Mobile learning: a professional teacher technical identity development framework

by

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Declaration

I declare that the thesis, which I hereby submit for the degree Philosophiae Doctor (Computer Integrated Education) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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Kimera Moodley

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Ethical clearance certificate

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The author, whose name appears on the title page of this thesis, has obtained, for the research described in this work, the applicable research ethics approval. The author declares that she has observed the ethical standards required in terms of the University of Pretoria's *Code of ethics for researchers and the Policy guidelines for responsible research*.

Dedication

This PhD is a dedication to my mom Sallyana Moodley for always believing in me and continuously supporting my academic career.

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To my Family

Thank you for your support and encouragement to continue persevering and your understanding though this journey.

Abstract

This study explored Professional Teacher Technical Identity Development through the use of Mobile Technology. A sample of fifteen teachers was conveniently selected from one school in an urban setting. An action research was designed consisting of three phases. Each phase formed the basis of the next phase to identify the development of professional teacher technical identity. Data was collected using a written questionnaire, two reflective journals, an online questionnaire, focus group discussions, lesson reflections, and interviews. Each instrument was designed using the literature to identify factors that impact on the implementation of mobile technology in classrooms and teachers' acceptance towards mobile technology. The results were interpreted using three existing models to create a framework: The Technology, Pedagogy and Content Knowledge model, Technology Acceptance Model and Substitution, Augmentation, Modification and Redefinition Model.

It was found that there are six factors that affect the perceived usefulness and perceived ease of use of technology. These are attitude, anxiety, ability, subjective norm, facilitating conditions and voluntariness. The perceived ease of use and perceived usefulness determine the level at which technology is implemented in classrooms. The level of integration determines whether or not successful teaching in terms of the three elements of TPCK is being used. During the process whereby teachers attempt to implement technology in their classrooms, it is possible to identify changes in their professional teacher technical identity development. These changes are interpreted and a new framework for Professional Teacher Technical Identity Development is created. It is proposed that this framework can be used to explain the implementation process and behaviour of teachers during the process as their teacher identity is altered.

Key Terms: Mobile Learning, Teacher Technical Identity, Teacher Professional Development, Teacher Identity

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List of Abbreviations

ARCS – Attention, Relevance, Confidence, Satisfaction

CAPS- Curriculum Assessment Policy Statement

CK- Content Knowledge

CSIR- Council of scientific and Industrial Research

GPRS- General Packet Radio Service

GNU- Government of National Unity

HSRC- Human Science Research Council

ICT- Information and Communication Technology

ICT4RED- Integrated Communication Technology for Rural Education

IT- Information Technology

LIMVIT- Limitless Virtual

LMS- Learning Management System

PC- Personal Computer

PCK- Pedagogical Content Knowledge

PDA- Personal Digital Assistant

PK- Pedagogical Knowledge

SAMR- Substitution, Augmentation, Modification, Redefinition

SITES- Second Information Technology in Education Study

SPSS – Statistical Package for Social Sciences

TAM- Technology Acceptance Model

TCK- Technology Content Knowledge

TESSA – Teacher Education in Sub-Saharan Africa

TECH4RED – Technology for Rural Education

TK-Technology Knowledge

TPCK- Technology, Pedagogy Content Knowledge

TPK- Technology Pedagogical Knowledge

TTPID- Teacher Technical Professional Identity Development

Table of Contents

List of Figures

Page:

List of Tables

Page:

Appendices

1. Appendix A - Instrument 1- Appendix A - Written Questionnaire.pdf
2. Appendix B - Instrument 2 - Appendix B - Online Questionnaire.pdf
3. Appendix C - Instrument 3 - Appendix C - Lesson Reflection.pdf
4. Appendix D - Instrument 4 - Appendix D - Reflective Journal 1 and 2.pdf
5. Appendix E - Instrument 5 - Appendix E - Focus Group Discussion 1.pdf
6. Appendix F - Instrument 5 - Appendix F - Focus Group Discussion 2.pdf
7. Appendix G - Instrument 6 - Appendix F - Focus Group Discussion 2.pdf
8. Appendix H - Data Analysis - Appendix H - Data Analysis.pdf
9. Appendix I – Proof that age and years of experience are normally distributed

Chapter 1

Introduction

"I hear and I forget, I see and I remember, I do and I understand."

Confucius

1.1 Orientation

"Technology has become so much a part of our lives in the 21st century that even being fully literate now includes an aspect of 'computer literacy'." (Mayisela, 2013, p. 1). Computer literacy being the forefront of technology literacy has advanced to the development of mobile technology and "mobile technology literacy". Mobile teaching and learning is a method of teaching and learning that allows teachers and learners to use mobile devices containing digital content anywhere and at any time. These devices include PDA's (Personal Digital Assistants), laptop computers, cellular phones with wireless communication capabilities, as well as customized hardware (Ismail, Bokhare, Azizan, & Azman, 2013; Liu & Hwang, 2010; Mac Callum, 2010; Mayisela, 2013; Teo & Milutinovic, 2015). The latest development of mobile devices otherwise known as hand-held devices such as iPads, tablets and smartphones has stirred great debate about how these devices can be used as a resource in teaching and learning (Crompton, 2013a; Summey, 2013; Traxler, 2013d). Since mobile devices are affordable and easily accessible they are now owned by the masses. "Likewise, developments in wireless communication networks such as the 3G/data card, data bundles, Bluetooth, Wi-Fi and general packet radio service (GPRS) further extend this opportunity for mobile technology users." (Mayisela, 2013. p. 1).

1.2 Background

Over the last decade the effectiveness and efficiency of mobile technology as a teaching tool and learning resource has been tried and tested in various educational fields in both formal and informal settings such as maths e.g. (Zurita & Nussbaum, 2004), science e.g. (Huang, Jeng, & Huang, 2009), language e.g. (Cui & Bull, 2005),

environmental e.g. (Chu, Hwang, Tsai, & Tseng, 2010; Lai, Yang, Chen, Ho, & Chan, 2007; Rogers et al., 2005) and ecological e.g. (Chu, Hwang and Tsai, 2008; Hwang, Kuo, Yin, and Chuang, 2010) studies.

These studies show that without proper instructional strategies, the results of these initiatives can be disappointing (Chu, Hwang, & Tsai, 2010; Hwang, Chu, Shih, Huang, & Tsai, 2010). Hoppe and colleagues (2003. p. 255) argue that learning with wireless mobile computing supports "active, productive, creative and collaborative learning methods". In education there has been great debate about the effectiveness and efficiency of mobile technology being used as a teaching tool or a learning resource (Govender & Govender, 2014; Herselman & Botha, 2014; Hoppe et al., 2003; Kihoza, Zlotnikova, Bada, & Kalegele, 2016; Nkula & Krauss, 2014). Teachers are encouraged to use technology as a resource and allow learners to explore and discover through different methods of learning. To ensure that learners do not aimlessly roam around on these devices, teachers need to carefully structure and design a learning environment that is interactive and stimulating but at the same time educational (Peng, Su, Chou, & Tsai, 2009). In order to implement this type of teaching method the needs of teachers have to be addressed (Cobcroft, Towers, Smith, & Bruns 2006; Peng et al., 2009).

In South Africa the educational use of mobile phones is gaining momentum (Motlik, 2008). Motlik's (2008) study compared the use of mobile technology in Asia, North America and Africa. He found that Asia, more specifically China was leading in terms of mobile technology diffusion. America was found to have the highest number of internet adopters and Africa the lowest mobile technology and internet diffusion rates. A study done by Brown (2003) at the University of Pretoria, reported that mobile learning "has already started to play a very important role in e-learning in Africa" and that the growth of mobile learning "has brought e-learning to the rural communities of Africa to learners that we never imagined as e-learning learners just a few years ago" (p. 11). Due to the rising demand of learner population coupled with a more diverse body of learners it has become a need to mediate though Information and Communication Technologies (ICTs) and find innovated modes of delivery in education (Evoh, 2011). Higher education institutions are finding more learners that are under-prepared and it is becoming more difficult to bridge the gap without

remedial support in ICTs (Jaffer, Ng'ambi, & Czerniewicz, 2007). The White Paper for e-Education that was released in 2003 recognises the objectives of education to be of quality, equity and relevance. In implementing this, factors such as connectivity in schools, ICT integration in teaching and learning, support for ICT facilities etc., were some of the targets. The Department of Basic Education in South Africa confirmed that ICT use in education was of high importance and that all students should be computer literate by 2013 (Nkula & Krauss, 2014).

In 2013, Mayisela from Walter Sisulu University conducted a study at three tertiary institutions focusing on the accessibility and communication of coursework in various fields. He found that due to the number of learners that have smartphones, tablets and iPads, the accessibility of coursework and communication with mobile devices was available. However, it was not evident as to whether learners with access to these mobile applications received better results than learners that did not have access. Nkula and Krauss (2014) found that schools that have access to ICTs use it in a limited manner and focus mainly on acquiring ICT skills as opposed to implementation with integration.

1.3. Social context

Tertiary institutions such as the University of Pretoria, University of Witwatersrand, Stellenbosch University, Cape Peninsula University of Technology, University of South Africa and University of Cape Town, have recently started offering courses on mobile technology to help train and provide professional development for teachers (e.g. University of Pretoria – "mobile learning for the 21st century facilitator"). These courses aim to train teachers how to implement mobile technology into their teaching practice and also assist in the development of technology literacy, more specifically their mobile technology literacy. During this process of implementation, learning and teaching, an aspect of teacher professional identity is developed (Ben- Peretz, Kleeman, Reichenberg, & Shimoni, 2010; Dinkelman, 2011; Izadinia, 2014). The identity development is a crucial aspect of change in a teacher's life as it creates a different framework for each teacher to develop personally and professionally (Summey, 2013).

Within the South African context of education we are currently aiming towards the use of mobile technology in classrooms. Initiatives such as Information and

Communications Technology for Rural Education (ICT4RED) in the Eastern Cape and Gauteng Online are a few projects that have started to bring mobile technology to all areas in South Africa (Herselman & Botha, 2014). The success of these projects have led to further projects such as Technology for Rural Education (TECH4RED) now in other provinces such as Eastern Cape and Free State. Recent newspaper articles (Mailoane, 2015; staff, 2015a, 2015b) indicate that the Gauteng Department of Education has started distributing tablets to different schools in the Gauteng province as a form of introduction to mobile technology but there are challenges that come with the implementation for teachers. Studies are being done in rural areas to encourage the use of mobile technology in classrooms (Herselman & Botha, 2014; Jacobs, 2013). However, the training for teachers is still an aspect that needs to be addressed more adequately by the Department of Education (SchoolNetSouthAfrica, 2018). Tertiary institutions have started to include coursework to ensure that new teachers are digitally literate to cope with the demands of modern teaching methods (Nkula & Krauss, 2014). However, current teachers in the system are not receiving professional development in this regard. This leaves schools with resources and learners that may be able to use these resources but teachers that do not know and understand how to use and incorporate these resources for effective teaching and learning in their classrooms.

This study took place in an urban school in Pretoria. The school was well equipped with technology and available Wi-Fi. Fifteen teachers were purposefully chosen from different learning areas to participate in the study. The study comprised of a case study within a practical action research. The study followed a cyclic approach and is discussed in detail in Chapter 4. The teachers were required to integrate mobile technology into their teaching. Due to the inconsistency of technology ability amongst the teachers, a mobile learning workshop was presented to the teachers to give them the basic technology literacy that they required to complete the tasks for the study. The teachers were then required to teach using technology and report on their teaching during a five week focus group discussion and support session. The researcher was able to identify factors that affect the implementation of technology in teaching and develop a framework of professional teacher technical identity by using three models described in Chapter 3.

1.4 Problem

With the continuous developments in mobile technology that is occurring almost daily and the vast research being done on how “mobile apps” are beneficial or superficial. There is a digital divide between teachers and teaching, and teachers and learners that is increasing. This gap is widening with the strong resistance from educational environments (Blignaut, Hinostroza, Els, & Brun, 2010; McClure, 2011). With the implementation of the new Curriculum Assessment Policy Statement (CAPS) syllabus, South African teachers are expected to make their lessons interactive and use technology as a learning tool. Furthermore, as technology and teaching methods change and adapt according to the syllabus and the world we live in, the training and development of teachers in terms of teaching methodology needs to be addressed. Teachers are expected to use innovative teaching methods but the extent to which they understand and are aware about how and when to use these methods raises concern as they lack the necessary ICT skills (Nkula & Krauss, 2014) (see paragraph 2.7). As teaching and learning changes due to technology, there is deliberation as to whether learners find these methods better than conventional teaching methods. Currently there is no comprehensive framework that explains the complex interrelationship between the technological developments, their potential for learning and their place in our everyday lives (Cochrane, 2013a). Mobile technology has been tried and tested in many primary, secondary and tertiary institutions but it appears as if very little research is done on the implementation process and the teachers’ professional identity development during the adoption of mobile technology. According to Kihoza et al. (2016. p. 108), “there is no framework globally accepted and applicable to all education systems….to enhance and transfer practical technology use skills amongst young teacher trainees.” At this stage teachers are pressured with a syllabus to complete and content that is not easily understood by all learners. The South African White Paper on e-Education identified that the greatest challenge associated with teaching and learning with ICTs in South African schools is ICT adoption (Nkula & Krauss, 2014). Rajasingham (2011) and Nkula and Krauss (2014) found that even though mobile technologies are convenient and accessible, the focus is on the collaboration of learning between teachers and learners, and between learners, to process and construct new knowledge that can be applied to real-life problems to add value to society. In order for this to occur there needs to be

effective mediating of the interlinking of technology and pedagogy (Chu, Hwang, & Tsai, 2010; Hwang et al., 2010). Nkula and Krauss (2014) emphasises that implementation with integration does not merely mean technical skills and learning *about* a computer or mobile device but it means learning *through* a computer or mobile device. Integration implies that technology is used as a means to facilitate teaching and learning. Research on successful implementation of mobile technology to achieve optimum learning outcomes and the alignment of learner/teacher expectations for a generation of new skills are still scarce. Jude, Kajura, and Birevu (2014) present four main issues that need to be addressed in order to bridge the gap between ICT in education.

1. *Lack of a strong and vibrant unit that can push for the implementation of educational technologies*
2. *Lack of knowledge on how to use the ICTs in question*
3. *Non-availability of relevant ICT infrastructure*
4. *The lacklustre implementation of educational technologies policies*

This study aims to address the first and second aspects. As we begin to address these aspects of knowledge in ICT and the implementation of it, a shift in identity amongst teachers is evident. However the shift within teacher education programmes and teacher development is only beginning. Teacher professional development is the most cited barrier to the integration and implementation of ICTs (Nkula & Krauss, 2014). The importance of teacher identity development and the notion of identity shifts has become a crucial discussion of recent (Beauchamp & Thomas, 2009; Hoban, 2007). Hammerness, Darling-Hammond, and Bransford (2005. p. 383) make the following statement on teacher development which still holds true for our current education system:

> *Developing an identity is an important part of securing teachers' commitment to their work and adherence to professional norms…the identities teachers develop shape their dispositions, where they place their effort, whether and how they seek out professional development opportunities, and what obligations they see as intrinsic to their role."*

Therefore, there is a need to bridge the gap between the implementation of mobile technology and the professional identity development of teachers, taking into consideration their social context, availability of resources and technology proficiency (Blignaut et al., 2010; Czerniewicz & Brown 2005; Louw, Brown, Muller, & Soudien, 2009).

1.5 Rationale

The core focus of this study is to understand the growth and development that takes place in teachers as they adopt mobile technology in their classroom, paying special attention to their professional identity. The study investigates the possibilities to bridge the gap between teacher and technology and between teacher and learner and, in so doing, create awareness as to the type of professional development required for current and future teachers. This will enable them to keep up with the standards of the technologically advanced learners of today, create awareness, assist in bridging the gap between learners and teachers and allow for further growth. It will take into consideration the social context, willingness to learn, growth and change, and the development of a technically savvy attitude, within the education framework and allow for the growth of digitally based lessons as a branch of pedagogy.

1.6 Purpose

The purpose of this study is to create a framework that will support professional teacher technical identity development for mobile learning adoption in secondary schools in South Africa. It aims to explore Mobile Learning acceptance on all levels suggested by the SAMR model. This study will propose a framework to integrate knowledge of content, technology and pedagogy with teacher identity and professional development through the use of mobile technology. This framework will incorporate aspects from the Technology, Pedagogy and Content Knowledge (TPCK), Technology Acceptance Model (TAM) and Substitution, Augmentation, Modification and Redefinition (SAMR) models. The study aims to use an existing mobile learning workshop as a form of training to help in-service teachers implement mobile learning through integration. They will be assessed in terms of how teachers experience implementation, teacher adoption and acceptance and teacher identity in terms of growth and development.

The objective of the study is to highlight three aspects that will contribute to the union of technology in education and professional teacher technical identity development:

- Theoretical contribution

The theoretical contribution of this study is to provide a framework for Professional Teacher Technical Identity Development.

- Methodological contribution

  The methodological contribution of this study is to provide a practical action research approach to implement mobile technology.

- Practical contribution

  The practical contribution of this study is to identify a practical process that can be implemented for identity development.

1.7 Aim and research questions

The broad aim of this study is to explore the growth and development of teacher's professional identity as they implement mobile technology in their classroom. The study investigated the comparison between the challenges they encounter, their attitude and behaviour towards mobile learning acceptance, their willingness to learn how to use technology in their teaching and the change in lesson planning and productivity of their lessons during the adoption and implementation process. This will serve as a means of identifiable development.

Main research question for this study is:

How does mobile technology acceptance advancement shape professional teacher technical identity development?

Sub questions to assist in addressing this question.

1. What are the beliefs of teachers towards mobile learning?
2. What are the identifiable mobile technology acceptance advancements during formal mobile teacher training?
3. How do teachers implement mobile technology in teaching after formal training?
4. What factors influence the level of implementation of mobile technology in classrooms?
5. How do these factors shape teacher identity development?

1.8 Concepts

Core concepts: Mobile Learning, Teacher Technical Identity, Teacher Professional Development, Teacher Identity.

Various definitions are given for mobile learning (Ju-Ling, Chien-Wen, & Hwang, 2010; Keskin & Metcalf, 2011). “Mobile learning” defined by Sharples Taylor & Vavoula, (2005) is learning that takes place in a familiar environment with the use of a mobile device. The e-Learning Guild describes mobile learning as “an activity that allows individuals to be more productive when consuming, interacting or creating information, mediated through a compact portable device that the individual carries on a regular basis and had reliable connectivity and fits in a pocket or purse”. For this study mobile learning will be defined as the learning involving the use of a mobile device such as a tablet or smartphone.

Teaching is seen as a personal activity and is therefore influenced by the perceptions of the individual and how they view the world (Nias, 1989). Therefore teacher identity is developed and ever changing as the individual’s perceptions are influenced or modified. Teacher technical identity development will therefore be seen as an ongoing process that changes during the course of the study.

Teacher professional development can be seen as a complex process, which requires both the cognitive and emotional involvement of teachers as individuals and collectively. It is their willingness and capacity to examine one another in terms of their convictions and beliefs and peruse or enact appropriate alternatives for change and improvement (Avalos, 2011).

Teacher identity can be seen as a frame or analytic lens through which we examine different aspects of teaching like the way learners integrate a range of influences or the necessary confrontation of tension and contradictions in their careers (Olsen, 2008). McKoen and Harrison (2010. p. 27) define identity as a “socially and culturally constructed “self” formed through a life’s experiences and through communication about these experiences.” Alternatively it can be seen as the way in which teachers organise their lives professionally and explain, justify and make sense of themselves in relation to others and the world around them (MacLure, 1993).

1.9 Research methodology

This section will present the research methodology and include the aspects of philosophy, design, approach and strategy that are employed in the study. Using the "research onion" proposed by Saunders, Lewis, and Thornhill (2000), the research design for this study is presented in Figure 1.1. This model symbolises the research design as layers of an onion, where each layer influences and to some extent predetermines the decisions or options for the next layer. The layers on the onion need to be considered in totality to ensure the synergy between each layer. This model forms the basis of the research and each layer needs to be understood in order to follow the research process. The model is explained in detail in Chapter 4.

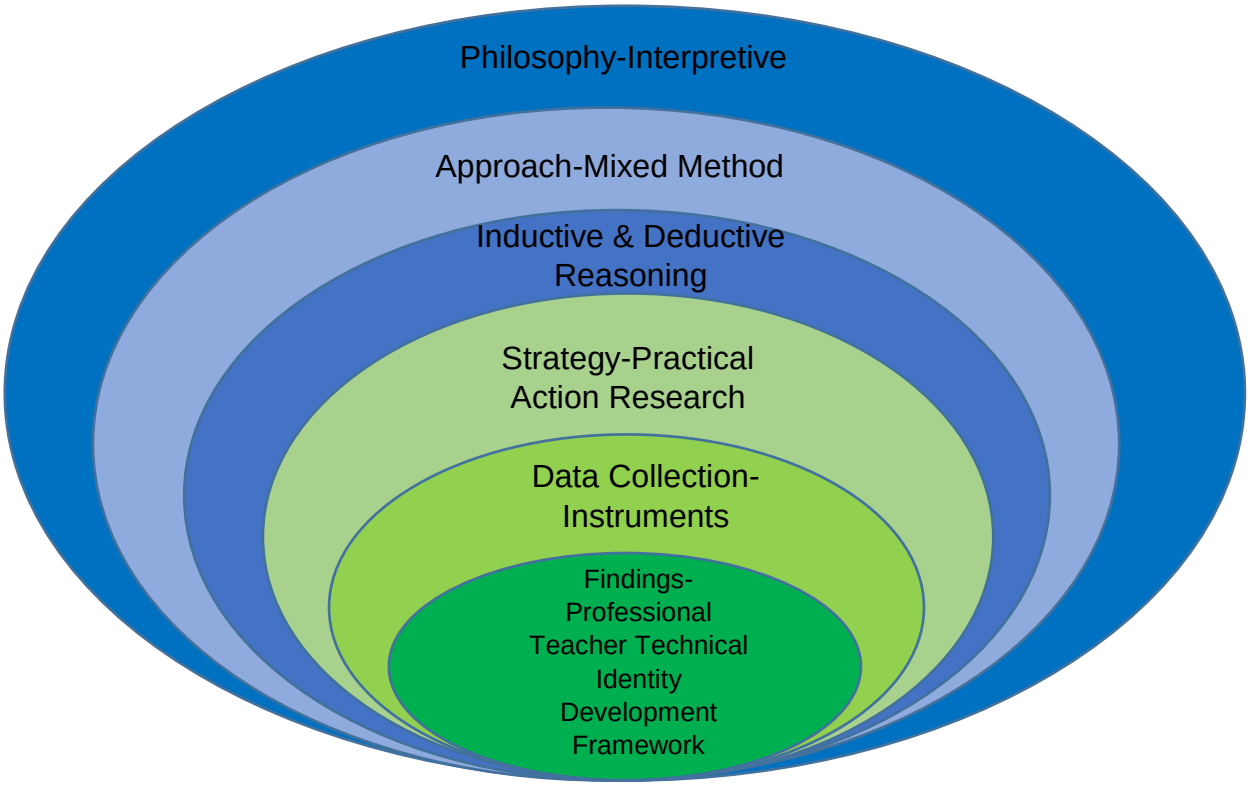


Figure 1.1: The Research Process "onion"

(Saunders et al., 2000. p.85)

The study followed a practical action research approach. A convenient sample of fifteen teachers was chosen across twelve different learning areas from an urban school in Gauteng. The study incorporated both qualitative and quantitative methods. Figure 1.2 illustrates each phase of the research design and the action taken.

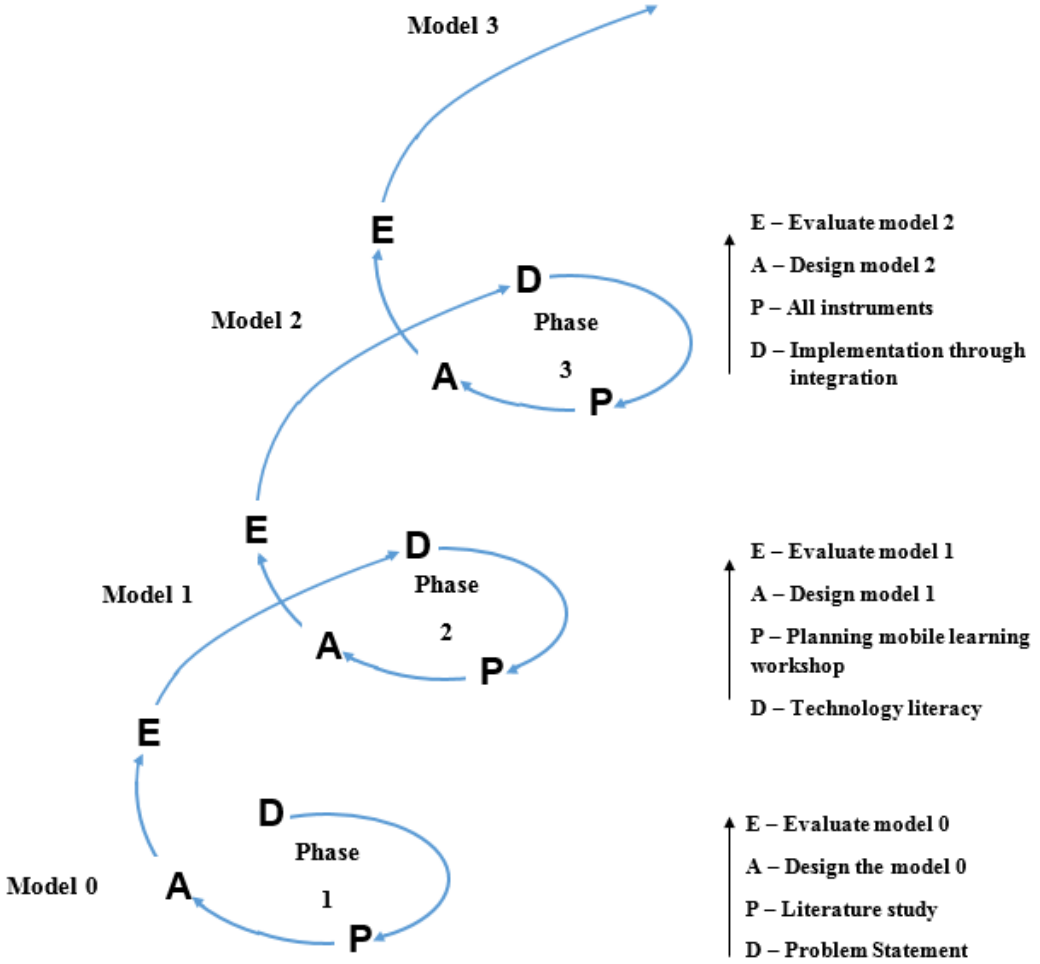


Figure 1.2: Research Design

The study follows a cyclic approach consisting of three phrases. The design and action research process is discussed in great detail in Chapter 4. An intervention in the form of a mobile learning workshop is presented to the participants to provide the basic knowledge of mobile technology use. Together with continuous support in the form of focus group discussions, teachers are expected to implement mobile technology through integration in their teaching. This resulted in the design of a Professional Teacher technical Identity Development Model that was redesigned after each cycle to produce the final Model.

