrative systems, tools and technologies group
Meraka Institute
Building 43, room C 203
CSIR
Tel: +2712 8413081
Fax: +2712 8414720

Appendix D: Questionnaire

A framework for the user experience of teachers using mobile technology in resource constrained environment.

- **The purpose of this study is to explore and evaluate the user experience of teachers using mobile technologies (tablets) in resource constrained environments (rural schools).**
- **The participants chosen to participate in the study are teachers who participated in the Information Communication Technology for Education (ICT4E) project, where teachers were trained to use tablets at schools for teaching and learning.**
- **The feedback of participants is important as this study will be used to develop a framework that will act as a guideline to improve the use of tablets in rural schools.**
- **The questionnaire is divided into four sections (Section A, B, C and D).**
    - **Section A: Demographic details (Participants' information)**
    - **Section B: Questionnaire on User (Teacher)**
    - **Section C: Questionnaire on Mobile technologies (Tablets)**
    - **Section D: Questionnaire on Context (School)**

Note: Your personal details are not attached to the questionnaire, therefore, your participation will remain anonymous. The information provided will be treated as confidential because your privacy is important to us. Please try to answer all the questions. At the end of the questionnaire please provide your comments or suggestions about how the use of tablets at schools for teaching and learning can be improved.

<u>Section A: Demographic details</u> (Profile of the participant)

Please put an 'X' next to selected option.

1. Gender

1.1	Male	
1.2	Female	

2. Age of participants

2.1	Less than 20	
2.2	21-30	
2.3	31-40	
2.4	41-50	
2.5	Above 50	

3. What qualification do you hold? (more than one qualification can be selected).

3.1	National certificate	
3.2	Diploma	
3.3	Bachelor's Degree/ B-Tech	
3.4	Honours Degree	
3.5	Masters	
3.6	PhD	
3.7	Other	

If other, please specify……

4. Did you attend any training on using the tablet for teaching and learning?

4.1	Yes	
4.2	No	

How was the training ……

5. How do you rate your skills in using mobile technologies such as the tablets?

5.1 Novice	5.2 Average	5.3 High	5.4 Very high

6. How often do you use the tablet at school?

6.1 Everyday	6.2 Once a week	6.3 More than once a week	6.4 Few times a month	6.5 Never used it after training

Motivate your answer……..

7. What do you use the technology for? (more than one option can be selected)

7.1	Research
7.2	Administration
7.3	Creation of module pages to distribute content to learners and use it in a form of m-learning
7.4	Other

If other, please specify ……

8. What is your experience in using tablets for teaching and learning at school (please circle the response that you feel is applicable, you can choose multiple responses)?

8.1 I find it easy to use the tablets in teaching and learning
8.2 I am confident about using the tablet on my own

8.3 The tablet does not meet my expectations in teaching and learning
8.4 I enjoy teaching with the tablets
8.5 I do not recommend the use of tablets at schools for teaching and learning
8.6 The tablet I am using motivates me to deliver teaching and learning
8.7 I find the interface of the tablet attractive
8.8 My mood does not affect my use of the tablet at school in teaching and learning
8.9 I am able to apply my skills quickly when using the tablet
8.10 I have a positive perception about the use of tablets at schools
8.11 I feel negative about teaching the learners using the tablets
8.12 My experience with the tablet is positive

Section B: Questionnaire on User (Teacher): (*Please make a selection by putting an 'X' in an appropriate box, and please provide a comment in support of the selected option). Note: Teacher under description refers to the participants.*

Component User: Teachers	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	Agree	Not sure	Disagree	Strongly disagree	
B1. User's	B1.1 Needs	**B1.1.1.** Teacher needs to be satisfied with the use of the tablet at school.						
		B1.1.2. Teacher needs the tablet to be user friendly (ease of use).						
		B1.1.3. Teacher needs to accept the use of tablet at school.						
		B1.1.4. The teacher should be able to perform tasks using the tablets effectively.						
		B1.1.5. Teacher needs to be encouraged when engaging with the tablet.						
	B1.2 Perception	**B1.2.1.** The perception of teachers about the use of the tablet is very important.						
		B1.2.2. As a teacher I have a positive perception of the use of tablets at schools.						
		B1.2.3. Teachers perceive tablets as beneficial (helpful) to teaching and learning.						