1.10 Structure of this Thesis

Figure 1.3 illustrates the structure that this thesis will follow.

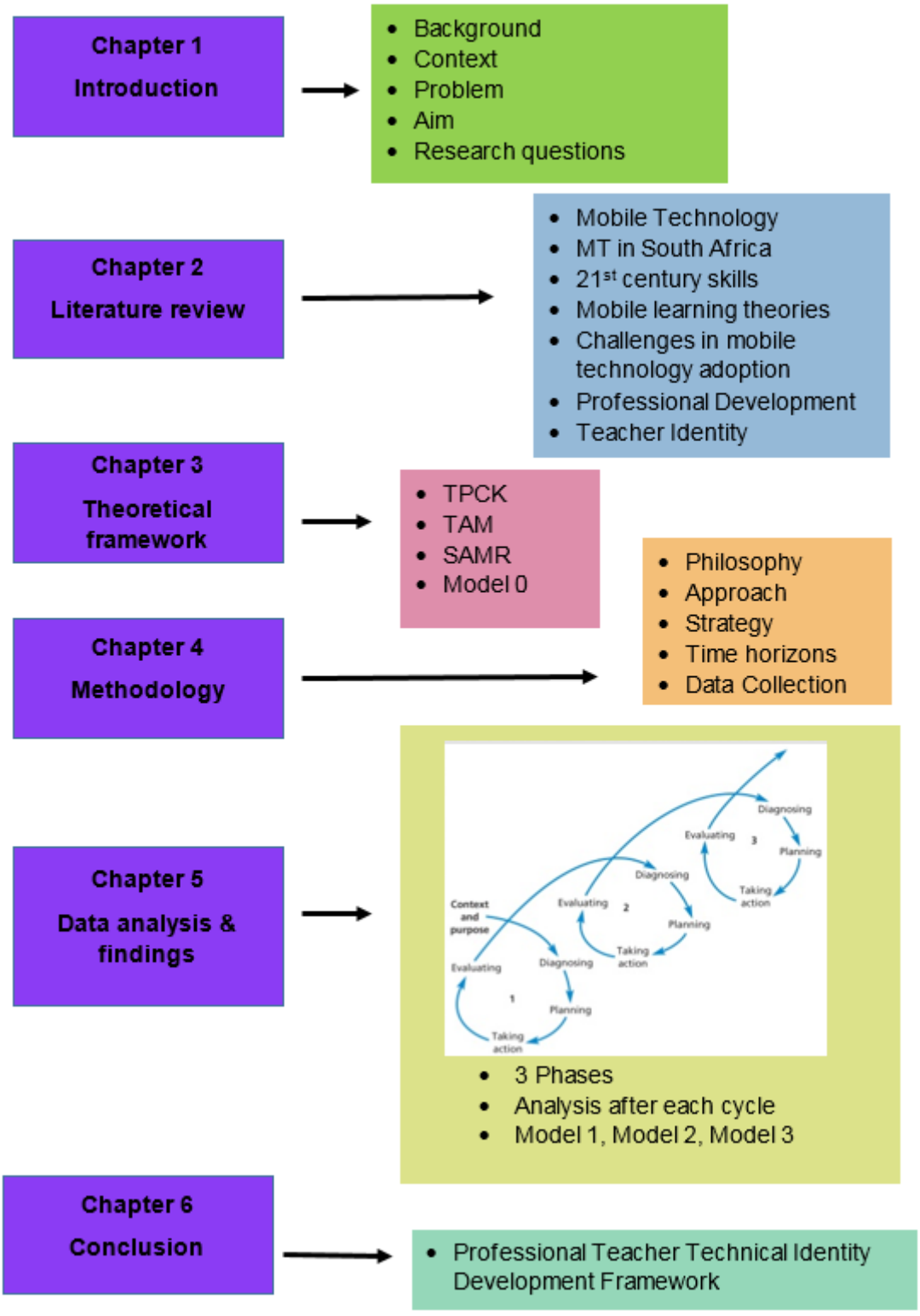


Figure 1.3: Structure of Thesis

This thesis comprises of six chapters. The first chapter is an introduction to the research and a motivation as to why the researcher decided to do this study. Chapter 2 comprises of an extensive literature review regarding previous research on mobile technology, the strengths, weaknesses and challenges of mobile technology, learning theories and professional identity development. Chapter 3 will discuss the theoretical framework which underpins this study and how it will be used to analyse the data. Chapter 4 outlines the method that the researcher will follow to conduct this study. A description of the sample, design, instruments, data collection methods and the ethical procedures will be given. In Chapter 5 a comprehensive data analysis will be given followed by a discussion of the outcomes from the data analysis. Findings and results will be presented for each phase. The final chapter will present a consolidated discussion of the data and conclusions to the study. Further recommendations for research will be included. References and annexures will follow thereafter.

Chapter 2

Literature review

"Technology will not replace teachers, but teachers who use technology will replace those who do not"

Unknown Author

2.1 Introduction

Over the last decade the use of mobile devices has become common (van Praag, 2016). From simply making phone calls, instant messaging, emailing and accessing the internet, to mobile applications such as GPRS[1], social networking such as Facebook, Twitter, etc, gaming and many more. Mobile devices are seen as portable, convenient, ubiquitous and easily accessible (Motlik, 2008; van Praag, 2016). The use of mobile devices in higher education has been deliberated largely over the last few years. Mobile technologies have advanced rapidly allowing for many pilot projects of implementation to be tried (Rajasingham, 2011). These projects however do not always illustrate the strengths or weaknesses of mobile technology as a subset to e-learning as they are very often small projects over a short period of time.

In this chapter aspects of mobile learning and professional teacher identity development are discussed. The history of mobile learning and research is presented. Educational theories that have links with mobile learning and some of the controversial views regarding the benefits of mobile learning are deliberated. Teaching strategies for mobile learning and challenges that teachers face to adopt mobile learning provide insight on the type of professional development required for implementation through integration. A look at the mobile learning initiatives in the South African context and 21st century skills will be discussed. The role of teacher identity development and its link to technical identity development is described. Figure 2.1 below provides an overview of the chapter.

[1] General Packet Radio Service

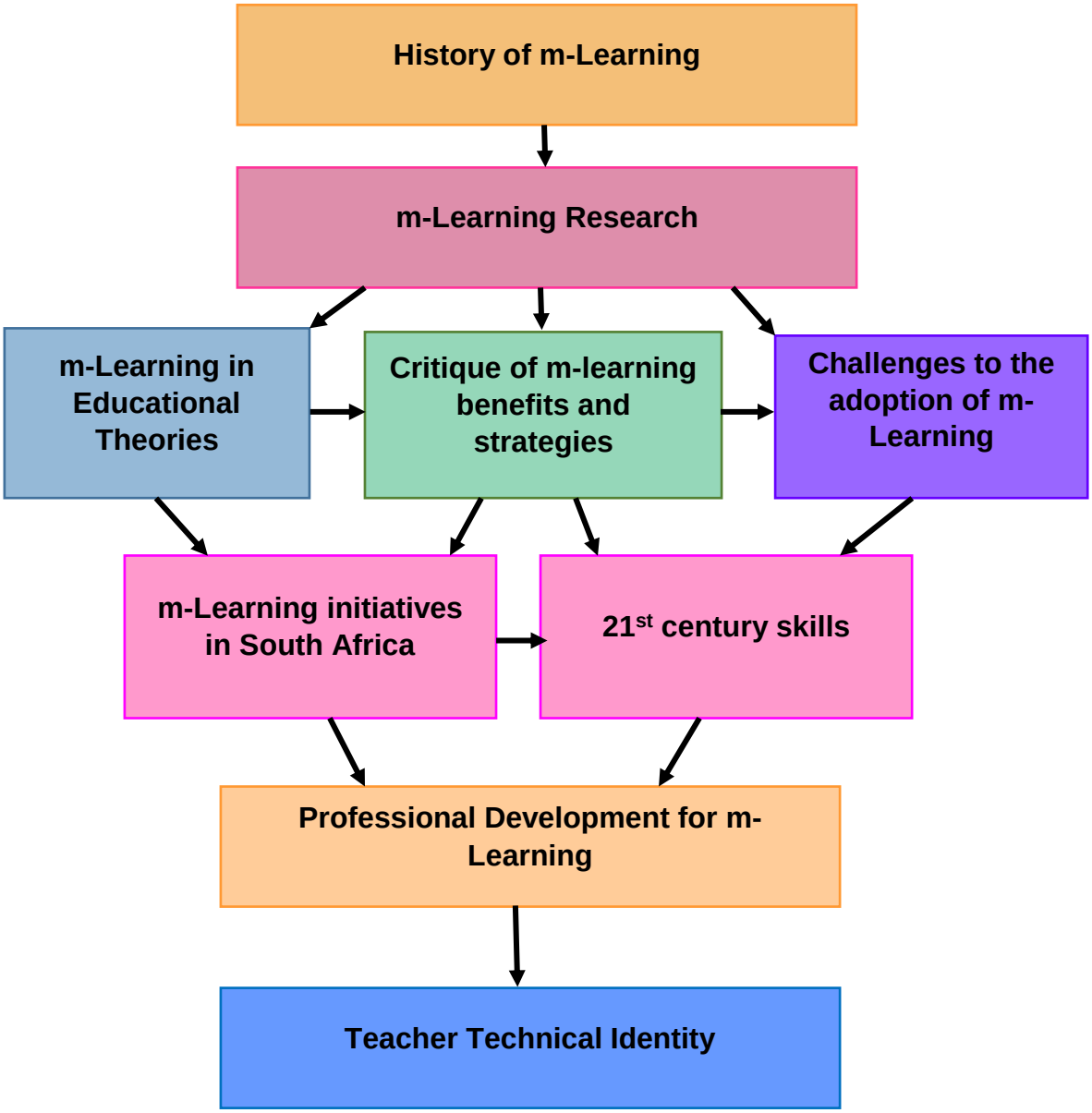


Figure 2.1: Chapter overview

m-Learning research looks at three aspects. Each aspect has an impact on the other. These aspects influence the initiatives within the South African context and also determine the level of 21st century skills being achieved. In order to address this professional development is needed to reconstruct the teacher identity and allow for a paradigm shift towards technology teaching and learning.

2.2 History of m-Learning

Looking at the advances in technology, the 1970's was the decade when the development of hardware and software began, such as floppy disks, microcomputers and video cassette recorder, etc. started. The 1980's was the introduction of hand held computers.

In the 1990's there was a movement to learner-centred pedagogy in schools (Crompton, 2013a). It was then stated by Soloway, Guzdial, and Hay (1994, p 38) that, "Simply put, the HCI (Human Computer Interaction) community must make another transition: we must move from 'user centred' design to 'learner-centred''s design". Soloway et al. (1994) studies focused on the support of technology in education and the issues involved in providing this support. It was at this stage that Sharples started to recreate the Dynabook which was first created by Kay in 1972 (Crompton, 2013a). The Handheld Learning Resource (HandLeR) project was started by Sharples in an attempt to provide and instrument that could aid in "lifelong learning" (Crompton, 2013a). Since then mobile devices have "decreased in size and cost and increased in power, speed, memory and functionality" (Crompton, 2013a, p10).

Mobile technology is defined by Jarvenpaa and Lang (2005 p.8) as, "handheld IT artefacts that encompass hardware (devices), software (interface and applications), and communication (network services)." For this study mobile technology will be regarded as any technology that can be used on a mobile device such as a smart phone or tablet.

In January of 2005, Laouris and Eteokleous (2005) reported 1240 items when doing a Google search for the terms "mobile learning definition" which is abbreviated as **m-learning** from this point forward. In the same year, they did the same search in June and found 22700 items. It can be assumed that 2005 was the year that m-learning became a recognized term (Laouris & Eteokleous, 2005). One of the earliest definitions of m-learning was simply the use of a palm as a learning device (Quinn, 2000; Soloway et al., 1994). Since then there has been debate about which attributes should be included in defining m-learning (e.g. Laouris & Eteokleous, 2005; Sharples, Taylor, & Vavoula, 2007a; Traxler, 2009a). From the studies one can conclude that there are four central constructs that appear consistently: pedagogy, technical

devices, context and social interactions (Crompton, 2013a). Sharples (2004) a researcher in the field defines m-learning as, learning that occurs outside of one's current learning environment and involves the use of mobile devices. Another useful definition provided by Rajasingham (2011) is that m-learning involves individuals productively, consuming, interacting or creating information that is mediated through a mobile device that has reliable connectivity and can be used anywhere at any time. As research on mobile learning progressed the definitions kept changing. As a result, Sharples et al. (2007a, p4) defined m-learning as "the process of coming to know through conversations across multiple contexts amongst people and personal interactive technologies". It was however found that even though this definition included all four constructs it was seen to be confusing and ambiguous (Crompton, 2013a). In this study mobile learning will be referred to as "learning across multiple contexts, through social and content interactions, using personal electronic devices," which is an edited version of Sharples et al. (2007a) definition by (Crompton, Berge & Muilenburg, 2013, p4) as an attempt to reduce the ambiguity and enhance the clarity.

Rajasingham (2011) explores the potential of m-learning causing a possible paradigm shift in education. Her argument supports the need for a paradigm shift but clearly indicates barriers that restrict this from occurring. A paradigm shift can only occur if it is accepted by most members of society. She gives several reasons for m-learning to cause a possible paradigm shift in education: the exponential growth of universities, significant decrease in government funding, demand for higher education, change in the nature of knowledge, change in learner demographics and expectations and global competition. Conversely other research studies (Cubukcuoglu, 2013; Kreijns, Van Acker, Vermeulen, & van Buuren, 2013) show that a shift in teachers role "from an ICT user to a facilitator retains the needs for teachers to serve as leaders in technology enhanced classroom (Kihoza et al., 2016)." Rajasingham (2011) illustrates the need for teacher training *about* m-learning and teacher training *with* m-learning. This is of particular importance to the study as it shaped the data collection process for implementation with integration. Figure 2.2 illustrates the difference between teacher training about m-learning and teacher training with m-learning. Teachers are often trained about m-learning and not with m-learning (Rajasingham, 2011).

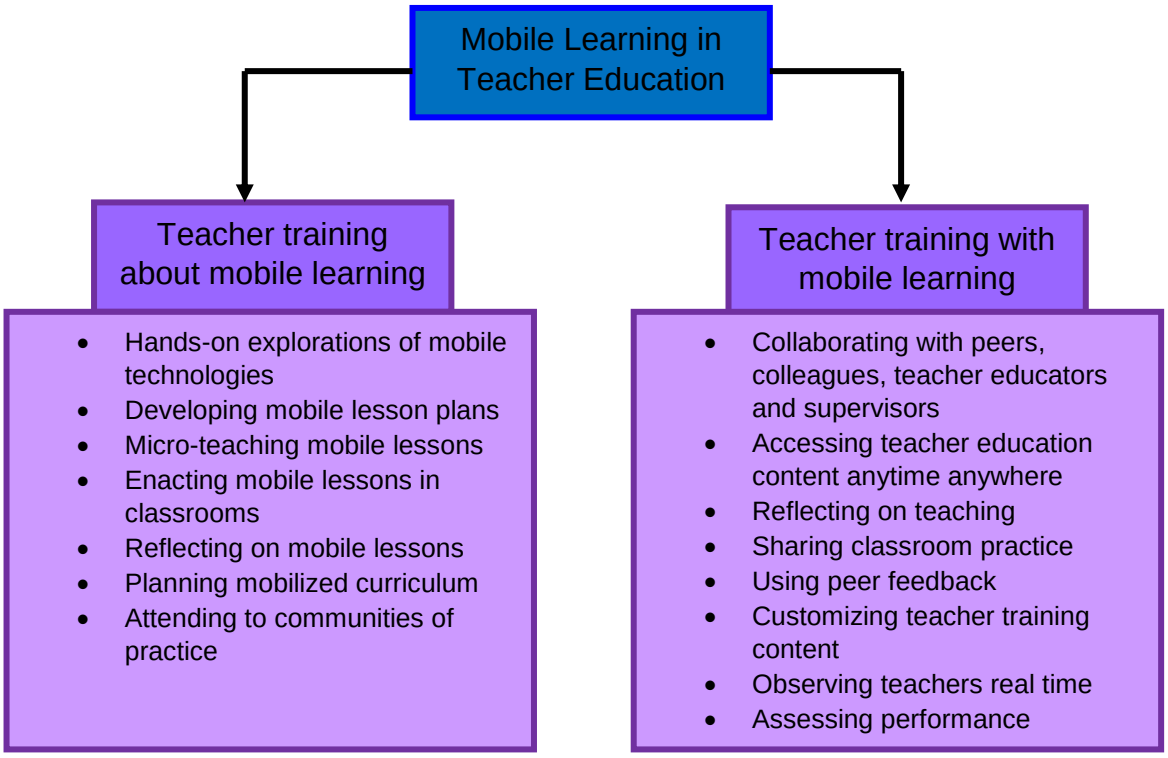


Figure 2.2: Mobile learning in teacher education

Keskin and Metcalf (2011, p202) claim that "mobile learning perspectives accept m-learning as a paradigm change". For example in the case of a learner-centred perspective, m-learning would be any learning that takes place when a learner is not in any fixed position (O'Malley et al., 2003). This has given rise to the idea of virtual universities. The first virtual university was started in Spain 1995, two decades ago, allowing learners to receive online education from enrolment to graduation. This university (The Open University of Catalonia) adopted a new paradigm as a holistic system and has shown great success of learners. The development of Open Universities led to Open Education Resources. Open education resources have attracted curriculum designers from all around the world. Businesses such as LIMVIT[2] and TESSA[3], in South Africa have started creating platforms where teachers can create and share subject specific lessons and activities with other teachers all around the world. These lessons are all within the requirements of the countries education and curriculum policies and provide instant interactive and fully planned lessons for teachers and learners. Professional networks such as LinkedIn, social platforms such as Twitter and educational platforms such as Edmodo and Kahoot allow teachers to share information and resources. According to Second Information

[2] Limitless Virtual
[3] Teacher Education in Sub-Saharan Africa

Technology in Education Study (SITES) (2006), one of the limitations to resource availability in South Africa is language. English being the most common language on the World Wide Web (WWW), poses as an obstacle to the implementation of ICT in South African schools (Anderson & Plomp, 2008; Blignaut et al., 2010).

With mobile technology and m-learning being at the forefront of educational development, the need for such a conceptual change in how learners learn and how teachers teach has raised debate. If m-learning is seen as a subset of e-learning and e-learning has been accepted for expressing the efforts of transforming educational processes to suit the needs of learners in terms of study, style, culture, time and space, then m-learning can be said to do the same. However, many researchers (Dhanarajan, 2001; Leach, Ahmed, Makalima, & Power, 2005; Rajasingham, 2011) claim that m-learning can be seen as a double edged sword. While m-learning has proven to be beneficial in so many fields such as medicine, economic and social transformation, natural disaster communications, etc., in education there is still a need for policy makers to be clear about the educational outcomes that are being targeted. Benedek (2007) and Ding (2010) believe that these new methods of learning will provide opportunities such as flexibility, accessibility and convenience with a pedagogy that will be personalised, learner-centred, contextualised and cooperative.

According to Traxler (2010b), learning cannot be seen as the simple consumption of information. Mobile devices ensure that learning becomes constructive and interactive. Traxler (2010b. p. 152) observed in his study that, “these devices are personal, universal, and closely linked to identity.” The instructor or teacher is able to see the personalities of learners by the choice of mobile device, colour, font, apps and accessories. The frequency of the use of the device is dependent on the familiarity that the learner has with mobile devices. The personal nature of a devices suggests the usefulness of the device. This is also evident in teachers. The more familiar the teacher is with a device, the more use they will make of the device. Therefore it can be said that the perceived ease of use of the device leads to the perceived usefulness of the device which is necessary in the technology acceptance model. M-learning is therefore classified as a personalised method of learning (Romrell, Kidder, & Wood, 2014). Figure 2.3 shows the evolution of telecommunications and the development of mobile devices. This timeline

emphasises the importance of mobile devices for 21st century teaching and learning. These devices cater for various functionalities that are required for interactive teaching and learning.

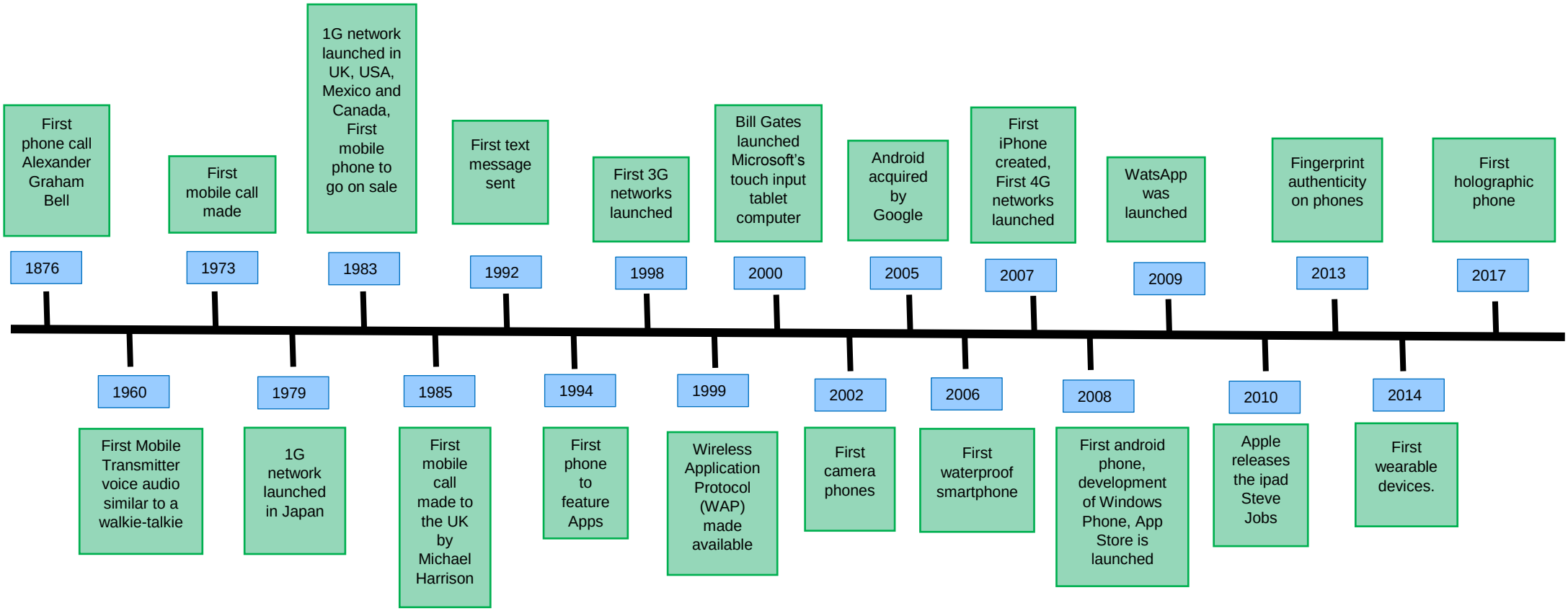


Figure 2.3: Mobile Technology Timeline.

2.3 M-learning research

Traxler and Kukulska-Hulme (2005) found that the main critique to early m-learning projects usually lacked rigour in evaluation and epistemological underpinnings (Cochrane, 2013b). Internationally all the projects on m-learning before 2005 were short-term pilot projects, however now research in m-learning is done all across the globe: for example Africa (Vosloo, Walton, & Deumert, 2009), Asia (Ogata et al., 2010a), North America (Metcalf, 2006), Europe (Seta et al., 2010), Scandinavia (Laine & Suhonen, 2008), Australia (Herrington, Herrington, Mantei, Olney, & Ferry, 2009) and New Zealand (Cochrane, 2011). The 21st century has turned out to be the consolidation and maturing of m-learning (Traxler, 2010a). Research into m-learning is evident and can be acknowledged through various developments. Table 2.1 highlights some of these developments.