Component User: Teachers	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
		B1.2.4. Teachers perceive the tablets as easy to use.						
		B1.2.5. The tablet is perceived as a useful tool in teaching and learning.						
	B1.3 Attitude	**B1.3.1.** The teacher's attitude towards the use of the tablet is very important.						
		B1.3.2. As a teacher I have a positive attitude when it comes to use of tablets in teaching and learning at schools.						
		B1.3.3. As a teacher I am comfortable with the use of tablets for teaching and learning at schools.						
		B1.3.4. Teacher's attitude is an important factor in accepting or rejecting the use of tablets in schools.						
	B1.4 Experience	**B1.4.1.** The experience of teachers when using the tablet is very important.						

Component User: Teachers	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	Agree	Not sure	Disagree	Strongly disagree	
		B1.4.2. Teachers require skills to have a good experience with tablets at school.						
		B1.4.3. Gender may influence the teacher's experience of the use of tablets in schools.						
		B1.4.4. Age may influence the teacher's experience of using tablets at schools.						
	B1.5 Expectations	**B1.5.1.** The tablets meet our expectations of supporting teaching and learning at our school.						
		B1.5.2. Teachers expect the use of the tablet to meet the functionality requirements of teaching and learning.						
		B1.5.3. Teachers expect the use of the tablet to meet the non-functionality requirements such as performance, reliability.						

Section C: Mobile Technologies (Tablets): (*Please make a selection by putting an 'X' in an appropriate box, and please provide a comment in support of the selected option).*

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
C1. Features of the device (tablet)	**C1.1 Usability**	**C1.1.1.** Teachers find the use of the tablet to be efficient — quick to learn.						
		C1.1.2. Teachers expect the tablet to be easy to use.						
		C1.1.3. Teachers find it easy to navigate their way to certain functionality using the tablets.						
		C1.1.4. I am satisfied with using the tablet to perform my daily task as a teacher.						
		C1.1.5. The errors encountered when using the tablets do influence my experience of using the tablet.						
	C1.2 Hedonic and Aesthetic attributes	**C1.2.1.** The visualisation or the appearance of the tablet does influence my experience of using the tablet.						
		C1.2.2. The features of a tablet motivate teachers in their teachings.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
		C1.2.3. The tablets we received have proper visualisation, they are attractive to use.						
		C1.2.4. Teachers perceive the appearance of the tablets as pleasing.						
		C1.2.5. The tablet is perceived as a useful tool in teaching and learning.						
	C1.3 Functionality - efficiency	**C1.3.1.** Functionality of the tablet enables teachers to navigate the tablet without any constraints.						
		C1.3.2. The functionality of the tablet is easily accessible.						
		C1.3.3. I am satisfied with the functionalities of the tablets I use for teaching and learning.						
C2. Users expectations	**C2.1 Control & Ownership**	**C2.1.1**. Having control and ownership on the tablet motivates the user to navigate the tablet freely.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
		C2.1.2. I do not feel safe about sharing my tablet with other teachers.						
		C2.1.3. The administration functionalities of the tablet require confidentiality.						
		C2.1.4. The work of the teachers on the tablets needs to be protected.						
	C2.2 Flexibility	**C2.2.1.** Flexibility of the tablets gives teachers freedom to work anywhere.						
		C2.2.2. The tablets we received at our school give us flexibility to move around while teaching.						
		C2.2.3. Flexibility motivates the user as there is no limitation to teaching and learning while physically moving.						
		C2.3.1. Tablets need to be reliable.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
	C2.3 Credibility	**C2.3.2.** The tablets should be monitored, to ensure that they are used for learning and teaching purposes only.						
		C2.3.3. The tablets need to work consistently.						
	C2.4 Valuable	**C2.4.1.** The tablet enables me to perform my daily tasks.						
		C2.4.2. The tablet enables me to add value to the learners teaching and learning experience.						
		C2.4.3. Tablet is a helpful tool without it the task of teaching is much more difficult.						
		C2.4.4. The use of tablets add value to the education system in South Africa.						
	C2.5 Desirable	**C2.5.1**. The tablet should be (desirable) pleasing to interact with.						
		C2.5.2. The tablets that we use in our school are motivating.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
		C2.5.3. The aspect (physical features) of the tablet should be appealing to the teachers.						
C3. Digital skills	**C3.1 Technological skills**	**C3.1.1**. Teachers need to know how to operate the tablet for teaching and learning purposes.						
		C3.1.2. The issue of technophobic (fear of technology) teachers needs to be addressed.						
		C3.1.3. Teachers need to know how to operate the tablet for administration and research purposes.						
	C3.2 Critical thinking	**C3.2.1.** Teachers require critical thinking skills to engage with the tablet and its content.						
		C3.2.2. Teachers are expected to understand how the tablets operate.						
		C3.2.3. Teachers are expected to transfer skills to the learners.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**	
	C3.3 Problem solving	**C3.3.1.** Teachers require some level of problem-solving skills in order to learn to use the tablet.						
		C3.3.2. Teachers are expected to come up with solutions should the tablets be dysfunctional.						
		C3.3.3. Teachers require problem-solving skills to learn to work on technical tasks in teaching.						
	C3.4 Creativity	**C3.4.1**. Teachers are required to think creatively in order to apply knowledge when using the tablets.						
		C3.4.2. Teachers are required to be innovative when using the tablet.						
	C3.5 Qualified teachers	**C3.5.1**. There are an inadequate number of teachers at schools to teach learners using the tablets.						