Table 2.1: Research in M-learning developments

M-Learning developments	**Examples**
Emerging tools to enhance teaching and learning	(Anderson, 2007; Becta, 2007; Johnson, Levine, & Smith, 2008, 2009; Johnson, Levine, & Smith, 2007; McFarlane, Roche, & Triggs, 2007; McLoughlin & Lee, 2008; Sharples, Milrad, Arnedillo-Sanchez, & Vavoula, 2009; Traxler, 2007; Trinder, Guiller, Marggaryan, Littlejohn, & Nicol, 2008)
m-learning conferences	MLearn, HandHeld Learning, Multimedia and Information Communication Technologies in Education, the International Association for Development of the Information Society m-learning conference, Wireless Mobile and Ubiquitous Technologies in Education
Research projects and briefings	Joint Information Systems Committee (JISC) and the British Educational Communications and Technology Agency (Becta)
Articles in educational journals	*Educase* and *Journal of Computer and Assisted Learning*
The establishment of many new m-learning journals	International Journal of Mobile Learning and Organisation, International Journal of Mobile and Blended Learning, International Journal of Handheld Computing Research
m-Learning books	Ally, 2009; Metcalf, 2006; Pachler, Bachmair, & Cook, 2010; Ryu & Parsons, 2009; Woodhill, 2010

Various approaches to m-learning focus on content delivery (McKinney, Dyck, & Luber, 2009), short message service (SMS) (Mellow, 2005), polling (Dyson, Litchfield, Lawrence, Raban, & Leijdekkers, 2009) and location awareness (Pachler, Bachmair, & Cook, 2010). Other approaches facilitate learner-generated-content sharing and augmented reality. It was found that from the 102 innovative m-learning projects done between 2002 and 2007, most focused on the content delivery on a small screen device rather than the potential of using mobile devices for collaborative learning as proposed by Hoppe et al. (2003). To bridge the gap between the informal and formal contexts of m-learning projects such as the Advanced Mobile and Ubiquitous Learning Environments for Teachers and Learners (CeLeKT[4], 2009) were explored. This was to allow for indoor and outdoor learning experiences using mobile devices (Cochrane, 2013b). Other larger projects such as "m-learning project" (Attewell, 2005) and The Remote Authoring of Mobile Blogs for Learning Environments m-learning project (Trafford, 2005) were investigated to develop pedagogical strategies for the integration of m-learning in to tertiary education. Corlett, Sharples, Bull, and Chan (2005) identified that wireless connectivity is a necessity for the successful implementation of m-learning. Projects such as MobiLED[5] (South Africa; http://mobiled.uiah.fi/), MOBILearn[6] (Europe; www.mobilearn.org/) and MoLeNET[7] (UK) were started to create the necessary infrastructure for m-learning implementation. The MoLeNET project was one of the projects that focused on developing a framework that would aid in professional development and support for educators (Cochrane, 2013b). A rigorous evaluation process was followed to identify factors that would assist in the dissemination of knowledge through m-learning.

Cochrane (2013b) found in a review of the literature on m-learning that there are several shortcomings or gaps in m-learning research. These were identified by various authors and studies and are illustrated in Table 2.2.

[4] Center for Learning and Knowledge Technologies
[5] Mobile-led and Leading Via Mobile
[6] Mobile Learning
[7] Mobile Learning Network

Table 2.2: M-Learning shortcomings

A lack of explicit underlying pedagogical theory (Traxler & Kukulska-Hulme, 2005)
A lack of transferable design frameworks (Armstrong et al., 2008; Sharples, Crook, et al., 2009)
A general lack of evaluation of the projects (Kukulsa-Hulme & Traxler, 2005; Vavoula & Sharples, 2009a)
A lack of longitudinal studies (Traxler & Kukulska-Hulme, 2005)
A lack of the importance of pedagogical integration (Laurillard, 2007)
A lack of explicit learner and lecturer support and scaffolding (Attewell, 2007; Herrington & Oliver, 2000)
A lack of awareness of the ontological shifts (Chi & Hausmann, 2003) required for both learners' conception of learning and the lecturers' conception of teaching. Often "net generation" skills are assumed (Barbaux, 2006), and most of the case studies consist of lecturers who are early technology adopters (Armstrong et al., 2008)

(Cochrane, 2013b p.29).

Cochrane (2013b, p.29) also found that many research studies focused on the first four of these shortcomings and very little research has been done on the last three. There is very little emphasis on the "sustainable integration of mobile learning in formal education contexts." There is a need for a "pedagogical framework and foundational pedagogical theory" (Cochrane, 2013b, p.30) to guide and support m-learning in the future.

2.4 M-learning in educational theories

There are several learning theories regarding mobile technology. A theory as defined by the Oxford Dictionary (2015) is, "a supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained." A mobile learning theory has not been developed yet as it incorporates aspects of several other existing learning theories with technology (Traxler, 2012), each theory emphasising different aspects of learning. Table 2.3 offers a brief summary of the theories that have been used to try and explain mobile technology, how it can be incorporated into teaching and a brief description of the focus.

Table 2.3: Mobile Learning Theories

Theories	Definitions	Reference	Application
Behaviourist theory	Learning has occurred when learners evidence the appropriate reinforcement of an association between a particular response and stimulus.	(Smith and Ragan, 2005)	Information and content delivery in mobile learning
Cognitive learning	Learning is the acquisition or reorganisation of the cognitive structures through which humans process and store information.	(Good and Brophy, 1990)	Information and content delivery in mobile learning
Constructive learning	Learning is an activity process in which learners construct new ideas or concepts based on their current and past knowledge.	(Bruner, 1966)	Context and content-dependent mobile learning Collaboration and interaction in mobile learning
Situated learning	Learning is not merely the acquisition of knowledge by individuals, but instead a process of social participation.	(Brown et al., 1989).	Social Context and Social participant dependent mobile learning
Problem-based learning	Learning aims to develop learners' critical thinking skills by giving them an ill-defined problem that is reflective of what they would encounter as a practicing professional.	(Koschmann et al., 1996)	Problem based context and solved based content-dependent mobile learning
Context awareness learning	Context awareness means gathering information from the environment to provide a measure of what is currently going on around user and the device.	(Naismith et al., 2004)	Context aware in mobile learning
Socio-cultural theory	Learning occurs through interpersonal (interaction with social environment) rather than Intra-personal (internalization).	(Vygotski, 1978).	Social context and social participant dependent mobile learning
Collaborative learning	Learning is promoted, facilitated and enhanced by interaction and collaborations between learners.	(Vygotski, 1962)	Collaboration and interaction dependent mobile learning
Conversational learning	Learning is in terms of conversations between different systems of knowledge.	(Sharples, 2002)	Interaction and communication dependent mobile learning
Lifelong learning	Learning happens all the time and is influenced both by our environment and the particular situations we are faced with.	(Sharples, 2000).	Lifelong information and interaction with education content in mobile learning
Informal learning	Learning is a process that occurs autonomously and casually without being tied to highly directive curricula or Instruction.	(Vavoula, 2004)	Information and interaction with education content in informal mobile learning setting
Activity theory	Learning occurs with three features-involving a subject (the learners), an object (the task or activity) and tool or mediating artefacts and human behaviour is situated within a social context that influences their actions.	(Vygotsky, 1987).	User actions in social context dependent mobile learning
Connectivism	Learning is a process of connecting specialised nodes or information sources.	(Siemens, 2004).	Diversity of information sources in mobile learning
Navigationism	Learning is a process of connecting specialized nodes or information sources.	(Brown, 2005).	Complex of information sources in mobile learning
Location based learning	Location-based learning holds promise for just- in-time learning tied to a learner's physical location.	(Johnson et al., 2009)	Location context in mobile learning

(Keskin & Metcalf, 2011)

Terms such as virtual learning, electronic-learning (e-learning), distance-learning (d-learning), blended learning, ubiquitous learning, online learning and m-learning overlap and are still evolving. Mobile learning is often seen as a subset to electronic

learning commonly known as e-learning (Kadirire, 2009). This involves the use of electronic educational technology in learning and teaching, as the success of e-learning is largely dependent on the self-motivation of the individual to study effectively. M-learning as explained by Crompton (2013a, p10), “is not in the learning or in the technology, but in the marriage between the two entities.” E-learning was the first recognised term to connect learning with technology and is seen as teaching and learning that are supported by electronic media and tools (e.g. Pinkwart, Hoppe, Milrad, & Perez, 2003). It was also believed that e-learning was a type of distance learning (d-learning) as proposed by Tavangarian, Leypold, Nolting, and Voigt (2004, p274):

> *All forms of electronic supported learning and teaching, which is procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learning. Information and communication systems whether networked or not, serve as specific media to implement the learning process.*

The World Wide Web (WWW) made a significant contribution to e-learning in the 2000’s. From static to dynamic and interactive, Richardson (2005) emphasises the progression from a read-only Web to a read-write Web. Crompton (2013a, p11) explains that e-learning lacked the “physical interactions with the environment and society, without spatial and temporal limitations.” This brought about m-learning as a means to bridge the gap for learner-centred pedagogies. As mobile technology developed from smartphones to today’s tablets and iPads, the further extended learner-centred pedagogies became evident (Crompton, 2013a).

With the attempt to include m-learning into one of the above theories, researchers have not been able to find a set definition for m-learning as it is constantly changing (Brown, 2005; Sharples, Taylor, & Vavoula, 2007b; Traxler, 2009a). Tavangarian et al. (2004) illustrated the interconnected relationship between e-learning, d-learning and m-learning. It is understood that the nature of m-learning forms part of e-learning and d-learning as indicated in Figure 2.4.

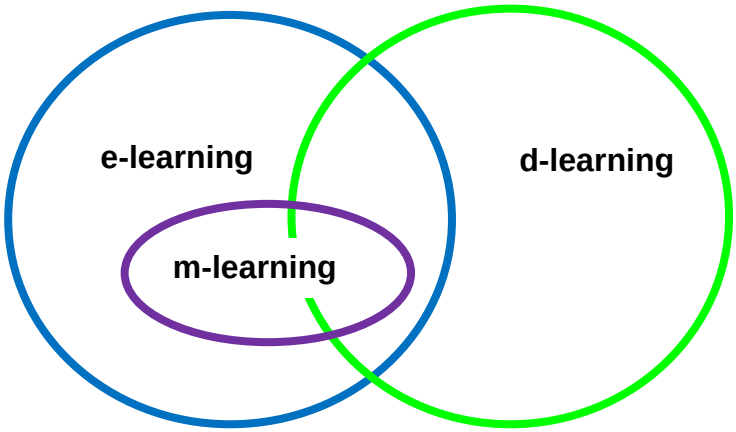


Figure 2.4: Interconnected Nature of D-Learning, E-Learning and M-Learning

(Tavangarian et al., 2004)

Traxler (2010) and Tavangarian et al. (2004) being prominent researchers in the field explained the overlapping of e-learning and d-learning as e-learning does not need to be networked learning and therefore does not need to be nested within d-learning. M-learning is situated outside the typical academic setting which can be recognised as d-learning and "m-learning has always tacitly meant mobile e-learning" (Traxler, 2009b). Comparative studies were done by Laouris and Eteokleous (2005), and Traxler (2009c) on the various attributes found in traditional learning, e-learning and m-learning. Themes such as time, personalisation, private learning, context, formal/informal, socio-connectivity and spontaneity arose. It was found in all cases that m-learning includes attributes of both traditional and e-learning methods. The differences found could be simply due to the technologies involved in mediating or facilitating the learning (Peters, 2009). This suggests that the actual ubiquity and mobility makes m-learning a discrete form of learning (Peng et al., 2009).

Sharples et al. (2007a) postulates four criteria that need to be considered before an m-learning theory can be developed. They explain four factors:

- To acknowledge what distinguishes m-learning from other learning activities (Traxler, 2009c)
- To be cognisant of the substantial amount of learning that takes place beyond the academic and work settings (Vavoula, 2005)
- To ensure that learning is based on practices that have been deemed successful (Sharples et al., 2007a)

- Heed must be paid to the ubiquitous use of personal and shared technology (Sharples et al., 2007a)

Various researchers with specific reference to Koole (2009), Laurillard (2007), Naismith, Lonsdale, Vavoula, and Sharples (2004), Sharples et al. (2007a) attempted to create an m-learning theory but were unsuccessful, because these frameworks were simply connecting m-learning to existing theories and thus a final theory has not been determined. It was found through their studies that there were four emerging themes that surrounded m-learning (Crompton, 2013b) as indicated in Figure 2.5.

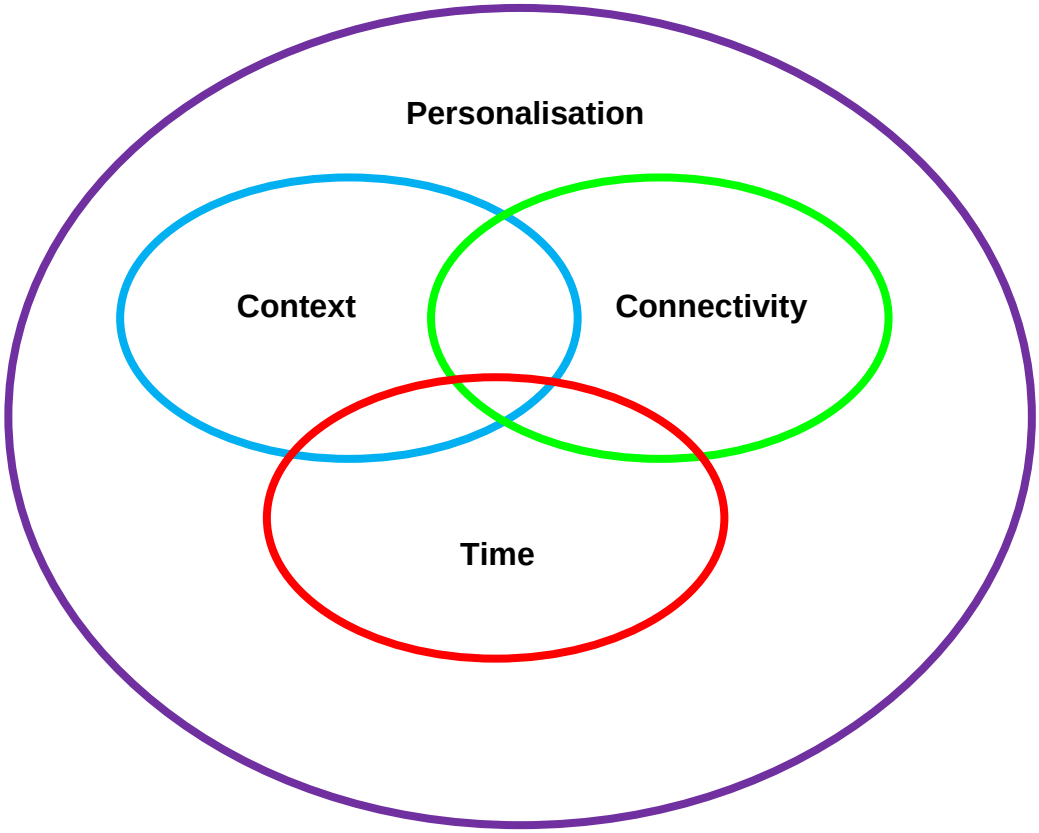


Figure 2.5: Overview of the emerging themes surrounding m-learning

(Crompton, 2013b)

Moura and Carvalho (2013) proposed a framework for mobile learning integration into educational contexts. This model emphasises the understanding of the relationship between technological and pedagogical domains (Crompton, 2013b).

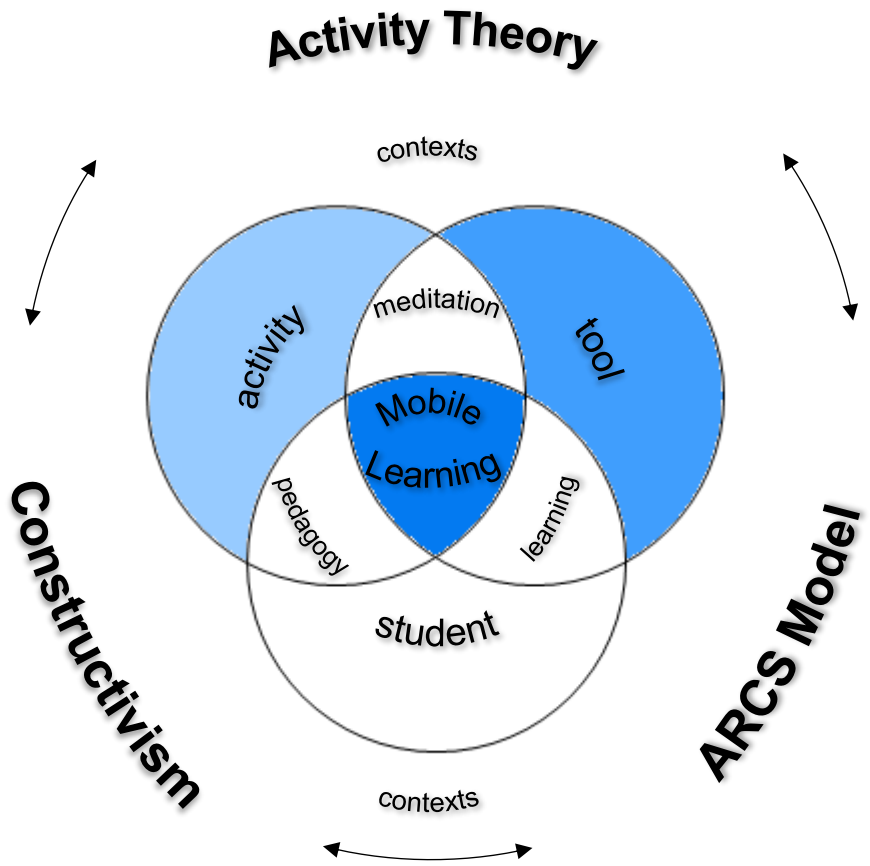


Figure 2.6: Framework for mobile technologies' integration in the learning process

(Moura & Carvalho, 2013)

This model was created by using the constructivist approach (Fosnot, 1996), the activity theory (Engestrom, 2001; Nardi, 1996) and the Attention, Relevance, Confidence, Satisfaction (ARCS) model (Keller, 1987; Shih & Mills, 2007) together with relevant research (Kukulsa-Hulme & Traxler, 2005; Naismith et al., 2004; Traxler, 2007; Vavoula, Pachler, & Kukulsa-Hulme, 2009c) in m-learning (Moura & Carvalho, 2013). This study supported the positive learning experiences emphasised by Parsons and Ryu (2006) by suggesting a deep reflection into what "creates the quality of learning" (Moura & Carvalho, 2013. p. 68) rather than too much use of technology.

Whilst many researchers (Mac Callum, Jeffrey, & Kinshuk, 2014; Rajasingham, 2011) are in favour of mobile technology and the potential success of m-learning in the future a different approach is looking at m-learning through the eyes of Christensen's

Theory of “disruptive technologies”. He believes that although virtual universities may thrive on traditional colleges and universities, it would need to operate outside of the normal management and value frameworks and it runs the risk of losing institutional control. This could result in a delay of creating a paradigm shift. He found that m-learning is seen to be more successful in the corporate world as opposed to higher education. Traxler (2005a) illustrates some of the characteristic differences between e-learning and m-learning as shown in Figure 2.7. However, over the last decade there have been so many advancements in m-learning that there is a much greater overlap in characteristics over the last few years.

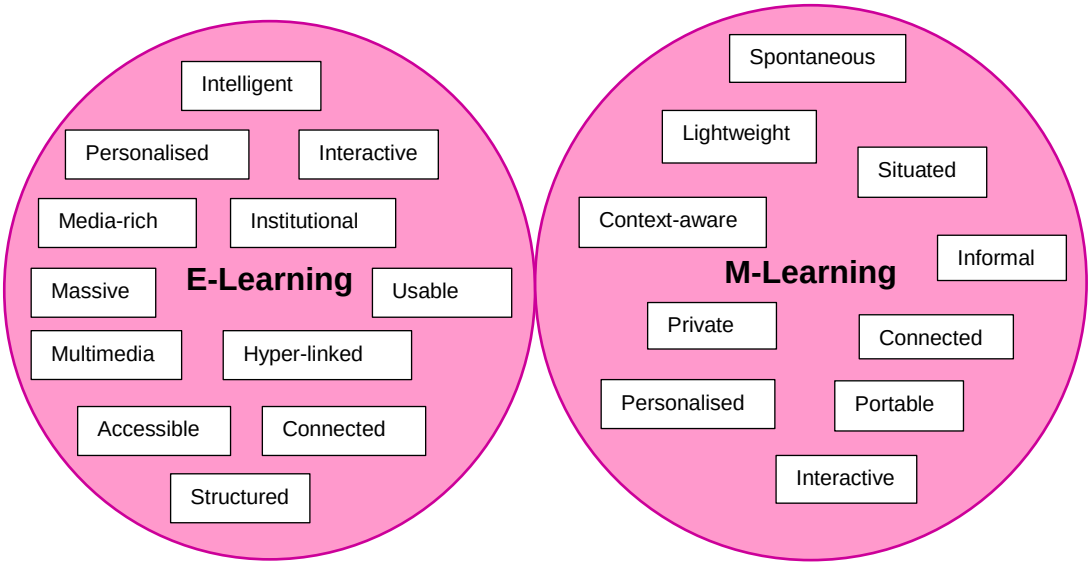


Figure 2.7: E-learning vs m-learning

2.5 Critique of m-learning benefits and teaching strategies

Research shows that due to small scale pilot projects that are insufficient in assessing the long term use or implementation of m-learning, or weaknesses in the process of implementation and poor instructional design and staff development programmes there is a failure of new approaches to m-learning (Christensens, 1997; van Praag, 2016). Furthermore, m-learning needs to be synchronised and standardised providing a platform that can operate both PC and mobile devices. Ryu and Parsons (2009) claim that mobile learning may have the potential to facilitate learning through the use of mobile devices and this could blur the boundaries between communication and computation. It will combine the ubiquity and utility, challenging traditional

pedagogy and andragogy, offering more a complementary approach to teaching and learning.

Royle, Stager, and Traxler (2014) advocate that research in mobile technology in education has been found to be skewed and biased in that the success of it outnumbers the failure. Literature is littered with multiple causalities and unexpected consequences as to why mobile learning is a successful method of teaching. Traxler and Kukulsa-Hulme (2006) found that the evidence and evaluation of mobile learning is not always credible or rigorous. It is questionable as to whether this evidence is transparent, objective or intellectually sound. Royle et al. (2014. p.30) explains that "the place for mobile technology in education is still unclear and not enough instances of teacher development with mobiles are available to allow for analyses that inspire confidence." Becta ICT Research (2004) found that ICTS have the potential to enhance teaching and learning by enriching the curriculum, improving delivery techniques by offering new opportunities through technology and extended methods of presentation, and allowing teachers to manage and reduce their administrative workload.

Al-Kahtani (2004) claims that technology use has several factors that affect and/or prevent their use. He describes these as Overt or Covert. If there is an absence of detailed instruction or teacher development courses there is no guarantee that teachers will use technology. The combination of these overt and covert factors play an intricate role in the facilitation of mobile teaching and learning. Figure 2.8 illustrates these Overt and Covert factors.

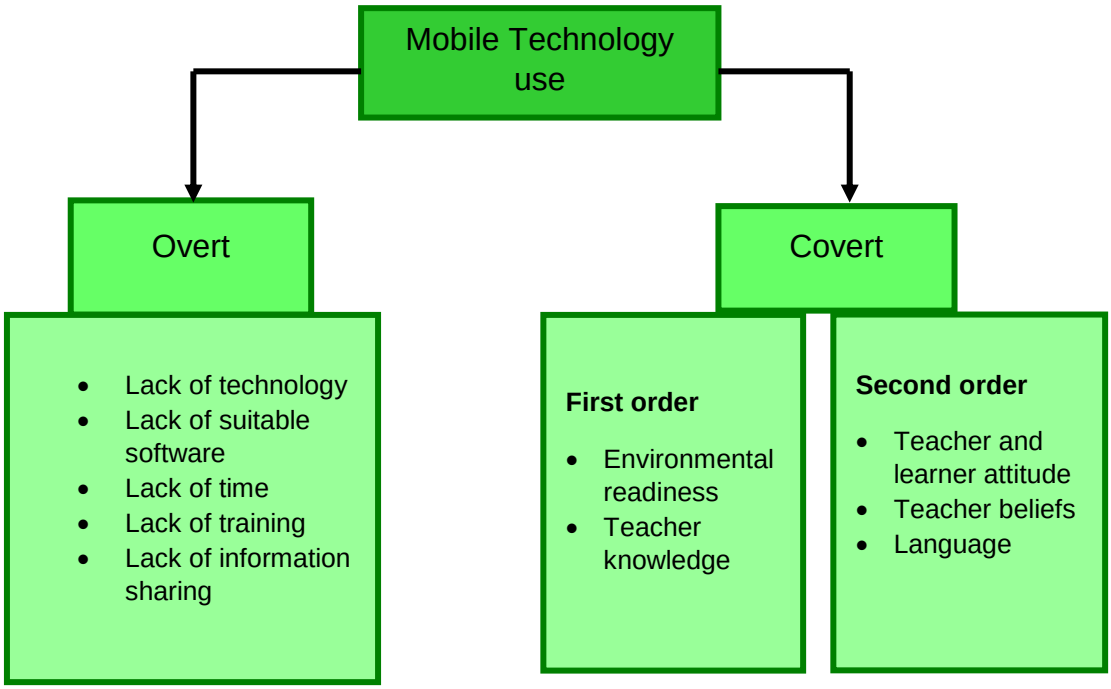


Figure 2.8: Factors affecting and preventing technology use

Smeets (2004) promotes mobile technology as it adds authenticity to learning. Luzon and Gonalez (2006) claim that this is in addition to autonomous learning. One of the major benefits is the accessibility of anytime, anywhere learning (Derakhshan & Khodabakhshzadeh, 2011).

Haddad and Draxler (2002) suggested five possible levels of the use of technology in education to achieve optimum learning outcomes, meet the alignment between teacher and learner expectations as well as bridge the gap between the demands for new skills in response to the needs of society. These levels were: (1) presentation; (2) demonstration; (3) drill and practice; (4) interaction; (5) collaboration. Similar use of these levels was tested by Blignaut et al. (2010) to assess the frequency of the use of technology and which technologies were used.

The role of m-learning should not aim to eliminate the teacher but rather to aid the learner and teacher by providing on-the-go communication. Due to the changes brought about by digitalisation and the internet, the role of teachers, learners and the nature of knowledge itself has changed. There is on-going debate as to whether m-learning can in fact provide “deep learning” as it provides “just-in-time learning moments” (Rajasingham, 2011). There was very little evidence of mobile learning

providing pervasive learning activities (Mac Callum et al., 2014; Rajasingham, 2011), however, recent attempts to facilitate learning through creativity seem to have become more fruitful in this regard (Jahnke, 2013; Warner & Myers, 2010).

Quinn (2013) emphasises the use of augmentation and how it can be used to create the resources and environment for the learner to ensure better learner performance. The capabilities of augmented reality and alternate reality have brought about new visions in m-learning (Quinn, 2013). "Augmented reality is where information is layered on top of the world, typically via a digital device (Quinn, 2013. p88)". For example: the camera captures a photo onto a screen and information can be added to this picture, like a map with directions- GPRS[8]. "Alternate reality is a notion of a separate universe (Quinn, 2013. p. 88)." This is when a fictitious world is created that intrudes upon the regular world for example: games. Quinn (2013) further explains that "although content, computing, communication and capture are valuable components, it is the important combinations that move the components from information to a learning experience." Liu and Tsai (2013) found that augmented-reality mobile learning increases the effectiveness of learning. This still shows the personalised nature of mobile learning. They are supported by Wu, Hwang, Su, and Huang (2012) who did a similar study but instead of using augmented reality, they used a context-aware mobile system.

Other uses of technology in education range from gamification, videos, simulations, role play to quizzes, interactive tasks for drill and practise and computer feedback activities (Blignaut et al., 2010; Van Eck, 2006). These can all be used as suitable resources to assist in teaching and learning. "The question that now arises is what drives learners to use ICTs independently for their learning? (Blignaut et al., 2010. p. 9)". Tai and Ting, (2011) claim that technology can assist teachers in preparation, enhance their technical skills, provide parallel and conventionally innovative teaching and learning activities for contact and non-contact times. This will assist learners in using ICTs independently for learning.

2.6 Challenges to the adoption of m-learning

The current challenges of mobile technology as it stands has many gaps as indicated by several researchers within the field (Mac Callum et al., 2014; Mayisela, 2013;

[8] General Packet Radio Services

Rajasingham, 2011). These range from access to ICT, different interpretations of mobile learning, insufficient staff training and development and poor learner support in promoting the long term usage of mobile technology in collaboration to teaching and learning.

There are several barriers to the adoption of mobile learning. It has been found that mobile learning is only beneficial when used in collaboration and conjunction with face-to-face (blended) and online learning (Carle, Jaffee, & Miller, 2009; Idris & Nor, 2010; Liu, Tsai, & Huang, 2014; Molins-Ruano et al., 2014).This process involves both cognitive and social connectivity for problem based learning and innovative and critical thinking demands deep concentration. Aspects such as paucity of imagination, lack of appropriate business models and poverty are factors that restrict the growth and adoption of m-learning. Wagner (2005) points out that even though m-learning is convenient it is not always pedagogically sound. Gaskell (2007) raises the argument that m-learning may be more related to the medium of delivery rather than pedagogical concern. The general use of technology in classrooms does not necessarily translate to effective classroom teaching. “Specific skills and pedagogies are needed to translate this general literacy in using ICT in teaching” (Mac Callum et al., 2014. p152). Czerniewicz and Brown (2005. p. 1) emphasises that: “access to ICTs does not ensure use, nor automatically add value.” Quinn (2000) mentions that the following aspects need to be addressed in order for mobile learning to be successful.

- A standard set of tools to develop m-learning
- A sound theoretical m-learning framework
- Auto-adaptation of different platforms so that what is developed will work across multiple devices
- Good examples of research on sustainable m-learning
- Capability of integrating m-learning with learning management systems (LMS)
- Course/instructional design for m-learning.

Milrad et al. (2013, p. 98) highlights that “an even greater challenge lies in how to shift the epistemological beliefs of individual learners (as well as teachers who are to facilitate seamless learning) from absolutism and transmissionism to constructivism and socio-constructivism.” If education is seen as a form of communication, then

teachers need to assist learners in constructing or applying their knowledge and the technology will be the driving force of this communication. This is how teaching and learning will then change. The use of mobile technologies is seen as the entry into professional teacher technical identity development and can be captured between theory and identity development. Ryu and Parsons (2009) and Shen, Wang, and Pan (2008) emphasise that the future success of m-learning is dependent on affordable and effective applications that match the needs of learners and their particular learning styles in their cultural context. Wong and Looi (2011) noted that learners need to engage in an enculturation process in order to transform their existing epistemological beliefs, attitudes and methods of learning. Goodyear (2011) believes that one of our biggest challenges in education is not to find different or better ways of delivery but rather to design, develop and implement interactive learning experiences that will enable learners to construct knowledge that will engage and inspire them to learn.

The challenges for teachers in using mobile technology are that the device needs to be able to assist them in a manner to ensure effective and efficient teaching. Teachers need to see the usefulness of digital technology and recognise it as a teaching tool rather than just for social purposes (Royle & Hadfield, 2012). In order for this to occur teacher educators and teachers need to be aware of their digital habits and how they can go about creating a digital idiolect. These have been summarised by Rajasingham (2011) as: catalyse the process and organisation for teaching/learning on the go; foster instant communications/collaborations; conduct assessments/evaluations; provide access to support/knowledge. A key thinker in mobile learning strategies, Judy Brown, poses the following questions to teachers: What do you expect from m-learners? Will they be consumers of content? Do you expect learners to create new content? Or both?

Teachers are posed with the challenge of designing instruction strategies that will provide instant communication, thus adhering to 21st century teaching. Several projects have been undertaken across the world to explore various approaches of integrating m-learning and find innovative uses for successful, quality learning. For example: the inquiry seamless learning project in Taiwan (Hwang & Tsai, 2011), the personal-inquiry project in the United Kingdom (Open University and University of Nottingham), the geometry mobile project in Sweden (Sollervall et al., 2011), the

sustainable seamless learning in Singapore (Looi et al., 2010) and the learning by logging project in Japan (Ogata et al., 2010b). These projects diversify the possibility to design, facilitate and practice m-learning. Due to learning taking place more continuously it was found that these studies are in line with Sharples (2009. p. 19) assertion that, “it may not be possible to determine when the learning begins or ends.”

With the gradual development in technology it has been found that learners learn better with interactive and visual activities. These types of activities provide anchored instruction, feedback, behaviourism, narrative psychology and collaboration. Oblinger and Oblinger in the Van Eck’s article (2006) found that gaming is a constructive method of helping learners to achieve the outcomes of a specific lesson. In order to use gaming as a teaching resource a teacher would need to carefully “align the gaming paradigm with the learning paradigm which will require addressing a clash of concept change” (Rajasingham, 2011). Teachers would now need to redesign their instruction to retain the intellectual depth but collaborate in a new technological mobile environment. This would then address the demands of learners by: multiple streams of information, inductive reasoning, frequent and quick interactions with content, exceptional visual literacy skills and games that offer insight to the context (Van Eck, 2006).

Rajasingham (2011) found that there is a dearth of research on instructional/course design for m-learning and it is critical that this be researched in order to ensure effective ways of delivering mobile education. A mobile theory and critical frameworks to evaluate mobile technology and the quality of education for mobile learners is crucial. Further development in the research of support systems for learners and teachers on how to learn in a mobile environment is critical.

A study conducted by Norris and Soloway (2013) identified several barriers to the adoption of mobile learning.

- Lack of vision - the deniers (teachers) who do not feel that they need to change their teaching methods because they did not learn in that way and learners don’t need to.
- “but we don’t have the money”- parents that complain about not being able to afford mobile devices, which in many cases means “they do not value that” and for schools that are just too pessimistic to even try.

- Curriculum, curriculum and curriculum - the lack of curriculum to help support teachers to make the transition and move out of their comfort zone.
- Need for on-going professional development - even when teachers are provided with curriculum support they may not attempt to use mobile devices unless there is a significant level of professional development.
- Lack of leadership - teachers do not react to “this is optional”, instead they just ignore it because it is not a requirement so there is no need to get out of their comfort zone
- 800 pound gorilla-assessment - teachers teach to the test. Standardised state wide tests drive instruction and if they don’t teach to the test they are being both impractical and unethical. Therefore teachers would rather focus on drill-and-practise rather than alternative teaching methods as their pay for learner achievement becomes more prevalent.

These barriers emphasise the key role of a teacher in the adoption process of m-learning. The attitude and beliefs of the teacher impact on their teaching and will then relate to the learning by the learner. Today’s learner is digitally literate, always connected and reachable (Oblinger, 2003, 2004). A study conducted by Khaddage and Latteman (2013) in Japan, Germany and Australia found that learners prefer to learn using mobile apps. Learners complained that they do not use mobile apps in formal settings as this type of learning is still unrecognised or not formally acknowledged by their teachers.

Literature shows that integrating technology into classroom instruction can increase learner motivation, learning efficacy, curiosity and creativity (Carle et al., 2009; Idris & Nor, 2010; Liu et al., 2014; Molins-Ruano et al., 2014). A study by Govender and Govender (2014) illustrates that teachers with computer competency skills and access to technology often do not incorporate technology in their teaching. Instead technology is frequently used to perform non-instructional tasks like monitoring attendance and grading (Gray, Thomas, & Lewis, 2010). Teachers that experience unsuccessful technology adoption in the classroom tend to feel demotivated which strengthens the need for creating successful enriching classroom experiences of technology integration (Slaouti & Barton, 2007). According to Akbaba-Altun (2006) in-service training courses fail to prepare teachers adequately to integrate technology as they lack hands-on activities. One cannot simply deliver instructions and

technology-related skills (Ferdig, 2006). Technology integration is more complex as proficiency in technological skills does not ensure successful application in classroom practice (Liu et al., 2014). Successful collaboration between colleagues and observation of successful teachers with technology use has proven to be more effective as this provides professional development of content and methodology and teachers are more likely to adopt new technological ways of teaching, known as 21st century teaching and skills (Anderson, Barkdale, & Hite, 2005; Powell & Napoliello, 2005; Tondeur, Kershaw, Vanderlinde, & van Braak, 2013).

Whilst teacher education programmes include various courses to assist teachers with technology integration-related knowledge, they fail to provide the opportunities for such knowledge to be applied (Liu et al., 2014). These courses also vary considerably (Lee & Lee, 2014). Russell, Bebell, O'Dwyer, and O'Connor (2003) claim that pre-service teachers tend to be more confident and express a higher proficiency in technology use than more experienced teachers. Experienced teachers express fixed teaching philosophies that lack technological skills (Liu et al., 2014). In order for effective technology integration to take place a combination of technological skills and teaching experience is required.

In Africa various projects were undertaken to implement mobile technology in education. For example: The SEMA[9] project in Kenya (Traxler, 2005b), SMS services at the University of Pretoria in South Africa (Traxler & Viljoen, 2007), The DEEP[10] project in the Eastern Cape, South Africa and Egypt (Traxler & Leach, 2006), The Dr Math project in South Africa (Butgereit, 2007; Butgereit & Botha, 2011), the m4Lit project in South Africa (Shuttleworth Foundation and NGO's[11], 2009). Currently local newspapers regularly report on pilot projects including the use of mobile devices in classrooms, however, cost, context, instructional resources and teacher development are amongst the few barriers and challenges that are still being faced (Pretoria News, Gauteng Rekord).

A study conducted by Blignaut et al. (2010) highlights the importance of ICT literacy and basic ICT integration for teaching and learning for:

[9] Sustainable Energy Market Acceleration
[10] Deep rural area
[11] Non-Governmental Organisations

- pre-service training in higher education institutions
- in-service teachers
- institutional managers
- provincial managers

There needs to be additional efforts in technical support and explicit ICT-based activities need to be carried out in order to produce sustainable changes in pedagogical practice and learner learning outcomes (Fullan, 1998; Hepp, Hinostroza, Laval, & Rehbein, 2004). Chen and Chang (2007) and Pelgrum (2008) support this argument and claim that sufficient, effective, on-going technical support and adequate pedagogical support is a necessity for integration to take place. The availability of pedagogical and technical support is relatively low in South Africa according to Blignaut et al. (2010), however there seems to be some developments recently.

2.7 M-learning initiatives in South Africa

Due to the lack of infrastructure in rural communities such as limited access to electricity, telephone networks, poor roads and postal services, there are fewer people that have expertise in the use of computers and mobile devices. This has resulted in the rapid growth of wireless infrastructure. Rao reported that at the end of 2011 there was an annual increase of 65%- twice the global average, of cell-phone users in Africa, with just over 600 million cell-phone subscribers, which is second to Asia (Rao, 2011). However, the pedagogical affordances of cell phones has not been fully explored in South Africa (Makoe, 2013).Teachers by large are not convinced about the potential use of cell phones in education. Those born in the 1980's are commonly known as the "net generation" (Barnes, Marateo, & Ferris, 2007) or "digital natives" (Prensky, 2001) and are able to use technology with ease. These digital natives have shown an increasing reliance and comfort in using computer technology in classrooms, however the "digital immigrants" which are considered to be the older teachers are still resistant to change and hesitant to join their learners that are on the digital age (McClure, 2011). The terms "digital immigrant" and "digital native" is populist and a very twofold way of viewing the uptake and use of technology. Despite the radical change in pedagogy that is currently taking place, the beliefs and attitudes of teachers towards the use of cell phones have contributed to their reluctance in

adopting technology. Small and Vorgan (2008) in their study of the “brain gap” found that the digital divide between younger teachers and older teachers was due to the difference in interpersonal and technological skills.

With more than two decades of research and the drastic change in technology effective integration of ICT into teaching and learning is still not occurring at the required pace (Jamieson-Proctor, Burnett, Finger, & Watson, 2006). The factors of time to integrate ICT effectively, resistance to change, training and lack of resources seem to be the same factors that are hampering the process for the last twenty years (Guru & Percy, 2005). van der Merwe (2004) identified the lack of commitment by teachers to change their teaching methods. Jimoyiannis and Komis (2007) claim that many in-service teachers do not understand how to proceed in integrating ICT in teaching and learning, some do not even understand what is meant by ICT integration. This contributes to the need for training of teachers in South Africa to prepare ICT lessons, use ICT for learner progress and assessment, and to obtain knowledge of generic and subject specific software.

International issues of implementation highlighted by Muir (2013) are very relevant to the South African context. Local culture, resources and needs, connectivity, cost, availability of mobile devices, bandwidth issues, technology-transfer restrictions, learning barriers, utilising local teachers, language barriers and local commitment and support are some of the factors that are restricting the adoption of mobile technology in the country.

There are various mobile learning initiatives in South Africa. Table 2.4 illustrates a few examples.

Table 2.4: Mobile learning initiative in South Africa.

Initiative	Project leader	Description
Dr Maths	Via MXIT[12] by CSIR[13]	Mobile mathematics tutoring programme
Quizmax	Via MXIT by University of Stellenbosch	Mobile physical science tutoring programme
Siyavula	Department of Basic Education	Free online textbooks
Nokia Mobile Mathematics	Nokia	Gr10-12 Online Teaching
SchoolNetSA	Edchat SA on Twitter by Cape Town Principal	Free online high school learning support
Creative Problem Solving Institute	Mpumalanga 5 Rural schools	Technology training for teachers and learners
ICT4RED	Eastern Cape Department of Education and CSIR	Technology training for teachers and learners
Ukufunda Virtual School	Department of Basic Education	Virtual learning environment within a physical school

Despite all of these initiatives it seems that ICT is neglected in education policies (Evoh, 2011) in that it appears in policies but is not implemented. With a need for an increase in the standard of education coupled with the demand and quality of CAPS, there needs to be a change from the traditional didactics of teaching to a more social constructivist perspective of learning (Haddad & Draxler, 2002). Since 1994 the integration of technology in education became a national priority in South Africa and was pointed out by the Government of National Unity (GNU). This was due to the demand of a more diverse group of learners and the need to "mediate through ICTs and other innovative modes of delivery" (Evoh, 2011). Goddard and Cornford (2002) claimed that ICTs promised gains in the efficiency of pedagogy, research and administration in South Africa. Brown (2008) noted that in the Western Cape 97% of academics teach using ICTs. Evoh (2011) uses the following model to illustrate the facets that are needed in sustaining ICT adoption in South Africa.

[12] Social media platform
[13] Council for Scientific and Industrial Research

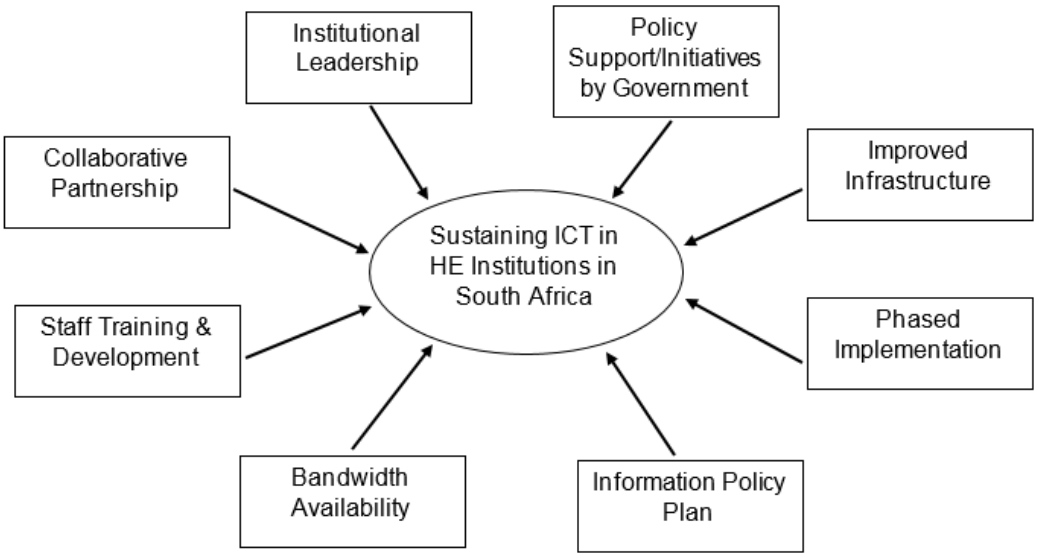


Figure 2.9: Facets of sustaining ICT adoption in Tertiary institutions in South Africa Project (Evoh, 2011)

However, policies have been developed and institutions are spending more money on ICTs than previously (Czerniewicz, Ravjee, & Mlitwa, 2005). Despite the constraints a rapid increase in the use of ICTs in South Africa has been reported (Czerniewicz et al., 2005; Paterson, 2004). It has now become a basic requirement of knowledge for society and schools and universities are expected to prepare learners with these necessary skills and knowledge (Burbles & Callister 2000; Castells et al., 1999). Policies such as The National Plan for Higher Education (Department of Education (DoE), 2001), The National Research and Development Strategy (Department of Arts, Culture, Science and Technology, 2002), the National Research and Technology Foresight ICT Report (Department of Science and Technology, 2000) and the White Paper on e-Education (DoE, 2003), emphasise the assumed role of ICTs in education. These policies argue that "ICTs will, variously, add value to education, improve teaching and learning, encourage innovation and contribute to transformation" (Czerniewicz & Brown 2005. p. 2). They claim that it is still not evident whether these arguments actually play out in practice and do in fact support teaching and learning. "Access to ICT alone does not ensure use, nor does it determine added value for education" (Czerniewicz & Brown 2005. p. 2).

Figures 2.10, 2.11 and 2.12 below emphasise the growing need for mobile technology and aspects such as mobile-based courses, mobile app analytics, bite-size learning, gamification of course work, augmented reality, eBooks dominate,

bring your own device to classrooms, online collaborative learning, social media learning and the rise of the tablet. These are the current phrases being used and dictate the new trends for schools and universities. The support from the corporate environment and the Department of Basic Education in terms of providing tablets to schools is acknowledged. Infrastructure is slowly being provided to support the use of technology and the Department of Education and relevant stakeholders support this notion. Therefore the gateway for implementation and integration has been opened.

Technology challenging teaching methods

IN THIS information age, where 24 hour connectivity is as much a part of our modern lives as wearing shoes, one key aspect of society struggling to keep up with these changes is education institutions.

Schools and tertiary institutions, and the learning therein, have remained largely unchanged since the 19th century. Pupils still sit in rows of desks, reading words on a board in the front of the class – words put there by a well-educated adult, sometimes several years ago. But how many of us went to work this morning wearing top hats or leopard skin – or riding a horse and cart for that matter?

With the dawn of the cellphone, digital information and wireless connectivity, society is changing faster than it possibly ever has. Indeed, a staggering 90 percent of the data in the world today was created in the past two years, according to IBM.

Schools have the responsibility to educate the next generation and to prepare that generation with the skills and knowledge required for learning, life and work. But society now moves at such a fast pace that the jobs which will one day be filled by our current students have not yet been invented. It is imperative then that schools provide pupils with the ability to learn for themselves, to adapt to new technologies and systems, and to create their own strategies for coping.

Being online comes naturally to most of our pupils these days, but they tend to see their time online as "social" rather than "useful". Why not tap into that space? Connected learners of the future will use everyday web tools and social media platforms to enhance learning and teaching.

Cellphones will become a medium of instruction, and learning will be localised as well as globalised, according to Delvin Munsamy, digital marketing manager at Rosebank College.

Let us explore the top 10 trends to watch out for that will become a reality for connected learners of the future.

Mobile-based courses

Mobile technology is a growing and powerful trend. As an indication, Africa is dubbed the mobile continent and researchers predict that internet use on cellphones will increase 20 fold on the continent in the next five years – double the ratio of growth than in the rest of the world. With this said, cellphones will be used in the same way as computers to house and disseminate learning material for pupils of the future.

Mobile app analytics

With the proliferation of mobile-based courses, mobile analytics will play a vital role in understanding pupils' interaction and behaviour with such courses by monitoring app traffic and engagement.

Bite-sized learning

Mobile is being projected as the ultimate medium for immediate support, which should come in easily digestible and immediately useful information nuggets. One of the criticisms of the digital generation is that they have short attention spans. Educators are taking note and are creating learning tools that offer snack-sized bites of learning for pupils.

Gamefication of course work

According to a survey conducted by M2 Research, almost 80 percent of learners say they would be more productive if their institution were more game-like.

> **New trends dictate the reality for schools and universities**

Learners remember 90 percent if they do the work themselves, even if it's only a simulation. Taking short quizzes and assessments on the cellphone is on the rise, and this trend is likely to continue.

Augmented reality

Augmented reality is already making big waves. With new apps such as Aurasma, learning is literally coming to life. In the future, pupils will be able to scan a page of their homework and a video of their teacher explaining a related concept could pop up, or book reviews will be available by simply scanning a barcode on the book.

ebooks dominate

Amazon.com is one of the largest retailers of books, but in the past year, its sales of ebooks has outstripped that of traditional books. The ebook is steadily becoming a popular part of everyday life for many around the globe, and the digital book is slowly making its way into the classroom as well. In the future, ebooks are likely to dominate virtual bookshelves.

Bring your own device to classrooms

Since most learners today already have access to mobile devices, schools are seizing the opportunity to turn these distractions into learning tools by incorporating these devices into classroom lessons and projects. From cellphones to laptops, teachers and pupils are increasingly bringing their own technology into the classroom.

Online collaborative learning

Most places these days have internet connection, and many people can now access the web from almost anywhere they can get a cellphone signal. Schools are embracing the web as a learning tool in a variety of ways, but a particularly exciting one has to be the growth of online collaborative learning.

This can mean a variety of things, but in many cases it involves pupils each participating in a project on the web.

Social media learning

When it was first created, Facebook was solely a place for college students to connect with one another. Today just about everyone has a profile on the site. Educators have begun using it as a way to connect with learners, spark discussion and relay important assignment information.

While social media in education is still a tricky area, as sites like Twitter and Facebook evolve, the ways they're used in the classroom will likely become more refined and more powerful in creating a better educational experience.

The rise of the tablet

Tablet computers come in many shapes and sizes, but as they grow smaller and more portable, they are becoming a fairly common addition to the classroom. They're great for doing everything from studying the periodic table to playing educational games. The app-based device has become a necessity in schools across the world.

With the proliferation of technology, educators are challenged to deliver and facilitate teaching in many new ways, and are discovering the potential that technology has in advancing learning.

Figure 2.10: Article on challenges that teachers face in implementing technology in their teaching methods

(Pretoria News, 2015)

Equipping young people with tech skills

The low rate of science and maths participation must be addressed

WORKPLACE STAFF

TECHNOLOGY plays a crucial role in the modern workplace and at home by making employees and students more productive in their personal and professional tasks.

Microsoft's global vice-president of Education, Anthony Salcito, is in the country to speak about how the company is empowering educators and inspiring students.

Microsoft is providing IT training and opportunities to diverse populations of young people to prepare them with the computational thinking and problem-solving skills necessary for success in an increasingly digital world, through partnerships with government, nonprofit organisations and local business partnerships.

Globally, Microsoft has committed to investing $75 million (R1 billion) over the next three years in community programmes to increase access to computer science education for all youth, especially for those from under-represented backgrounds, and build greater diversity into the tech talent pipeline.

"More and better education, combined with early access to the tools and skills used in the workplace, are proven to help create healthier communities, economies and workers who are ready to enter the workforce," said Salcito.

Microsoft's global vice-president Anthony Salcito with a government representative at Sci-Bono.

In South Africa, as with the rest of the world, educators face a variety of challenges ranging from planning and organising their day effectively to fit a broad range of activities into a limited amount of time, to using technology to help make lessons more accessible and entertaining for students.

The latter is very important in a country where schools face a maths and science participation rate of less than 45 percent, and a whopping 60 percent of schools have no computer lab facilities.