Component System: Tablet	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					Please provide a comment
			Strongly agree	Agree	Not sure	Disagree	Strongly disagree	
		C3.5.2. Unskilled teachers require training to enhance teaching and learning at schools using tablets.						
		C3.5.3. Teachers' professional development is important to accelerate the use of tablets at schools.						

Section D: Context (School):(*Please make a selection by putting an 'X' in an appropriate box, and please provide a comment in support of the selected option).*

Component context: School	Elements affecting the UX using Mobile technology	Description	*Please put an 'X' next to selected option.*					
			Strongly agree	Agree	Not sure	Disagree	Strongly disagree	

								Please provide a comment to motivate your selection
D1. Context	**D1.1 Physical context**	**D1.1.1**. The environment where the teaching and learning takes place might have an influence on the teachers' experience of using the tablets.						
		D1.1.2. Availability of technology support is important in resource constrained environments (rural schools).						
		D1.1.3. We do not experience any problems when using the tablets in our school.						
		D1.1.4. Poor environment may result in poor experience when using tablets at schools.						
		D1.1.5. The environment where teaching and learning is happening is important.						
	D1.2 Social context	**D1.2.1.** The opinion of other teachers on how their colleagues (teachers) should operate the tablets may influence the experience of the teacher.						
		D1.2.2. I operate the tablet freely without the intervention of my colleagues.						

		D1.2.3. The instructions from the school governing body or principal on how the tablets should be used by the teachers may influence the teacher's experience of using the tablet.						
		D1.2.4. The beliefs of other teachers about the tablets do not influence my experience with the tablet.						
		D1.2.5. Our school culture does influence the use of tablets in teaching and learning in my school.						
	D1.3 Task context	**D1.3.1.** Multitasking when using a tablet may affect the concentration of the teachers.						
		D1.3.2. Lack of educational resources such as instructions on how to perform a task using a tablet, may influence the teachers' experience.						
		D1.3.3. The focus of the teacher when giving tasks using the tablet is important.						
		D1.4.1. The availability of Information Communication Technology (ICT) services at schools is important when using tablets.						

	D1.4 Technical and information context	**D1.4.2**. Teachers at my school are able to connect to the Internet anytime using the tablets.						
		D1.4.3. The tablets operate well at our schools.						
		D1.4.4. Availability of network coverage at schools is important when using the tablets.						
D2. ICT integration at schools	**D2.1 Lack of policy implementation**	**D2.1.1**. The lack of policy implementation may have an influence on the use of technology (tablets) at schools.						
		D2.1.2. There are proper policies that govern the use of tablets at our school.						
		D2.1.3. Improper implementation of the Information Communication Technology (ICT) frameworks may have an impact on the adoption of mobile technologies at schools.						
	D2.2 Training	**D2.2.1**. The skills of the teachers in ICT are important to bring transformation and use of tablets at schools.						
		D2.2.2. We have enough trained teachers to support teaching and learning using tablets in my school.						

		D2.2.3. Training is required to ensure the adoption and implementation of tablets at schools.						
		D2.2.4. Teacher's readiness to adopt the use of tablets at school may influence the use of tablets at schools.						
		D2.2.5. Teacher's competence in ICT skills is imperative when using tablets for teaching and learning.						

Please provide any concerns or comments regarding your experience using tablets in schools for teaching and learning:

……

……

……

……

Thank you for your participation in the study!