"Local initiatives such as the Microsoft Innovative Educator expert programme helps local teachers to integrate technology into their lesson plans and make use of inventive teaching methods to not only ensure that students know how to use technology, but are enabled to create technology, empowering them to become future innovators, inventors and entrepreneurs who will drive local economic growth, create jobs and solve problems within their communities," says Zoaib Hoosen, managing director of Microsoft South Africa.

According to IDC's Economic Impact of IT, Software and Microsoft in South Africa report, the IT sector will generate more than 77 200 new jobs over the next four years.

"Microsoft plans on playing an active role to ensure that South Africa realises this statistic by developing skills and providing opportunities for young people from basic education through to starting their own businesses.

"This will be done through programmes such as the Student to Business programme whereby we are partnering to create over 1 500 jobs through internships and the AppFactory programme in which we are training interns to develop over 800 locally relevant apps.

"These initiatives will help us create a bridge to employment and financial independence," adds Hoosen.

In addition, Microsoft is sponsoring a year-long exhibition at Sci-Bono in Braamfontein, Joburg, which will be used to showcase the future of the classroom to local pupils and teachers.

This exhibition will feature various gadgets and applications including devices from Pinnacle that will enable visitors to get hands-on experience in the use of apps like Word, Excel, Skype and OneNote.

The case for gamification in the classroom will also be made as a driver of curiosity, persistence, concentration, and student engagement through educational games such as *Minecraft*.

Figure 2.11: Article on equipping young people with technology skills

(Pretoria News, 2015)

Paperless education key to future of SA economy - Ramaphosa

LERATO MAILOANE

Learners in Gauteng started the first day of school in paperless classrooms. The province has officially declared a duster and a chalkboard history in seven schools where the paperless classrooms was officially launched by Deputy President Cyril Ramaphosa, Minister of Education Angie Motshekga, Gauteng Premier David Makhura and Education MEC Lesufi Panyaza.

At Boitumelong Secondary School, each classroom has been fitted with an interactive board that links to each learner's tablet and educator's laptop.

Deputy President Cyril Ramaphosa said the introduction of paperless classrooms is critical in boosting the country's economy.

One of the factors constraining economic growth in South Africa is the relative shortage of e-skills," he said at the "Big Switch On" at Boitumelong Secondary School in Tembisa, Ekurhuleni.

Ramaphosa said the launch was in line with improving the education system in the country. He said instead of being complaisant government had a national e-skills plan, with education as a key part of the plan. "Information Communication Technology has revolutionised our lives and the way we do business".

"The economies of the twenty first century are rapidly becoming knowledge-based economies. Technology, the internet and multi-skilled workforce, innovation are critical in the knowledge based economy", he added.

The Gauteng Education Department hoped to roll out the project to all Gauteng townships and rural schools by the end of the 2017/2018 financial year at an estimated cost of R17 billion.

lerato.mailoane@gauteng.gov.za

CLASSROOM OF THE FUTURE: Learners use tablets in Gauteng classrooms
Photograph: Kwanele Mboso

Figure 2.12: Article on paperless education

(Gauteng Rekord, 2015)

A closer look at the use of technology in schools from a global perspective, one can see that countries that are using technology in education and teaching practice have high pass rates and more graduates, therefore a high level of academic learners which may impact the country as a whole (Mac Callum & Jeffery, 2013; Nkula & Krauss, 2014). Data also shows that these countries also have staff development and courses in place to equip teachers to facilitate knowledge using technology and therefore keep up with the "technologically savvy" era of learners and their demands of "on the go" learning (Blignaut et al., 2010). From a South African perspective the use of teacher development in terms of education technology is relatively new. Universities are currently developing programmes and course work suitable for teachers to assist in bridging the gap between the digitally literate learner and the common classroom practice teacher. The learner centred approach of education through communication, providing a meaningful experience where learners share knowledge, is necessary to produce 21st century learners with the necessary skills required for the workplace (Siddiq, Gochyyev, & Wilson, 2017; van Laar, van Deursen, van Dijk, & de Haan, 2017).

2.8 Twenty First century skills

Siddiq et al. (2017) and (van Laar et al., 2017) discuss the importance of 21st century skills and define it as the skills young people need to acquire in order to work effectively in the 21st century. Their research emphasises that 21st century skills are more extensive and broader than just digital skills. Voogt and Roblin (2012) identified eight skills that comprise 21st century skills: collaboration, communication, digital literacy, citizenship, problem solving, critical thinking, creativity and productivity. van Laar et al. (2017) highlight that 21st century skills do not mean mere technical annotation but go beyond at looking at how a person thinks, learns, the impact on the person's ability to function in a technology rich society using software and having the knowledge of how to use the software. Twenty first century skills should involve mastering cognitive tasks by using ICT applications, skills that are not necessarily technology driven but involve using specific software, skills that involve a high order of thinking, and skills that favour continuous learning and cognitive processes (Claro et al., 2012). Digital literacy is merely the ability to understand and use a variety of different digital sources (Gilster, 1998). In order for teachers to be regarded as being digitally competent they need to have mastered information management,

collaboration, communication and sharing, creation of content knowledge, ethics and responsibilities, evaluation and problem solving of technical operations (Ferrari, 2012). With the growing need for 21st century skills policy makers have proposed frameworks such as the Partnership for 21st Century Skills (P21CS (Skills & Education), 2010) and the Knowledge, Skills, Attitude, Values and Ethics (KSAVE) model (Binkley et al., 2012). These models were used during the Assessment and Teaching of 21st Century Skills (ATC21S) project in 2009 by three companies, Cisco, Intel and Microsoft, as a method to address the challenges of the world economy brought about by ICT developments (Siddiq et al., 2017). Figure 2.13 illustrates three types of skills needed for 21st century teaching.

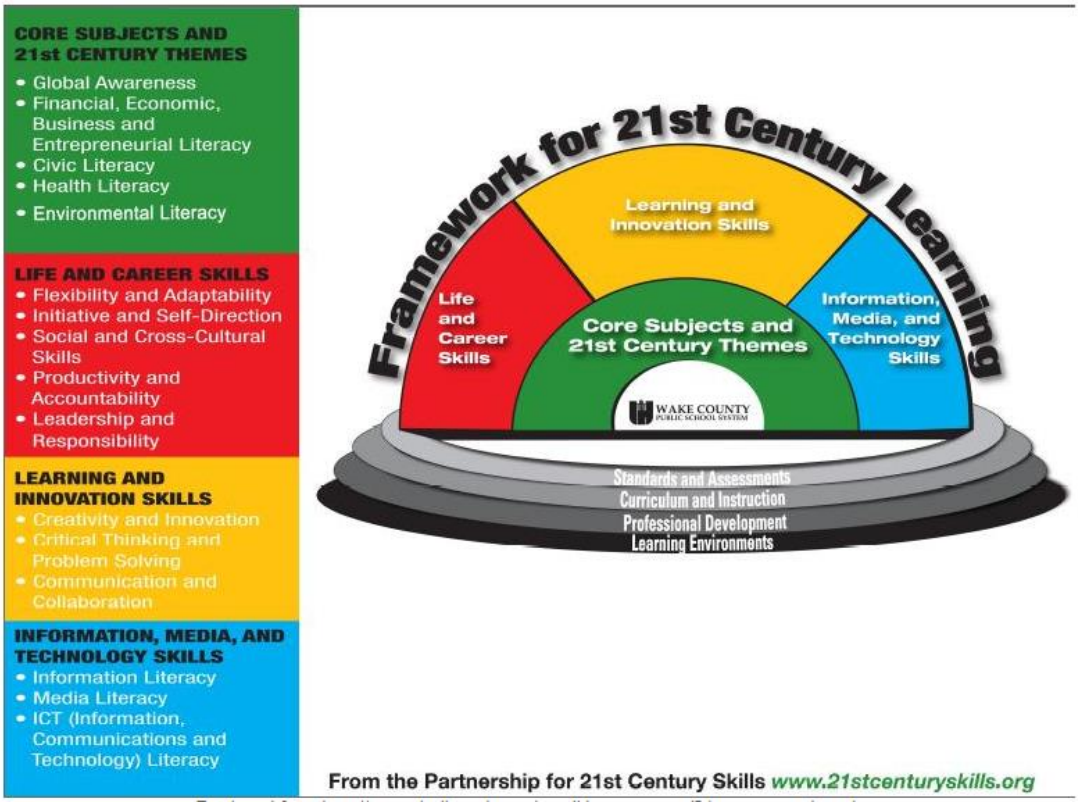


Figure 2.13: Partnership for 21st Century Skills

Figure 2.13 explains the ways in which the skills for 21st century teaching can be assessed using the Assessment and Teaching for 21st Century Skills model (ATC21S). Thus emphasising the relevance and range of assessment techniques required for a variety of skills developed.

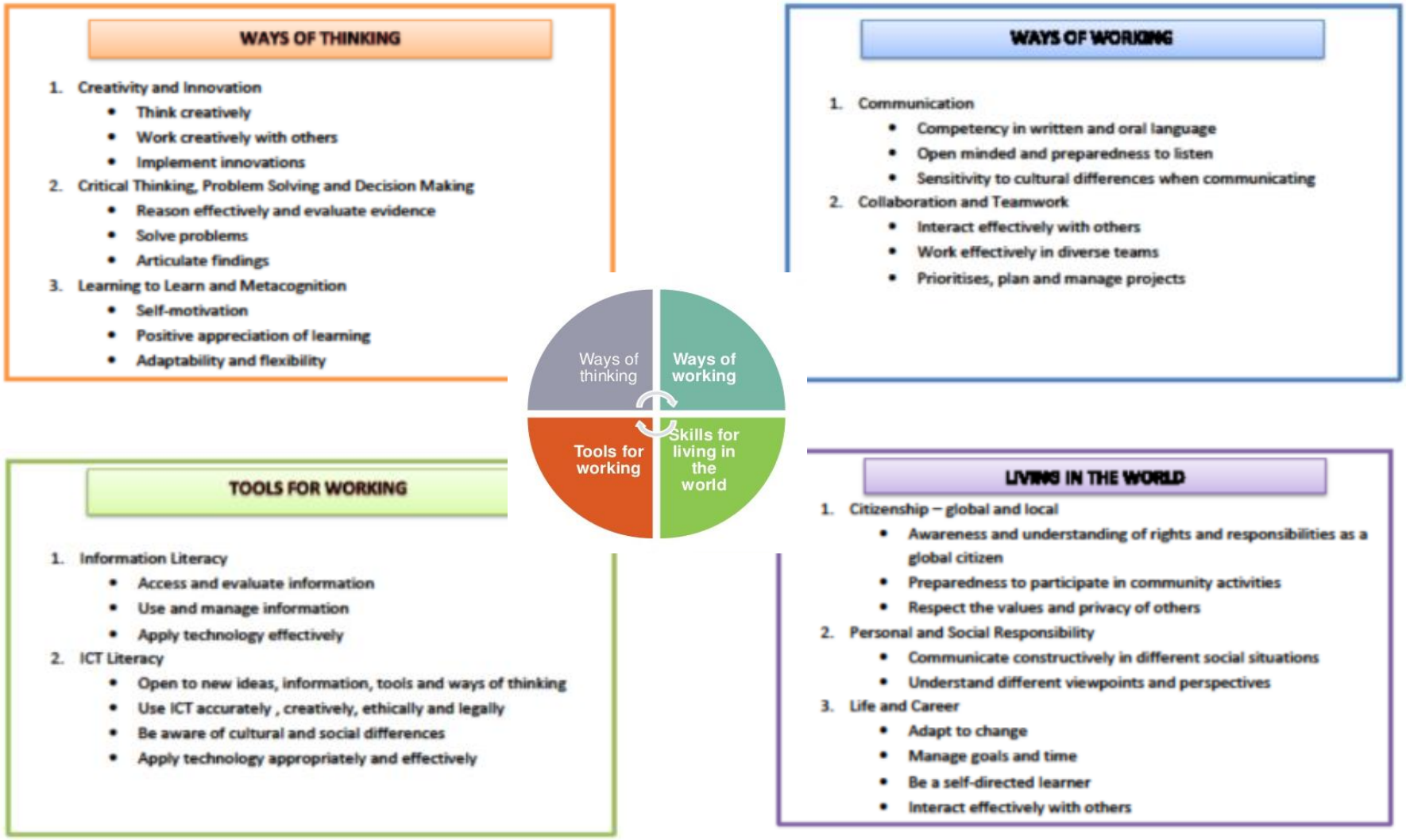


Figure 2.14: Assessment and Teaching for 21st century Skills (ATC21S)

Crosswell and Beutel (2017) look at the impact of 21st century skills on teacher identity, teacher resilience and teacher effectiveness. Resilient teachers maintain a commitment and agency in keeping up with everyday changes in teaching (Gu & Day, 2013). This impacts on their teacher effectiveness and allows for the reframing and adaptability of their teacher identity. The initial experiences of teachers with 21st century skills often determine the agentic behaviours about their own development and the consistency of adaptable teacher identity (Crosswell & Beutel, 2017; Mansfield, Beltman, Broadley, & Weatherby-Fell, 2016).

Lim and Khine (2006) claim that more support is needed for teachers to assist in introducing technology in education. This support is vital as it will enforce the adoption of mobile technology. “Teachers need access to more training, more information and more opportunities to see and use new technologies themselves” (Duncan-Howell & Lee, 1995 p.229).

2.9 Professional development for m-learning

Royle et al. (2014) focus on the aspect of continuing professional development as a focus of change. He found that technology has always presented education with challenges and opportunities which have a direct impact on teacher development. The use of mobile technology in education brings about a change in what people know, when they know it, how they know it, who they learn from and who they teach. Teachers need to adapt to this change in order to maintain a relevant, authentic and literally credible education system. What is problematic about this adoption is that even though it is crucially important to provide teachers with training within schools, it is most likely that the “tried and trusted” approaches will be propagated in such high performative and generally risk-averse cultures. (Royle et al., 2014. p.33)

Teacher professional development is often seen as a once-off effort to disseminate information and skills with no follow-up (Garet, Porter, Desimone, Birman, & Yoon, 2001). Research done by Mac Callum and Jeffery (2013) shows that the expected influence of mobile technology on teaching and learning, if introduced successfully, (Mac Callum, 2010) should yield great performance by learners. Factors such as environment, policies, support and beliefs have proven to be very influential on teachers introducing several technologies in the classroom (Albion, 2009; Hammond, Reynolds, & Ingram, 2011; Sang, Valcke, Braak, & Tondeur, 2010).

Cinque (2013) found that teachers are unable to design learning activities using technology and until courses are designed to extend their knowledge of multimedia communication and social networking, they will not be able to implement mobile technology into education. A study by Shohel and Power (2010) illustrates a model of the needs of teachers to implement mobile technology. The complexity of this model is an example that demonstrates the various support structures that need to be in place to assist teachers in implementing mobile technology and m-learning successfully in classrooms.

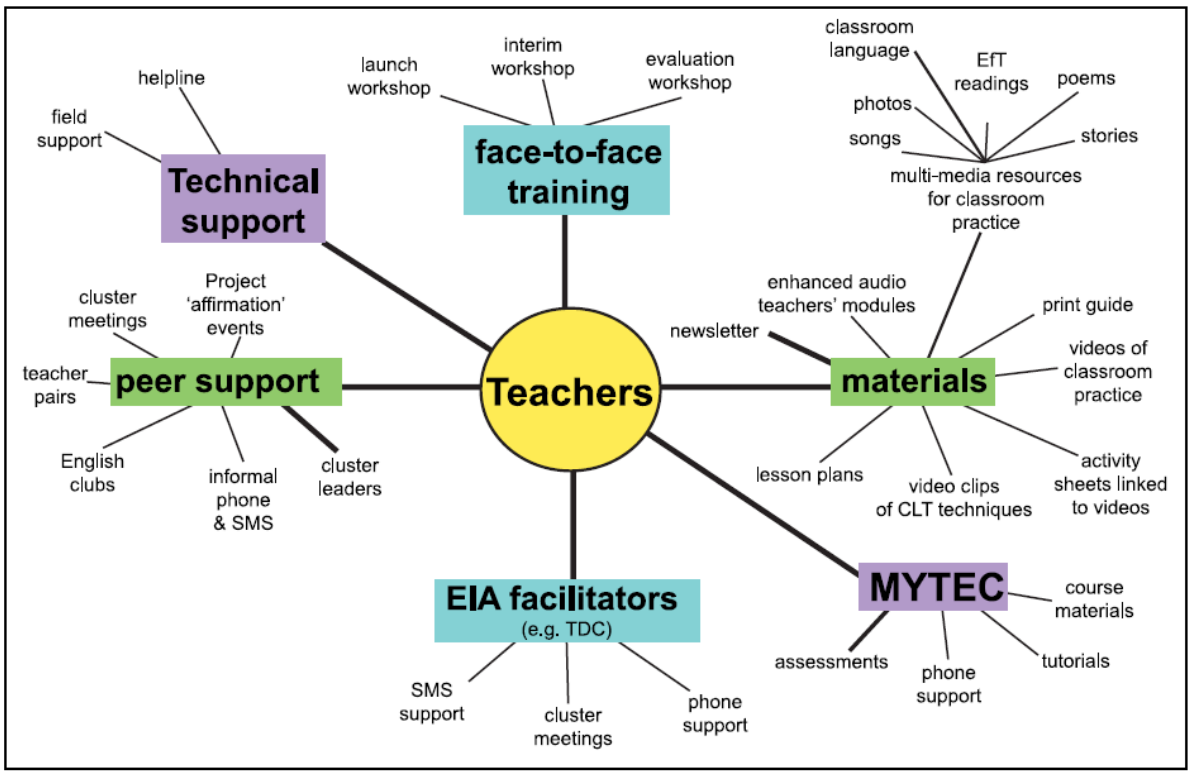


Figure 2.15: EIA School-based supported open learning model

Shohel and Power, (2010)

Researcher and Professor Simon Collin from Université de Montréal, Canada, in the World Social Science Forum (2015) looks at the use of digital technologies used by learners. In his studies he found that learners in high school use approximately four to seven technologies a week. This makes the learners of today “technologically savvy”. Collin emphasises the need for teacher development and how Canadian universities have included courses in their undergraduate degrees to equip teachers with the knowledge of how to include technology in their methodology. These courses

have been developed to be subject specific and are moving towards “anytime learning” for learners.

Lortie (1975) and Hargreaves (1980) argue that there is very “little opportunity or incentive for teachers to develop shared professional knowledge or a collegial sense of the “state of the art” (Nias, 1989. p156).” A teacher’s education, experience and conventional wisdom is governed by the uniqueness of the individual and the social context and primacy of the individual. Due to the freedom of political control that was once prominent in schools, teachers took decisions about curriculum and teaching methods that were dependent on their own knowledge, interests and preferences. However, there are many teachers that reduce the boundaries between their personal lives and occupational lives. For them teaching is “inclusive” and it absorbs much of their time and energy, giving them the ability to use all their talents, skills and abilities (Argyris, 1964). This way teaching is conceptualised as a relationship between the teacher and the learner and then becomes more personally and emotionally satisfying as an occupation. “Teaching has a bottomless appetite for commitment” (Nias, 1989. p. 160). The importance of the relationship that teachers build, how they think, why they think this way and how they teach, therefore has a direct impact on what they teach, when they teach it why they teach it and their commitment to teaching in general. With the “teaching” being the central aspect of teaching it is important to evaluate the terms of “teacher self-concept”, “teacher self-esteem”, “teacher identity” as these pay attention to the notion of the “self”.

Ball (1972) claims that since the “self” is developed from a young age it is very difficult to bring about change. Therefore, teachers’ self-concept is resistant to change and persistently defensive. Any form of change is seen as a compromise to the teachers’ attitude and value. C. Rogers (1982) and McClure (2011) argue that teachers reject new ideas which they do not perceive as compatible with their own views.

Hargreaves, Hester, and Mellor (1975) found that the nature of self-esteem is inconclusive but can be supported by the idea that teachers behave and maintain a stable self-image which creates a perception in others. This perception is believable because perceivers have the knowledge of the past and present experiences of the interaction.

Since teacher professional development is often approached as a fragmented effort to disseminate knowledge and skills (Garet et al., 2001) it is usually from disconnected administrators and outside consultants that do not really care about the individual needs of the teacher. “In reality, these individuals are just merely mistargeting their well-intended efforts” (Summey, 2013. p. 447). The portability of mobile devices suggest that m-learning and professional development should be coupled as it allows for collaborative, experimental learning to take place in authentic environments. “M-learning offers the ability to facilitate professional development that is differentiated based upon the unique needs of each teacher participant, in terms of technology, proficiency, instructional context and learning environment” (Summey, 2013. p. 448). Therefore mobile devices can motivate teacher engagement, but this is only if the teacher is open to change and freedom within his/her teaching. A teacher that does not feel comfortable with using mobile devices such as smartphones or tablets will be resistant to engage with m-learning in the classroom. The positive and negative feelings of teachers as individuals will determine their effectiveness of m-learning in their classrooms. In order for m-learning to be implemented successfully there needs to be on-going support for teachers which is often overlooked (Summey, 2013).

Czerniewicz and Brown (2005) explored the need for ICT investigation at a meso-level. According to Czerniewicz & Brown, (2005, p.2) these assumptions are:

- “ICT use needs to be understood in relation to its purpose
- Access and use are interlinked
- In order to understand ICT usage in pedagogical activity, the level of granularity to be focused on is that of teaching and learning “events”
- Media forms (both ICT and non-ICT) are integral to teaching and learning
- Specific media forms support are closely aligned to, or are associated with particular teaching approaches, learning experiences or teaching and learning events.”

Since research shows that ICTs show intrinsic benefits best when interwoven in practices with consideration of the context and purpose (Kling, 2000; Lamb & Johnston, 2004; Snyder, 1998; Warschauer, 2002, 2003a), this study aims at finding the link between teachers and their use of ICTs as a form of professional

development. Numerous studies (Bonk, Cummings, Hara, Fischler, & Lee, 2000; Mason, 1998) focused on the uses and categories of ICTs, and different levels of courses that have been helpful to contextualise the extent and nature of ICT use, however the pedagogical interaction of ICT bounded by the curriculum would form the basis of this study. By understanding the use of ICT at the level of pedagogical engagement, it may provide valuable insight into the relationship between teaching and learning and teacher professional development. “Pedagogy is about the various forms of interaction between three agents: teachers, learner/s and knowledge domain” (Czerniewicz & Brown 2005. p. 3). These three elements form a triangle of interaction (Garrison & Anderson, 2002), therefore technology and pedagogy involves the consideration of the interrelations between learning experiences, teaching approaches, the nature of the content being taught and the knowledge being created (Bernstein, 2001; Loveless, De Voogd, & Bohlin, 2001). In order for teachers to find the link between technology and pedagogy and ensure these interrelations they need to change the way they teach and therefore their teacher identity.

2.10 Teacher identity

“Teaching, like learning, has a perceptual basis” (Nias, 1989. p.155). It is important to note that teaching is seen as a personal activity. This includes the notion of the *self* and the notion of *identity*. This is due to the fact that the manner in which each teacher behaves is unique. “The minute-to-minute decisions teachers make within the shifting, unpredictable, capricious world of the classroom and the judgements they reach when they are reflecting on their work depend upon how they perceive particular events, behaviours, materials, persons” (Nias, 1989. p. 155). Perceptions are determined by schemata which were defined by Vernon (1955, p. 181) as the, “persistent, deep-rooted and well organised classifications of ways of perceiving, thinking and behaving which are also living and flexible” or by Abercrombie (1969, p. 641) as, “schemata … organised in more generalised, vague or ill-defined patterns.” Schemata are developed throughout life and are assumptions that are learnt (Nias, 1989). Life experiences impacts how we perceive the world and this has a direct influence on how teachers teach and how their learners learn. Nias (1989) claims that teachers interpret their learners and their actions and reactions based on patterns which will be unique to them. He believes that it does not matter how influential or persuasive the social or occupational culture may be, the actions and attitudes of

teachers are rooted in the way in which they perceive the world. Lortie (1975. p. 79) found that, “personal predispositions are not only relevant but, in fact stand at the core of becoming a teacher.” Similar studies by Woods (1981) and Sikes, Measor, and Woods (1985) also found that teachers’ personalities and qualities are often the deciding factor in their effectiveness. The Department of Education and Science in the United Kingdom, in their White Paper *Teaching Quality* argues: “Personality, character and commitment are as important as the specific knowledge and skills that are used in the day to day tasks of teaching” (DES), 1983. p. 26). The stress on personality was encouraged by the allegiance of philosophical traditions and personal relationship formed between teacher and learner that was seen as the centre of educational processes (Nias, 1989). Many primary school teachers still feel that the relationship built with their learners is not just merely a means to establish control but also to increase motivation and assist with education that needs to take place (Woods, 1987).

A presentation by the Human Sciences Research Council (HSRC) representative at the World Social Science Forum (2015) raised discussion and debate about “The shift from teachers to teaching”. The desire was for the knowledge of education to be more efficient and effective in schools and for the focus to be on teaching. One of the questions posed was: Should one not focus on the teachers because they are the facilitators of effective teaching? A study done by the University of Zululand on the effectiveness of CAPS training in SA schools found that teachers find this training to be ineffective and unhelpful. They are not taught any content and the sessions are purely theoretical based with little to no practical application. These sessions do not provide interaction or accommodate the contextual factors that may alter the pedagogies chosen for specific lessons or sections of work. A quote by Lant Pritchett; “Schooling ain’t learning” provides some insight on views that learning does not only take place in the classroom by one on one interaction with the teacher, but can also be effective and accessible through the use of technology which is proving to be more and more effective and beneficial. Due to the significant role that teachers play in facilitating technology usage in teaching the development of teacher identity is constantly changing. This identity will have a crucial impact on the success of the teaching.

There is a vast amount of research that has been done on the development of teacher identity (Olsen, 2008; Siddiq et al., 2017; van Laar et al., 2017). As future teachers or current teachers go through different programmes in teacher education, a shift in identity must occur as they face the challenging school contexts and technologically advanced learners of today. Teacher identity can be seen as a frame or analytic lens through which we examine different aspects of teaching like the way learners integrate a range of influences or the necessary confrontation of tension and contradictions in their careers (Olsen, 2008). McKoen and Harrison (2010. p. 27) define identity as a "socially and culturally constructed 'self' formed through a life's experiences and through communication about these experiences." Alternatively it can be seen as the way in which teachers organise their lives professionally and explain, justify and make sense of themselves in relation to others and the world around them (Crosswell & Beutel, 2017). According to Kreber (2010) the interplay between personal theories of teaching, perceptions of self and social and occupational contexts, shape what we call teacher identity.

Teacher identity has been explored in a variety of ways as shown in Table 2.5.

Table 2.5: Exploration of teacher identity.

In the constant "reinventing" of themselves that teachers go through	(Mitchell & Weber, 1999)
The narratives that teachers create to explain themselves and their lives as teachers	(Sfard & Prusak, 2005)
The variety of discourses that teachers participate in and produce	(Alsup, 2006)
The metaphors that may guide or result in a teachers understanding of the role	(Hunt, 2006; Leavy, McSorlet, & Bote, 2007)
In terms of the contextual factors that influence their practice	(Flores & Day, 2006)

As we move into a phase of technology-based education it is important to study the behaviour and change that take place in teachers as they shift towards a new identity development. This development of teacher identity occurs during interactions of teachers with learners, student teachers, colleagues and any others involved in education (Swennen, Jones, & Volman, 2010). Another significant contribution to identity development in teachers is context, practice and time (Dinkelman, 2011). Developing a professional teacher identity is recognised as a central process for teachers (Timmerman, 2009). This is due to the close connection between identity

and practice (Izadinia, 2014). Therefore, one can say that the development of a teachers practice is to some degree dependent on their development of professional identity (Ben-Peretz et al., 2010). Researchers have identified communities of practice (McGregor, Hooker, Wise, & Devlin, 2010; Murray, 2008; Poyas & Smith, 2007), reflective activities (Dinkelman, 2011; Haamer, Lepp, & Reva, 2012; Kim & Greene, 2011) and educational and professional experiences (Flores & Day, 2006; Hockings, Cokke, Yamashita, McGinty, & Bowl, 2009; Rodgers & Scott, 2008) as influential factors in teacher identity development.

This shift focuses on the redesigning of lesson delivery to ensure effective yet efficient learning for the learner and teacher. Since there are so many factors that influence the development of teacher identity, it is not possible to reach a definite definition. The notion of the "self" and "identity" form a close connection. Emotion, discourse, the power of stories, role of reflection and contextual factors shape identity development and create a link between identity and agency. It is not possible to focus on identity development without preceding to explain how one or all of the factors mentioned shapes and overlaps identity development. It is believed that identity development changes over time and this is due to both internal factors such as emotion (Rodgers & Scott, 2008) and or external factors such as context and life experiences (Flores & Day, 2006; Rodgers & Scott, 2008).

"Professional identity comprises the notion of agency, or the active pursuit of professional development and learning in accordance with a teacher's goals" (Beauchamp & Thomas, 2009. p. 177). Gee (2001) identifies four ways in which identity must be perceived: nature-identity, institution-identity, discourse-identity and affinity-identity. From a sociocultural perspective (Avraamidou, 2014; Olsen, 2008; Sfard & Prusak, 2005) teacher identity can be viewed as a "product (a result of influences on the teacher) and process (a form of on-going interaction within teacher development)" (Beauchamp & Thomas, 2009). Sachs (2005) encompasses the overall perception of identity with its centrality of the concept of teaching and dynamism inherent to it as:

> *Teacher professional identity then stands at the core of the teaching profession. It provides a framework for teachers to construct their own ideas of "how to be", "how to act", and "how to understand" their work*

> *and their place in society. Importantly, teacher identity is not something that is fixed nor is it imposed; rather it is negotiated through experience and the sense that is made of that experience (Sachs, 2005. p. 15).*

Identity is constantly reshaping with experience. Literature reveals great inconsistency in the language used to describe identity. Various terms are used to reference identity development such as “development of identity” (Olsen, 2008); “construction of identity” (Soreide, 2006); “formation of identity” (Rodgers & Scott, 2008), “identity-making” (Sfard & Prusak, 2005), “creating an identity” (Parkinson, 2008), “shaping and identity” (Flores & Day, 2006), “building identity” (Sfard & Prusak, 2005) and “architecture of teacher’s professional identities” (Day, Kington, Stobart, & Sammons, 2006). Beijaard, Meijer, and Verloop (2004) view teacher identity in terms of the knowledge that teachers need to possess: subject matter knowledge, pedagogical knowledge and didactical knowledge. There is a definite interrelationship between professional and personal identities and the “self” and “identity”. The works of Woods (1981) and Nias (1989) emphasise that there are many gratifications and dissatisfactions in teaching that come from the maintenance of teacher self-concept, self-image and identity. Integrating m-learning into professional development has been tested in various studies (Beauchamp & Thomas, 2009; Royle & Hadfield, 2012) and several guidelines have been created to avoid common mistakes that have been identified in order to support teachers with the implementation process. Even this comes with several gratifications and dissatisfactions which will be further explored in this study.

“M-learning provides a means by which to enable teacher professional development that is both meaningful and effective-that is differentiated and meets the unique and specific needs of teachers and their learners within the context of diverse learning environments, curricular guidelines, and technology constraints” (Summey, 2013. p. 447). Various programmes, m-learning strategies and research-based models that have been identified in m-learning as an integral part of professional development have been identified.

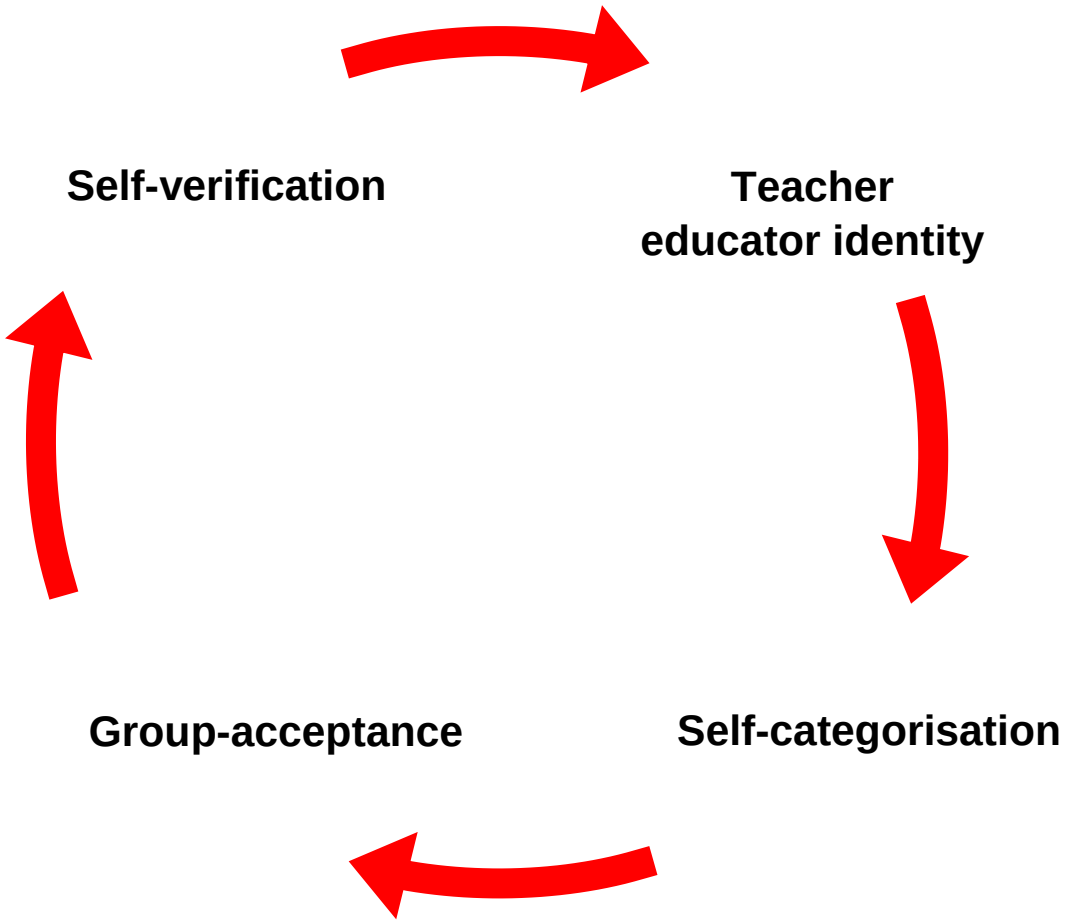


Figure 2.16: Process of teacher identity in teacher educators

(Izadinia, 2014)

Izadinia (2014) illustrates the cyclic process of teacher identity development as an on-going process in Figure 2.14. Field (2012) explains that the general idea of teacher identity forms from self-views. These could be of vulnerability, exposure, marginalisation, disempowerment and de-skill (Field, 2012; Izadinia, 2014). This satisfaction of knowing that one is successfully fulfilling a role can heighten feelings of self-worth and self-esteem. Whereas if the perception is not of satisfying a role the converse can be said. Feelings of distress and doubt of self-worth may be experienced (Field, 2012; Hoelter, 1986). A negative view of one's self can be created by uncertainty with regards to efficacy, high teaching loads, expectations, and stress (Boyd & Harris, 2010; Field, 2012; Loughran, 2011). Therefore teachers experience self-categorisation.

2.11 Conclusion

Having studied the literature in great depth on several aspects of mobile technology integration, the challenges and restrictions that teachers face in adoption, there is a great need for professional development to support a paradigm shift and identity change. The core focus of this study is to provide professional development to the teachers and also choose a context that will eliminate most of the contextual and resource factors. This is necessary because the study focuses on observing and identifying the identity change of teachers through the implementation of mobile technology and not necessarily the effectiveness of technology use. In order to consider all the aspects discussed in the literature that brings about identity change and create a context to allow for identity change, the study will be suggesting three models that will collectively frame and help categorise the data. These models are discussed in detail in Chapter 3.

Chapter 3

Theoretical Underpinnings

"Technology is just a tool. In terms of getting kids working together and motivating them, the teacher is most important"

Bill Gates

3.1 Introduction

The theoretical underpinnings of this study are focused on teachers being unable to successfully implement technology in their classrooms because of poor lesson objectives, classroom strategies and lack of knowledge of hardware and software (Liu, 2011). Since the study aims to explore the identity development of teachers as they implement mobile technology in their classroom, the conceptual framework has been designed to incorporate all aspects of the change process. This chapter provides a brief overview of the three models that were used as a basis for analysis in this study: The Technology, Pedagogy and Content model (TPCK) which looks at the interconnectedness of knowledge that is required for successful classroom practice, the Technology Acceptance Model (TAM) which indicates the factors that influence teachers adoption, adaptability and acceptance, and the Substitution, Augmentation, Modification, Redefinition model (SAMR) which focuses on different levels of technology integration in teaching in terms of planning and delivery. The link between each model and its relativity to the study will be emphasised, proposing a new framework for professional teacher technical identity development. This framework will, however, change throughout each stage of the data analysis to represent the findings from the study. Through this process the development of professional teacher technical identity will be observed and documented. An analysis of the observation and results from data will aid in the construction of a new framework for professional teacher technical identity development.

Since teaching and learning are likely to be linked to specific forms of technologies the engagement of teachers with the technology needs to be of a high level (Duncan-Howell & Lee, 1995). Technology proficiency amongst beginning teachers may be of

a higher level than those of teachers that are already in the teaching practice for several years (Liu et al., 2014; Marerum-Leys & Marx, 2002; Rastogi & Malhotra, 2013). According to Russell et al. (2003) novice teachers express greater confidence and higher proficiency in computer use when compared to experienced teachers. New courses are offered at universities as discussed in the literature study, however these courses tend to vary considerably (Lee & Lee, 2014). It is, however, necessary for teachers that are already in the teaching profession to develop their skills in technology to cater for the technically advanced learners of today. Equipping teachers with technology is not enough. Several factors influence a teacher's decision to use technology such as: access to resources, incentives to change, commitment to professional learning, quality of software and hardware, ease of use, and background informal training (Kihoza et al., 2016). They need to be shown how to use these ICTs and integrate it into their teaching at different levels (Goktas, Yildirim, & Yildirim, 2008). As a result, a pattern of technical growth and development needs to take place in a teacher. While several theories have been developed as documented in the literature review, a framework for the link between teachers that are already in schools and their ability to adapt to a 21st century method of teaching has not been found. Figure 3.1 below provides an illustration of the chapter overview.

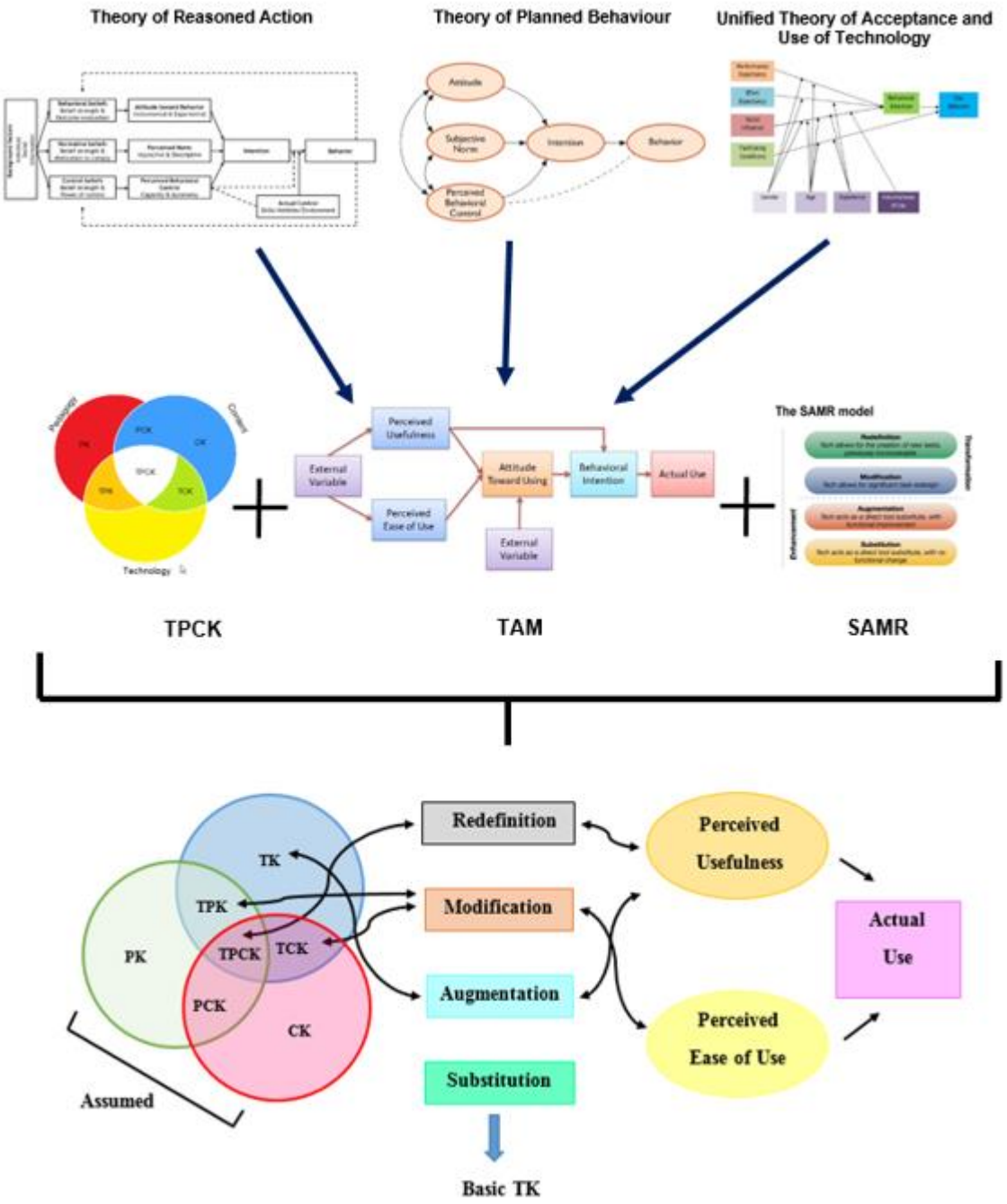


Figure 3.1: Overview of Chapter 3

(Mishra and Koehler, 2006; Mac Callum et al., 2014; Fishbein et al., 1977; Ajzen, 1985; Venkatesh et al., 2003a; Puentedura, 2012)

Figure 3.1 above illustrates the combination of three existing frameworks to develop Framework 0. An extensive study of frameworks used for technology acceptance was done. TAM being the most common encapsulated the aspects of technology acceptance relevant to the study. TPCK, TAM and SAMR were then combined and rearranged to create Framework 0 which is further explained.

3.2 Technology, Pedagogy and Content Knowledge Model (TPCK)

Over the last decade the use of TPCK as a framework in educational research has increased rapidly, especially with the inclusion of ICT's. Kihoza et al. (2016) define TPCK as "a tool for examining the pedagogically sound ways in which technology can support teachers' knowledge while keeping pace in the technology, content and pedagogy contexts". A teacher's role is to include technology into the learning process. TPCK originated from the initial PCK model proposed by Shulman in 1896. PCK was regarded as the dimensions of professional knowledge (Kirschner, Borowski, Fischer, Gess-Newsome, & von Aufschnaiter, 2016). PCK according to Shulman consisted of seven aspects; CK, general PK, curriculum knowledge, PCK, knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational ends, purposes, and values. His theory on teacher's professional knowledge was modified several times but the three dimensions of importance, CK, PK and PCK were constant. The inclusion of technology allowed for an additional aspect which was proposed by Mishra and Koehler in 2006. It is presumed that technology, pedagogy and content cannot be taught in isolation from one another as it may compromise good teaching or successful technology implementation (Baia, 2011). A year later Thompson and Mishra provided an acronym –TPCK as we know it today. Baia (2011) referred to Mishra and Koehler (2006, p. 1030) who wrote that "viewing any of these components in isolation from the other represents a real disservice to good teaching," thus emphasising the restructuring of professional development for teachers to foster these interconnections. He further discussed how the adoption of instructional technology cannot be considered without content and pedagogy as depicted in Figure 3.2.

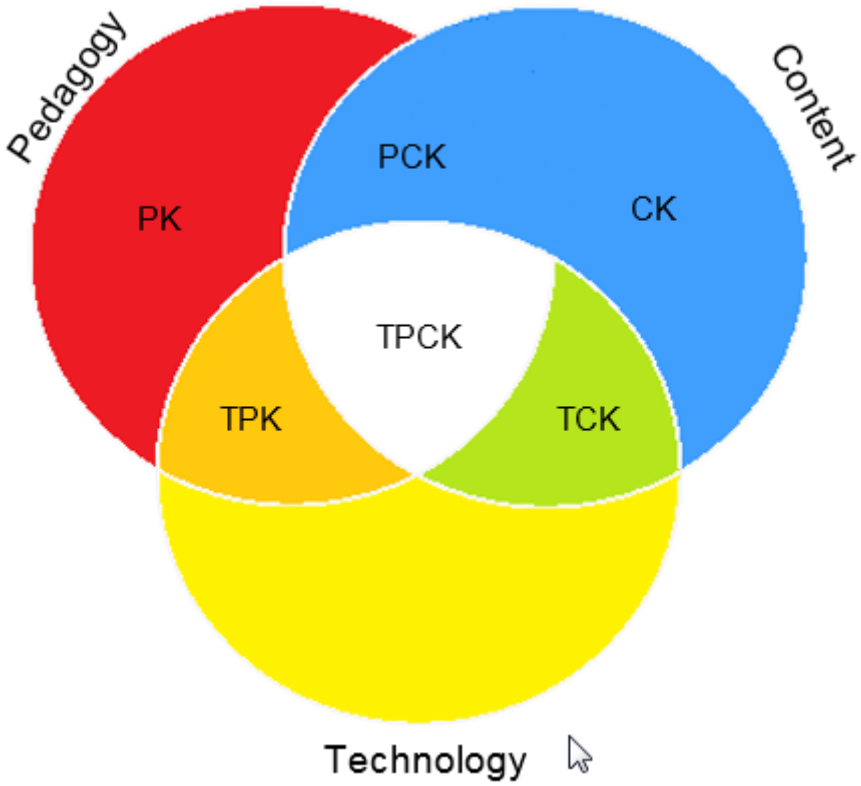


Figure 3.2: TPCK model

Mishra and Koehler, 2006

The outer circles of the model PK, CK and TK include the 3 elements of teaching. **Pedagogical knowledge** focuses on all methodologies needed to cover specific concepts in the syllabus and are subject-independent (Kihoza et al., 2016; Kirschner et al., 2016). It is the teachers' knowledge of effective general teaching methods (Cox & Graham, 2009). **Content knowledge** focuses on the syllabus itself comprising of rules, theories, phenomena, principles and models (Kihoza et al., 2016; Kirschner et al., 2016). This is the teachers' knowledge of the content for that particular learning area (Cox & Graham, 2009). **Technology knowledge** focuses on how to use digital devices such as computers, tablets, mobile phones, etc. and the relevant software. This is the knowledge that teachers have of emerging technology (Cox & Graham, 2009). As we move further in there are three overlapping concepts in the model.

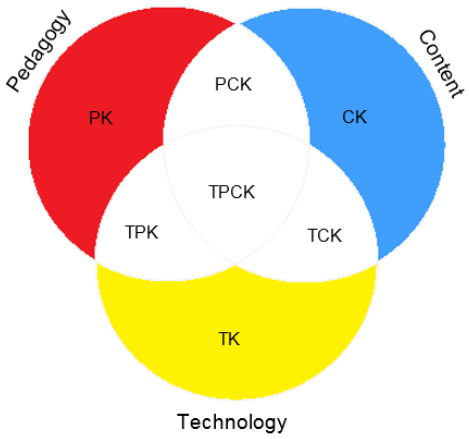


Figure 3.3: TPCK model

Mishra and Koehler, 2006

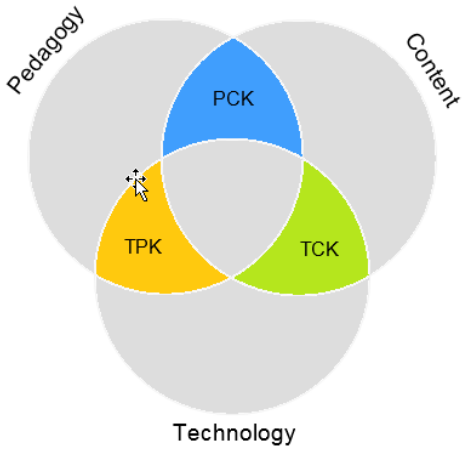


Figure 3.4: TPCK model

Mishra and Koehler, 2006

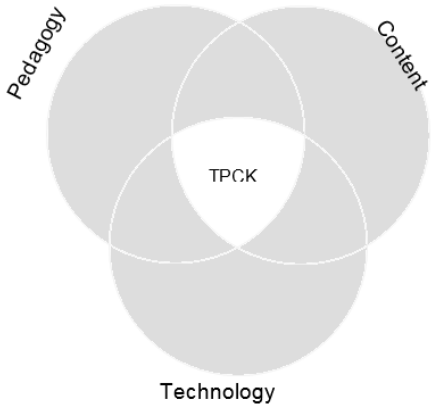


Figure 3.5: TPCK model

Mishra and Koehler, 2006

Pedagogical Content Knowledge (PCK) allows for the blending of content and pedagogy to ensure understanding of a specific concept. It is the knowledge of teaching and learning for a particular subject that is considered to be a synthesis of content and school related pedagogy (Shulman, 1987). Cox and Graham (2009) describe it as the teachers' knowledge to effectively teach their subject. **Technology Content Knowledge (TCK)** focuses on understanding the technology for that subject and how it is represented. Niess (2005) describes TCK as finding innovative ways to develop teaching content and teach content with the use of technology. It is how emerging technologies can impact and be used in a specific learning area (Cox & Graham, 2009). **Technological Pedagogical Knowledge (TPK)** aims at understanding how technology can shape the ways of teaching and learning. It is understanding the impact of how teaching and learning with the use of technology can change (Liu et al., 2014), or the teachers' knowledge of how to incorporate emerging technology for effective teaching (Cox & Graham, 2009). Together these three encapsulate what the essence of every lesson showed portray. This is known as **TPCK**, the "understanding that emerges from interactions among content, pedagogy, and technology knowledge" (Koehler & Mishra, 2009). Defined by Gur and Karamete (2015.p. 779) as "a systemic approach to joining technical expertise in teaching with pedagogical content knowledge". Studies done by Koehler and Mishra (2006) and Niess (2008) are examples of attempts to include technology in education and have proven to be successful. The most important influence in this is the need for the teacher's understanding of how to implement technology, most specifically mobile technology and the ability to do this with ease. Furthermore, TPCK can improve the use of technology by in-service teachers as it provide a foundation for more effective technology-based instruction (Liu et al., 2014; Niess, 2011; Wetzel & Marshell, 2012). If TPCK is applied correctly it draws from the interwoven aspects which makes it a highly situated educational construct that is complex and that cannot be easily learnt, taught or applied (Harris & Hofer, 2011).

Several studies have shown that PK drives the integration of technology into classroom practice (Koh & Chai, 2014; Koh & Divaharan, 2011; Liu, 2013). Liu (2013) claims that teachers with sufficient PK and CK can consider various instructional technologies and are able to adopt a technology to match their notions of technological integration. His study integrated PK, CK and TK during a professional

development programme and devised concepts of TPCK. Cox and Graham (2009) claim that TPCK inspires teachers, teacher trainers and education technologists to create a more meaningful way of effective instruction by good technology use, engaging pedagogy and meaningful content. TPACK provides this unifying framework that suggests that each of the three domains function individually and collectively (Hilton, 2015). The ability of understanding how these domains work together and crafting learning activities that will draw from each domain simultaneously is regarded as effective technology use (Hofer & Grandgenett, 2012; Koehler & Mishra, 2009). The TPCK model is constantly changing as new technologies emerge and teachers try to find more effective ways to incorporate technology in their classrooms (Hilton, 2015). Teachers need to think with flexibility to conceive all the uses of technology and remain consistent within their existing beliefs and subject expertise (Koehler & Mishra, 2009).

Chai, Koh, and Tsai (2011) describe TPCK as a multiplicative framework where TK, CK and PK have positive influences on TPCK and TK and PK have positive influences on TPK which results in a positive influence on TPCK. Kihoza et al. (2016) advocates that TPCK alone cannot cater for the needs of pedagogical approaches to maximise learning with relevant technological tools. There are more aspects and frameworks that go beyond TPCK that are required to foster successful integration of technology (Brantley-Dias & Ertmer, 2013). An illustration of the interconnected relationship of the elements of TPCK is given below.

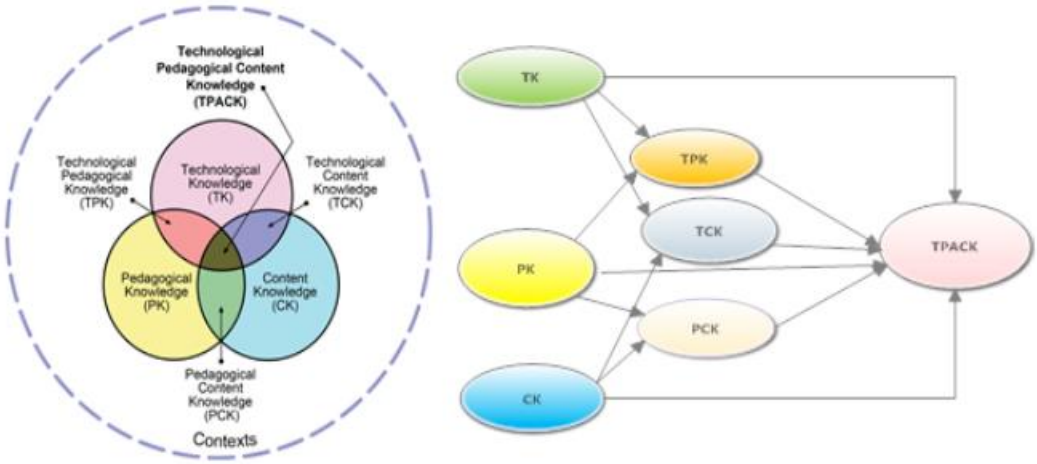


Figure 3.6: TPACK components and the extract of structural model of interrelationships among TPACK constructs

Adapted from (Kihoza et al., 2016)

Teo and Milutinovic (2015) found that the lack of sophisticated knowledge to support effective technology integration is one of the main one reasons for the low ICT usage for teaching and learning by teachers. However, this has been mitigated by younger teachers who have shown attempts of teaching with technology (Dimitrijević, Popović, & Stanić, 2012). Teo and Milutinovic (2015) suggest that in order for teachers to act as change agents and achieve educational goals, it is necessary that all teacher training faculties insist on one compulsory ICT course to provide professional development. Younger teachers display a higher level of aptitude and commitment to continuous education in using technology in their teaching and learning. This has been found to have significant impacts on the use of technology in teaching and learning (Teo & Milutinovic, 2015). Studies conducted by Pierce and Ball (2009) and Hermans (2008) identify technology acceptance as the key factor in ICT usage. “The technology acceptance model (TAM) (Davis, 1989) has been found to be a robust and parsimonious model for understanding the factors that affect users’ intention to use technology in education (Teo, 2012; Teo, Luan, Thammetar, & Chattiwat, 2011).

3.3 Technology Acceptance Model (TAM)

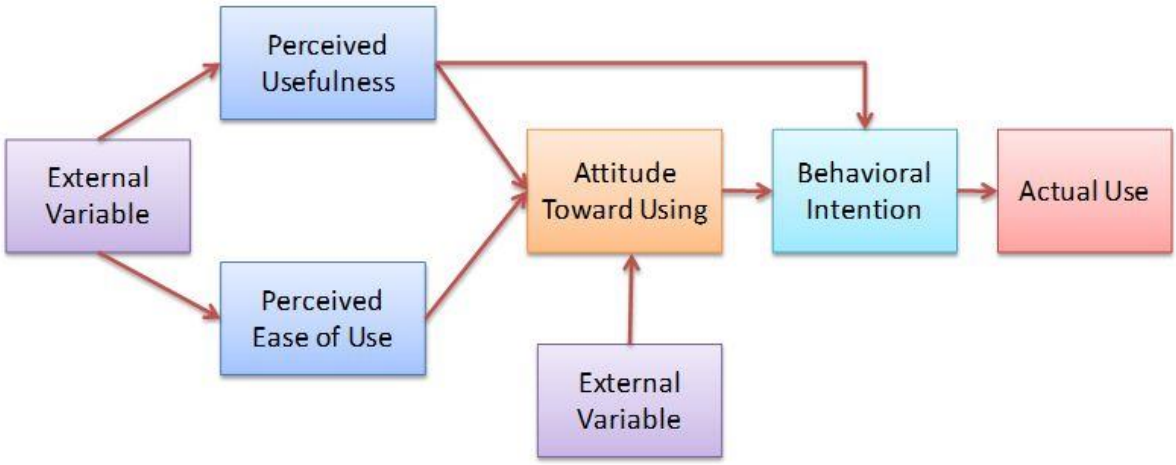


Figure 3.7: Technology Acceptance Model

(Mac Callum et al., 2014)

The Technology Acceptance Model (TAM) was developed by Fred Davis in 1989. This model was changed and adapted in many studies by several researchers and has many links with other models (Adams, Nelson, & Todd, 1992; Davis, Bagozzi, &

Warshaw, 1992; Hendrikson, Massey, & Cronan, 1993; Mathieson, 1991). Fred Davis drew on the Theory of Reasoned Action proposed by Fishbein and Ajzen in 1977 where he realised that the beliefs and evaluation that a person makes impacts on their attitude. He then added the aspects of Perceived Usefulness (PU) and Perceived Ease of Use (PEU). After a few studies he realised that the perceived ease of use and perceived usefulness had a direct influence on the behaviour of the individual. In 2000, Davis and Venkatash added the aspect of external variables as they found that there were several reasons as to why an individual would find a given system useful. Therefore external variables appear twice in the model. The first type of external variables are regarded as the environmental or context type that plays a role in whether teachers find using technology useful or easy to use. The second mention of external variables refers to the teacher's internal beliefs of teaching with technology, influence of other colleagues, support and their ease in using the technology.

In the TAM model the external factors constitute social factors, cultural factors, contextual factors and political factors. The social factors include skills, language and political crises, political factors include technology, politics and political crises and cultural factors include the beliefs of the individual and their desire to employ a particular information system application. Perceived usefulness is regarded as the extent to which a person believes a certain technology is useful to them in their lives and perceived ease of use is regarded as the measure of the extent to which an individual believes a certain technology is effortless (Mac Callum et al., 2014). The attitude to use is concerned with the desirability and evaluation of the information. The behavioural intention is the likelihood of the individual carrying out the task successfully (Surendran, 2012).The Teo and Milutinovic (2015) study proved that attitude has a significant influence on behaviour.

Adoption can be defined as the stage when an individual decides or selects technology for use in teaching (Sahin, 2005). The process of adoption is highly dependent on the individual's willingness and intent to use of technology. Other theories that have linked and created debate around the credibility of the TAM model are the Theory of Reasoned Action, Theory of Planned Behaviour and the Unified Theory of Acceptance and Use of Technology (Surendran, 2012).

In 1977 Fishbein and Ajzen proposed the Theory of Reasoned Action which was adapted by Davis in 1989 to form the TAM. This model however proposed that behavioural intention could be determined by the attitude of an individual towards the actual behaviour and the subjective norm associated with that behaviour (Chuttur, 2009). Fishbein and Ajzen (1977) suggested that the attitude of a person towards a behaviour can be measured as the sum of their beliefs of the consequences of the behaviour and the evaluation of the consequences of that behaviour. The subjective norm would then be defined as the individual's perceptions of what others around them that are important to them will think or feel about them performing this behaviour (Chuttur, 2009).

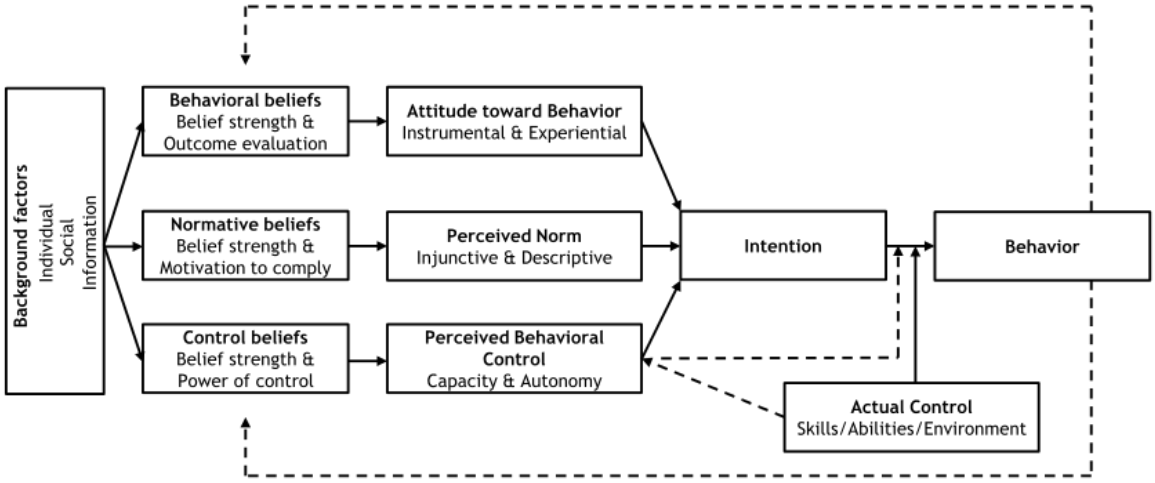


Figure 3.8: Theory of Reasoned Action

(Fishbein et al., 1977)

The Theory of Planned Behaviour proposed by Ajzen in 1985 was another model similar to the Theory of Reasoned Action but it took into account an additional construct of behavioural control. Behavioural control defined by Chuttur (2009. p. 12) is the "perception of control over performance of a given behaviour." Mathieson (1991) compared the TAM model and the Theory of Planned Behaviour and found that even though the TAM model was simple and easy to implement it lacked the external variables such as the perceived behavioural control and subjective norms. TAM gives a more general idea of implementation but the Theory of Planned Behaviour would identify more specific beliefs of that particular system (Chuttur, 2009). Park (2009) found that self-efficacy and subjective norms play an important role in attitude. Attitude is regarded as the degree to which the behaviour of a person

has a favourable or unfavourable outcome (Taleem, 2016). Subjective norms refer to whether the person performing the behaviour is accepted by those that are important to them (Taleem, 2016). This will determine whether the behaviour is performed. Perceived behavioural control refers to whether the person performing the behaviour finds it easy or difficult to perform the behaviour (Taleem, 2016). This varies according to the situation and was added later, creating the shift from the Theory of Reasoned Action to the Theory of Planned Behaviour. Behavioural intention refers to motivational factors that will influence the behaviour. The stronger the intention, the higher the likelihood to perform that behaviour (Taleem, 2016). Some limitations to this model is that it does not take into consideration normative influences such as environmental and economic factors and other variables such as motivation, fear, threat, mood or past experience. Another crucial factor that is not considered is the time frame between “intent” and the actual “behavioural intention”.

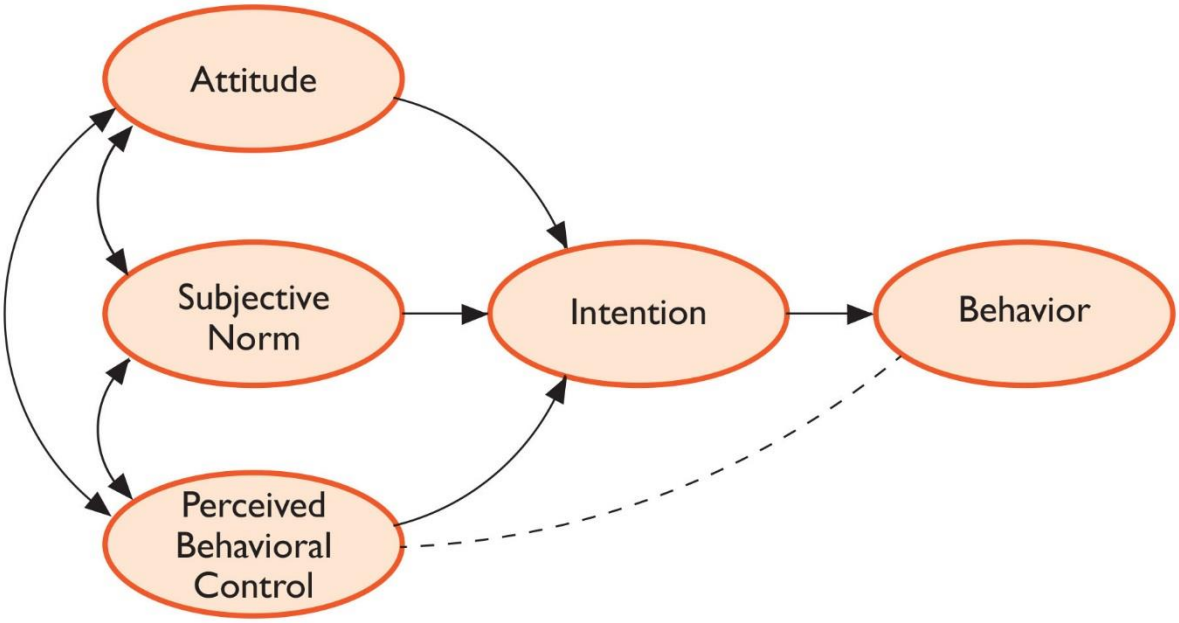


Figure 3.9: Theory of Planned Behaviour

(Ajzen, 1985)

The Unified Theory of Acceptance and Use of Technology (UTAUT), which consists of four main concepts, was formulated by Venkatesh, Morris, Davis, and Davis (2003a). AlQudah (2015) defined these four concepts as follows: Performance expectancy refers to the individual believing that the use of technology will improve job performance. Effort expectancy refers to how easy the technology is to use. Social influence refers to whether the individual perceives the importance of the

technology and what others believe about the technology. Facilitating conditions refers to whether the individual believes that there is sufficient technical and organizational infrastructure to support the use of technology.

Oye, Iahad, and Rahim (2014) found that the use of the TAM model to understand technology acceptance shows a higher improvement of acceptance when compared to a combination of the eight existing models in the UTAUT. These models include:

- TRA – Theory of Reasoned Action
- TPB – Theory of Planned Behaviour
- TAM – Technology Acceptance Model
- MM – Motivational Model
- C-TPB-TAM - Combined Theory Of Planned Behaviour and Technology Acceptance Model
- MPCU – Model of PC Utilisation
- IDT – Innovation Diffusion Theory
- SCT – Social Cognitive Theory

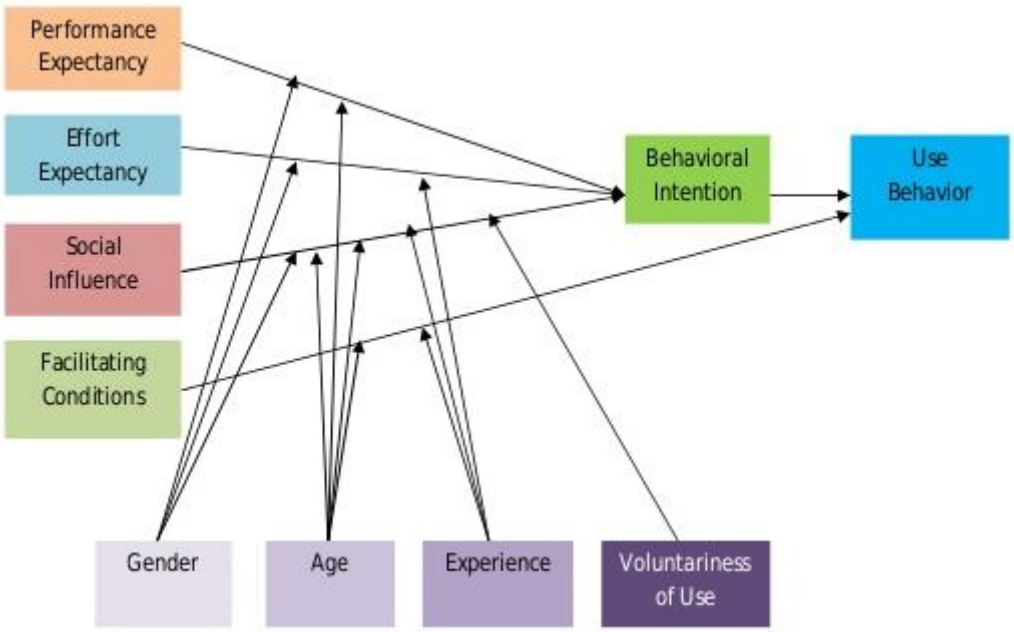


Figure 3.10: Unified Theory of Acceptance and Use of Technology (UTAUT)

(Venkatesh et al., 2003a)

Nevertheless, TAM still remains the most widely used adoption model with constant additions and adaptions in various studies (Oye et al., 2014; Padilla- Melendez, Aguila-Obra, & Garrido-Moreno, 2013). It was therefore chosen as the most suitable

model for this study because the researcher cannot assume what factors will contribute to the perceived usefulness or perceived ease of use. These factors are still to be investigated within the study. An example of the adaption of TAM is given by Mac Callum et al. (2014). This example was chosen as digital literacy, ICT anxiety and ICT teaching self-efficacy are assumptions of outcomes to teacher adoption for this study. This model is explained as it provides insight and a starting point to what factors currently influence technology acceptance. It is important to note that the study by Mac Callum was done in 2014, a year before the current study.

Mac Callum et al. (2014) in a study entitled, “Factors impacting teachers’ adoption of mobile learning” found that apart from the Technology Acceptance Model (TAM), there are three other factors that can be included in affecting the adoption of technology by teachers. TAM being one of the most widely used adoption models (Venkatesh, Morris, Davis, & Davis, 2003b) was modified to explore a range of educational technologies. Mac Callum’s study focused on five aspects that restrict the integration of technology. Firstly the beliefs and attitudes of teachers play a crucial role in the adoption of mobile technology (Kebrithchi, 2010; Mac Callum, 2010; Mac Callum & Jeffery, 2013; Wang, Wu, & Wang, 2009). There are two factors that TAM discusses: firstly the perceived value of the technology (perceived usefulness) and, secondly the perceived effort that is required for the use of technology (perceived ease of use). Chuttur (2009) claims that the perceived ease of use has a direct impact on the perceived usefulness, because if a teacher is not comfortable using technology they may avoid using it. Mac Callum et al. (2014) added the skills of technology and pedagogy that are needed to integrate technology into education. Further emphasis was placed on three factors that restrict the integration of technology in education. She termed these, digital literacy, ICT anxiety and ICT self-efficacy. It is important for designers to focus on the ease of use of mobile technology (Gedik, Hanci-Karademirici, Kursun, & Cagiltay, 2012) since this may influence the actual use.

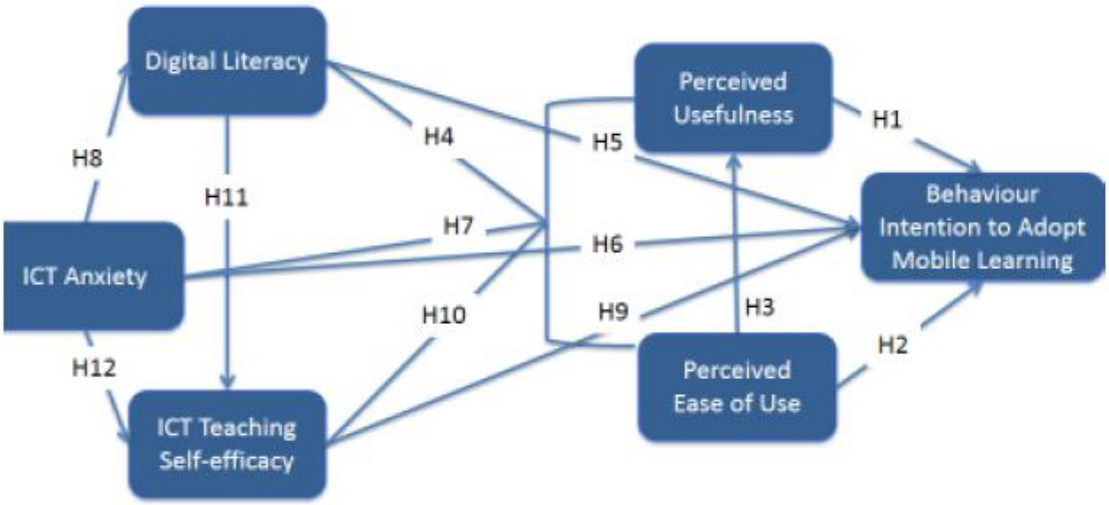


Figure 3.11: Adapted Teacher Adoption Model (TAM)

Mac Callum (2014)

Digital literacy has been defined by Mac Callum (2014) as “the measure of an individual’s ability to use digital technology, communication tools, and/or networks to access, manage and integrate digital resources” (p143). Therefore it is the range of technologies that an individual can use successfully (Magdigan, Goodfellow, & Stone, 2007; Markauskaite, 2007). Studies show that the perceived digital literacy has had a positive impact on the adoption of technology (Hasan, 2003; Hasan & Ahmed, 2010) but there is very little written on its influence of perception change and acceptance of mobile learning (Wang et al., 2009).

It has been found that anxiety about the use of technology is a resisting factor to the adoption of technology and it may have a strong negative impact (Agarwal, Sambamurthy, & Stair, 2000; Beckers, Wicherts, & Schmidt, 2007; Imhof, Volmeyer, & Beierlein, 2007; Parayitam, Desai, Desai, & Eason, 2010; Saade & Kira, 2009; Smith & Caputi, 2007). If teachers are not confident about how to use the technology and how to integrate it into their teaching and learning they cling to traditional methods. ICT anxiety is “any negative emotional response typically ensuing from a fear that the use of technology may have a negative outcome” (Mac Callum et al., 2014 p.143). There is great disparity between the perception of technological competence and the amount of learning that is required to utilise ICT effectively (Phelps & Ellis, 2002). Emotions such as: feeling threatened, overwhelming, looking foolish, incompetent in front of learners, inadequacy, doubtfulness are some of the

reasons to disincline the use of ICT in classrooms (Hennessy, Ruthven, & Brindley, 2005; Mac Callum et al., 2014; Nunan & Wong, 2005).

Mac Callum et al. (2014, p.144) defines teaching self-efficacy as “the belief an educator had about his/her ability to perform a variety of teaching tasks”. Factors such as: their ability to use ICT, (Hammond et al., 2011; Mueller, Wood, Willoughby, Ross, & Specht, 2008) teaching philosophy (Albion, 2009; Vananatta & Fordham, 2004), past experiences with computers (Albion, 2009; Mueller et al., 2008; Sang et al., 2010), past training or workshops on ICT in education (Vananatta & Fordham, 2004; Vannatta & Banister, 2009) and the level of assistance that they may need from others (Mueller et al., 2008) restrict them from adopting mobile technology. Therefore, the effectiveness of ICT in classrooms is dependent largely on self-efficacy (Hasan, 2003; Potosky, 2002; Sang et al., 2010).

The TAM model has been adapted by several researchers to include factors such as self-efficacy, perceived risk, social influence, experience, peer influence, compatibility, cognitive absorption, age, level of education, voluntariness, etc. to suit many studies on technology acceptance (Chuttur, 2009; Park, 2009; Surendran, 2012). The TPCK model explains how technology fits into education and the TAM model demonstrates the role of the teacher in the adoption process. It is also important to consider how lessons need to change if we have willing teachers and technology available. This can be revealed by using the SAMR model. The TPCK places the primary focus on the teachers whereas the SAMR focuses on the learners (Hilton, 2015). However, the SAMR provides the opportunity to design a more learner centred activity to imbed technology that will improve independent learning capacity (Hilton, 2015).

3.4 Substitution, Augmentation, Modification, Redefinition Model (SAMR)

The Substitution, Augmentation, Modification, Redefinition model (SAMR) was developed by Dr Puentedura in 2012. The model provides a framework to identify and evaluate technology based activities and improve integration of these emerging technologies into everyday teaching (Hilton, 2015). It is used to develop, design and infuse digital technology. As teachers and instructional designers implement mobile technology, it is of the utmost importance that they understand how mobile devices can improve learning. Often it is assumed that mobile devices are used to perform

tasks that were previously performed without the use of a mobile device (Romrell et al., 2014). This assumption is incorrect as it only lends itself to the lowest level represented on the SAMR model. This model facilitates m-learning activities and supports the transformation of learning. Cummings (2014) infers that SAMR should facilitate an acquisition of proficient software and modern consumer technologies that cater for staff and learners and promote 21st century skills.

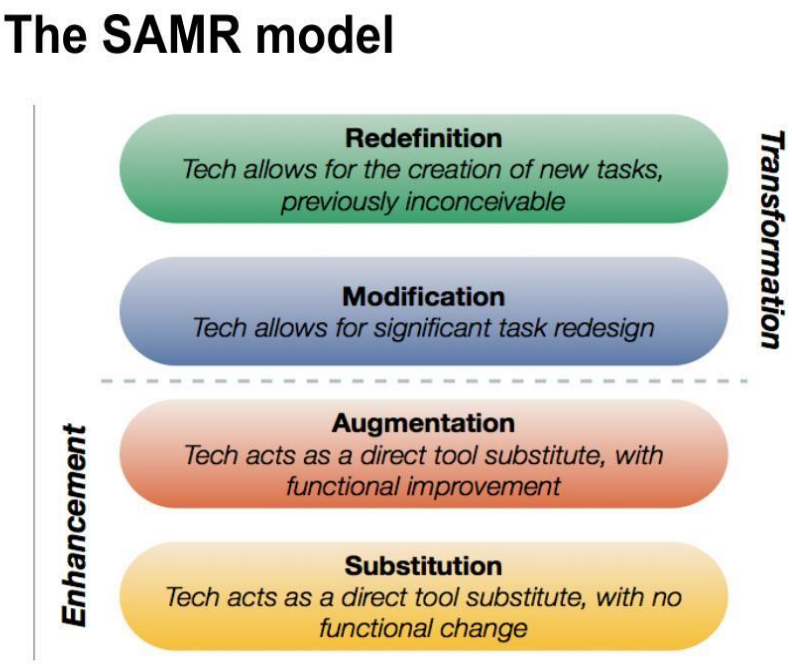


Figure 3.12: The SAMR model

(Puentedura, 2012)

The SAMR model is hierarchical and divided into four levels which are grouped in two different areas. Substitution and Augmentation are grouped as "**Enhancement**" which means that they focus on using technology to replace or improve existing teaching and tools (Hilton, 2015; Kirkland, 2014). Modification and Redefinition are grouped as "**Transformation**" which means that new opportunities for teaching and learning are provided and it may not have been possible for them to take place without technology (Hilton, 2015; Kirkland, 2014).

To unpack the SAMR model one needs to understand what is occurring at each level and how it is used as a framework to evaluate m-learning. Kirkland (2014) explains

the challenge that teachers face when trying to design a rich learning task with the use of technology as it adds an element of risk and uncertainty. In order for the SAMR model to be used as a framework to evaluate effective teaching it needs to show the link between traditional teaching methods and mobile technology. This link should emphasise the same outcomes for creation of knowledge (Kirkland, 2014). Bloom's Taxonomy which was created by Benjamin Bloom in the 1950's and has been used for years as a basis for measuring learner performance. It was later revised by a group of researchers, in the 1990's, with David Krathwohl being the lead author and Lorin Anderson, a former student of Bloom. If Blooms taxonomy is seen as the lens through which we measure different levels of teaching outcomes, there needs to be an association between the SAMR model and Blooms taxonomy. It can be said that all the levels of cognitive development and knowledge creation are catered for in mobile teaching. It is important to note that the technology does not have to be complex, but the task for which technology is used could be of a high level. It is necessary to pay attention to the task and how the technology supports the learning activity. The topic of series and parallel circuits is used to demonstrate the difference of teaching at each level. These are examples that have been created as a means to demonstrate the researcher's understanding of how the model can be used at different levels. The level of SAMR is in bold and the level of Blooms taxonomy is in blue italics. The examples, to demonstrate this, are in a text box.

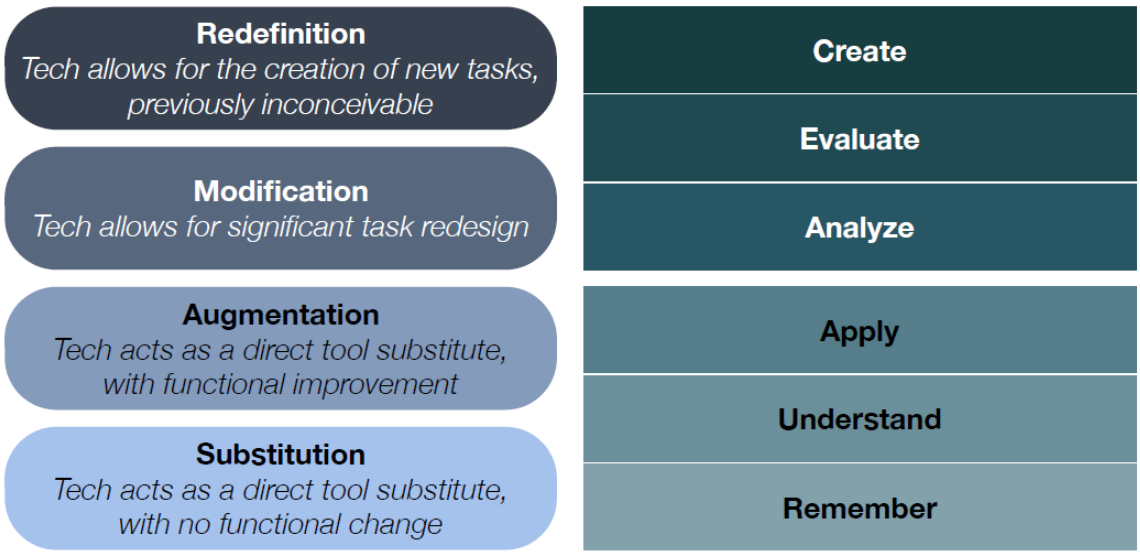


Figure 3.13: The SAMR and Blooms Taxonomy

(Puentedura, 2012)

The first level of **Substitution** is regarded as the easiest and simplest way to implement m-learning (Hockly, 2013). An activity can be classified as substitution if it was possible to do the activity without the use of technology (Hilton, 2015; Kirkland, 2014). These can be seen as activities that will fall under the first two levels of Blooms' taxonomy being *Remember* and/or *Understand*.

> An example of this would be showing learners a demonstration via Youtube of how to construct a series and parallel circuit and ask them to watch the video whilst building their own circuit. This could have been done by the teacher in the class. In this level the technology serves as a method to enhance student learning. The teacher demonstration is therefore substituted by the Youtube video and the learners are expected to *remember* what they watch and build their own circuit formulating some *understanding* of what they are doing.

In this example the learners need to listen and watch what is shown on the video and then remember and attempt to understand. Should the teacher not play the video and do a demonstration of exactly what was on the video then the technology would be eliminated. Therefore the technology serves as a direct substitution of what the teacher would have done as a demonstration.

Gromik (2012) and Lan, Tsai, Yang, and Hung (2012) both found that substituting mobile learning for other methods of learning was beneficial. Learners enjoyed working with their mobile devices and it provided a positive alternative to traditional teaching methods. Other examples would be reading an e-book as opposed to a textbook or using a power point presentation as opposed to a projector.

Augmentation goes beyond the level of substitution as it involves some type of functional improvement over what could have been achieved by traditional methods (Hilton, 2015; Kirkland, 2014). In this example the technology allows for some further improvement to the task that would not be possible if the technology was not used.

An example of this would be showing learners a demonstration via Youtube of how to construct a series and parallel circuit and ask them to watch the video whilst building their own circuit. This could have been done by the teacher in the class. This way they can rewind, fast forward or pause the video at any given time to allow them to make the correct connections. In this level the technology serves as a method to enhance student learning. The teacher demonstration is therefore substituted by the Youtube video, however the video offers some functional improvement to the task by allowing the learner to *apply* their knowledge and *analyse* their circuit setup. By having the opportunity to rewind, fast forward and pause the learners are able to identify errors and rectify them.

Chuang and Tsao (2013) and Pfeiffer, Gemballa, Jarodzka, Scheiter, and Gerjets (2009) used augmentation in their studies to enhance learning and found it to be advantageous to the learners. Other examples would be using a dictionary, study guides, sites to online texts, etc.

The difference between Augmentation and Modification is whether you are simply reproducing what you have done previously in practice or you are significantly modifying it in such a way that you still retain the intellectual depth.

Modification is taking pre-existing tasks and altering them significantly so that they will not be achieved without technology (Hilton, 2015; Kirkland, 2014). The focus is on visual, audio and textual tools to share knowledge.

An example of this would be to ask learners to use their understanding of circuit construction and video record an explanation as to why lights bulbs connected in parallel will glow brighter than light bulbs connected in series. They would then need to share these videos with their peers and then comment on the explanations given. These comments would need to either confirm or rectify the explanations given by their peers. This includes an aspect of *analysis* and *evaluation*. The learners are interacting with the technology and their peers whilst creating meaningful learning.

This transforms learning by allowing the learners to share knowledge and by creating and analysing each other's work through a social means. They are then able to

evaluate the explanations and reflect on their understanding. This prompts a slightly higher order of thinking in the learners so as to guide them to an outcome. This example shows the connected nature of mobile learning activities. By creating a video, learners are able to edit or modify their explanation. The technology allows learners multiple attempts for providing a sound explanation.

Studies by Wang, Yu, and Wu (2013) and Cornelius, Marston, and Gemmell (2011) support the usefulness of mobile technology at the modification level. Other examples of this would be voice recordings, online group discussions, interactive textual, etc.

Redefinition is the creation of a new task that would not be possible without the use of technology (Hilton, 2015; Kirkland, 2014). The focus is on the visualisation of narrative aspects found in texts (Puentedura, 2012; Puentedura, 2014).

An example of this would be asking the learners to use a simulation/augmented reality app to *create* series and parallel circuits that include voltmeters, ammeters and resistors. They would then need to upload their design onto a social platform for others to comment and observe. Here the learners have the freedom to design any circuit, for example the electrical connections in a kitchen. They can immediately see the real-life application in such a task. They would need to *evaluate* the design of their peers' circuits and the amount of power that would need to be supplied in order for their resistors to work effectively.

This allows for simulation redesign and real-time decision making by the learners. Each learner is able to participate individually supporting the personalised nature of mobile learning. The addition of feedback from other learners and the real-time decision making adds increased educational value for the activity. All the comments will allow for critical reflection by the learner and the ability to edit and re-design creates a platform for meaningful learning.

Using Bloom's taxonomy in mobile learning has brought about the concept of "Bloom's digital taxonomy" which is finding tools and apps that teachers can align with each level of cognitive development to ensure creative, interactive thinking enabling learners to share and connect on many different platforms with learners all around the world. Kirkland (2014) advocates that SAMR examines the learning task and the depth and complexity of the technology integration is determined. In Figure

3.14 Puentedura (2013) provides a ladder to assist with examining the technology integration, which includes questions to show the transition. Both Kirkland (2014) and Hilton (2015) studies found that teachers find it easier to use a particular technology to accomplish the instructional objective rather than having to design their own. This led to the creation of Bloom's Digital Taxonomy which was developed by Andrew Churches in 2008 to illustrate the merging of technology use in the different levels of Bloom's Taxonomy. Figure 3.15 shows Blooms digital Taxonomy and different software that can be used at different levels.

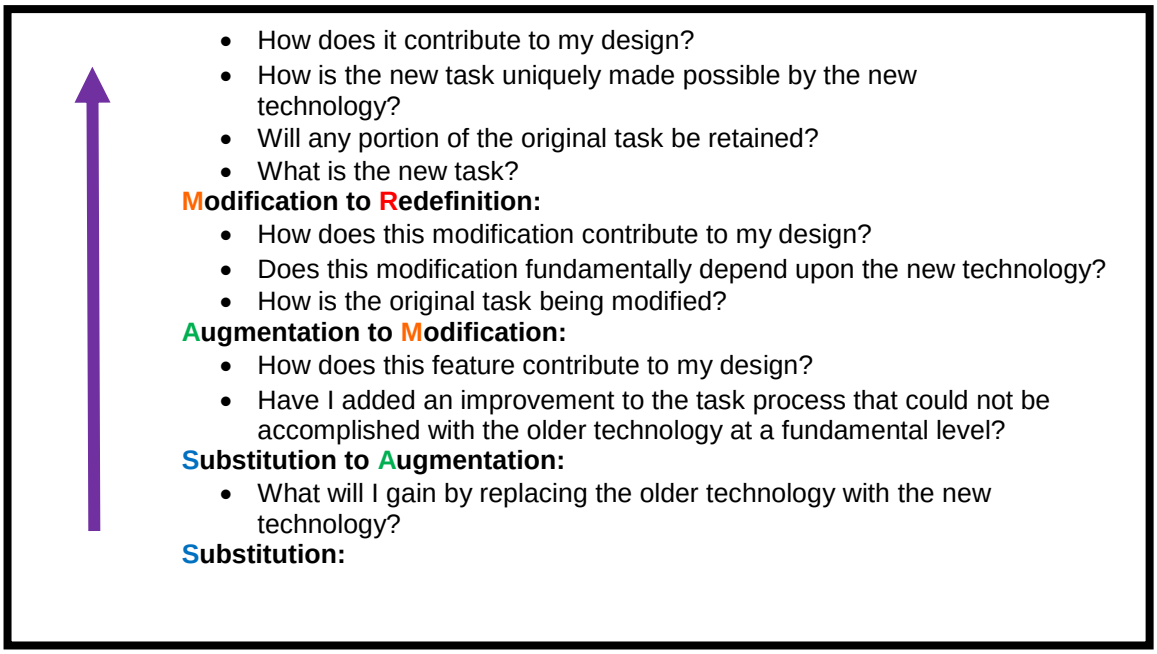


Figure 3.14: SAMR Ladder - Questions and Transitions

(Puentedura, 2013)

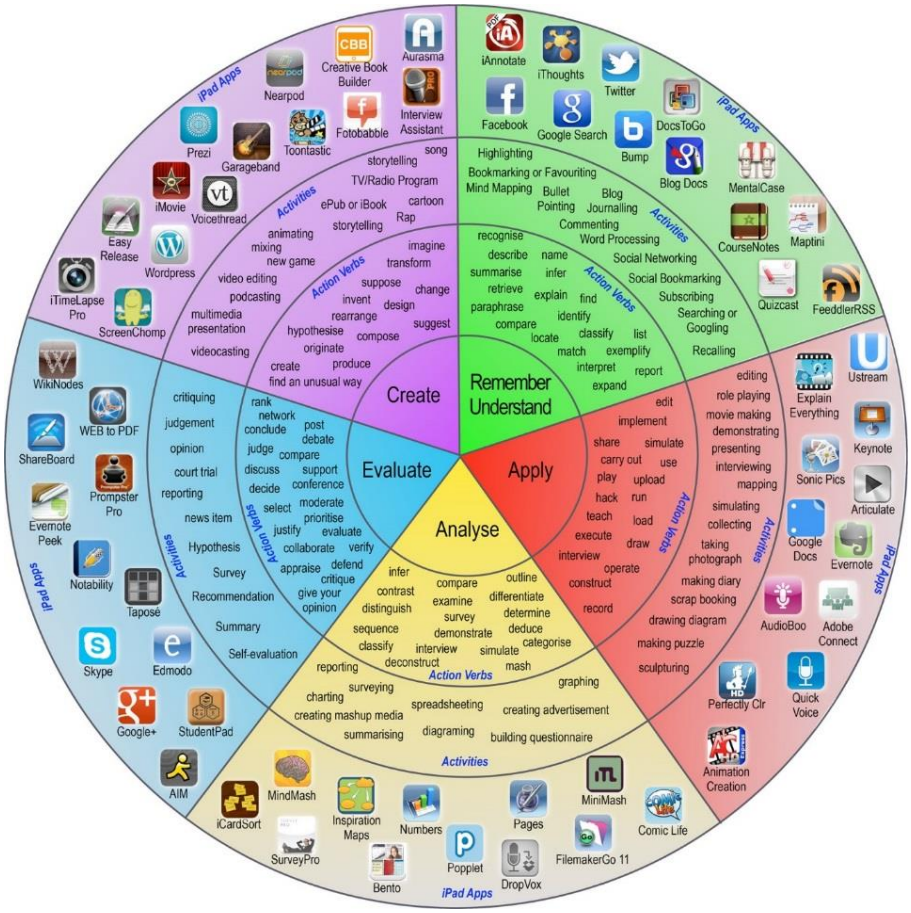


Figure 3.15: Bloom's Digital taxonomy.

(Churches, 2008)

In 2016, Andrew Carrington took Bloom's Digital taxonomy a step further by creating The Pedagogy Wheel. This wheel illustrates apps that can be used to teach at different levels of Bloom's Taxonomy, SAMR and is focused on Mobile technology such as the use of iPads, tablets, smartphones etc. as seen in Figure 3.15. Carrington (2016) created the wheel to help teachers think coherently and systematically about long term outcomes of how to use mobile apps in their teaching. The wheel aims to assist teachers in changing their mindset of teaching in the digital age.

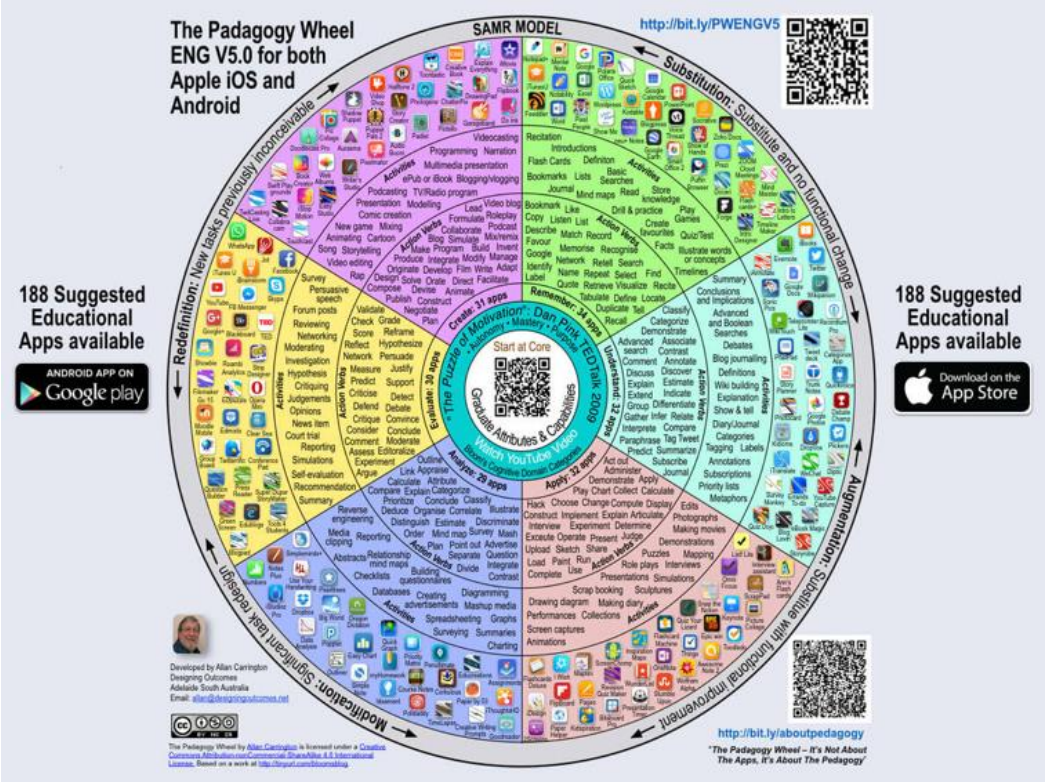


Figure 3.16: The Padagogy Wheel

(Carrington, 2016)

Due to technology being referred to as a pedagogy of teaching which utilises different ICT's, the TPCK model was chosen to enhance learning whilst still adhering to the requirements of older pedagogical methods. The role of the teacher in the implementation is significant and it is therefore crucial to elaborate on how technology adoption is directly dependent on the teacher's willingness to accept change. The TAM model was chosen to show the correlation between teacher acceptances of mobile technology. The SAMR model is used to explain and demonstrate how technology support teaching and learning. The different levels provide insight as to how the change process needs to occur and develop. The success of each level is reliant on the teacher's acceptance of change and use different technologies as part of pedagogy to teach content.

3.5 The researcher's proposed conceptual framework- PTTID

Recent studies show the link and application between the SAMR and TPACK model when reflecting on the integration of technology in education (Hilton, 2015; Kihoza et al., 2016). Illustrated and explained by Kihoza et al. (2016) the relationship between the two models are evident.

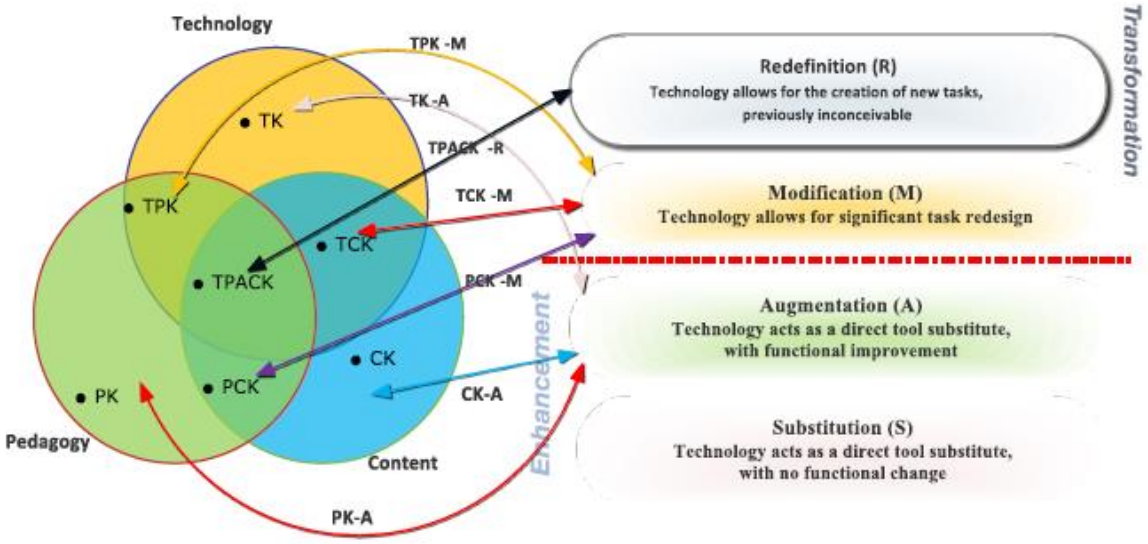


Figure 3.17: TPCK and SAMR model correlation

(Kihoza et al., 2016)

Both models focus on the integration of technology into classroom practice. The TPCK focuses more on the teachers' knowledge whereas the SAMR focuses more on the learners' activities (Hilton, 2015). Even though both models may be sufficient for their individual purposes, the integration of the two models may fabricate the transformation and enhancement of educational tasks (Hockly, 2012) and further clarify future educational technology use (Brantley-Dias & Ertmer, 2013). These two models support a holistic view of what happens in education with regards to the holistic integration of technology into teaching and learning. Drawing from the work of Kihoza et al. (2016) and Mac Callum et al. (2014) the following table was created. Table 3.1 illustrates the relationship between TPCK and SAMR as summarised with examples by Kihoza et al. (2016) and further linked through explanation to the TAM model created by Mac Callum et al. (2014).

Table 3.1: Relationship between the TPCK, SAMR and TAM.

TPACK	Relationship ⟷	SAMR	Relationship ⟷	TAM
TPK	TPK and M support TK, TPK and TCK. E.g. Sharing documents via email or Google drive.	**M**	PEU refers to TPK and M. E.g. the perceptions of technological beliefs, pedagogical beliefs and willingness to change are dependent on how easy it is to use.	**PEU**
TK	TK and A support TK, TPK and TCK. E.g. Powerpoints that are enhanced with sound and images.	**A**	PU refers to TK and A. E.g. lack of technology skills and external factors limited the perception of integration of blended learning.	**PU**
TCK	TCK and M support CK, TCK and PCK. E.g. Transforming marking by using Microsoft word tools.	**M**	PEU refers to TK and M. E.g. the more difficult the teachers find it to integrate technology the more they eliminate or resist using it.	**PEU**
PCK	PCK and M support CK, TCK and PCK. E.g. Transforming feedback with the use of comment services to share knowledge, experience and materials with learners.	**M**	Although PCK is needed for successful technology integration, it does not directly impact on the technical identity development of the teacher. In this study it is assumed that the teachers have sufficient PCK to integrate technology into teaching.	
CK	CK and A support CK, TCK and PCK. E.g. Enhancing word documents by using Google docs to auto sync, auto save and auto share.	**A**		
PK	PK and A support PK, TPK and CK. E.g. Enhancing word documents by using Google docs to auto sync, auto save and auto share.	**A**		
TPCK	TPCK and R supports all components of TPCK. E.g. redefining to form new tasks that include blended learning approaches	**R**	PU refers to TPCK and R. E.g. being able to incorporate various aspects of technology impacts on the use of the technology	**PU**

adapted from Kihoza et al. (2016) and Mac Callum et al. (2014)

The combination of these three models forms the basis of my conceptual framework that was developed. This framework will be evaluated after each stage of the research to provide the most effective, informative and beneficial framework for professional teacher technical identity development through the lens of mobile technology.

It is assumed that teachers have the PCK necessary for their subject since all teachers hold qualifications in their subject and had experience of teaching it. All aspects of SAMR were considered as they linked with all aspects of TPCK. Only the perceived ease of use and the perceived usefulness of the TAM model were used as all other aspects were also researched and verified in the study. Training on mobile devices during the training workshop, which was provided and is further explained in the next chapter, provided awareness of the software available for teaching and aimed to ensure that they have technology knowledge. This would assist in determining the level to which they plan and teach their lessons. Lessons were either enhanced by technology or transformed in such a way that the lesson would not have been able to be taught without the use of technology. The perceived usefulness and perceived ease of use were determined by their responses during focus group sessions, reflections and interviews. These responses are expected to give an idea of the emotions, perceptions, experiences, challenges, successes, etc. that they may have during the implementation process. This should illustrate trends in development or non-development in their professional identity through the actual use of mobile technology. The researcher therefore proposes the Professional Teacher Technical Identity Development Framework (PTTID). This Framework is further discussed in Chapter 5 as it forms part of the first phase of the study, the literature review.

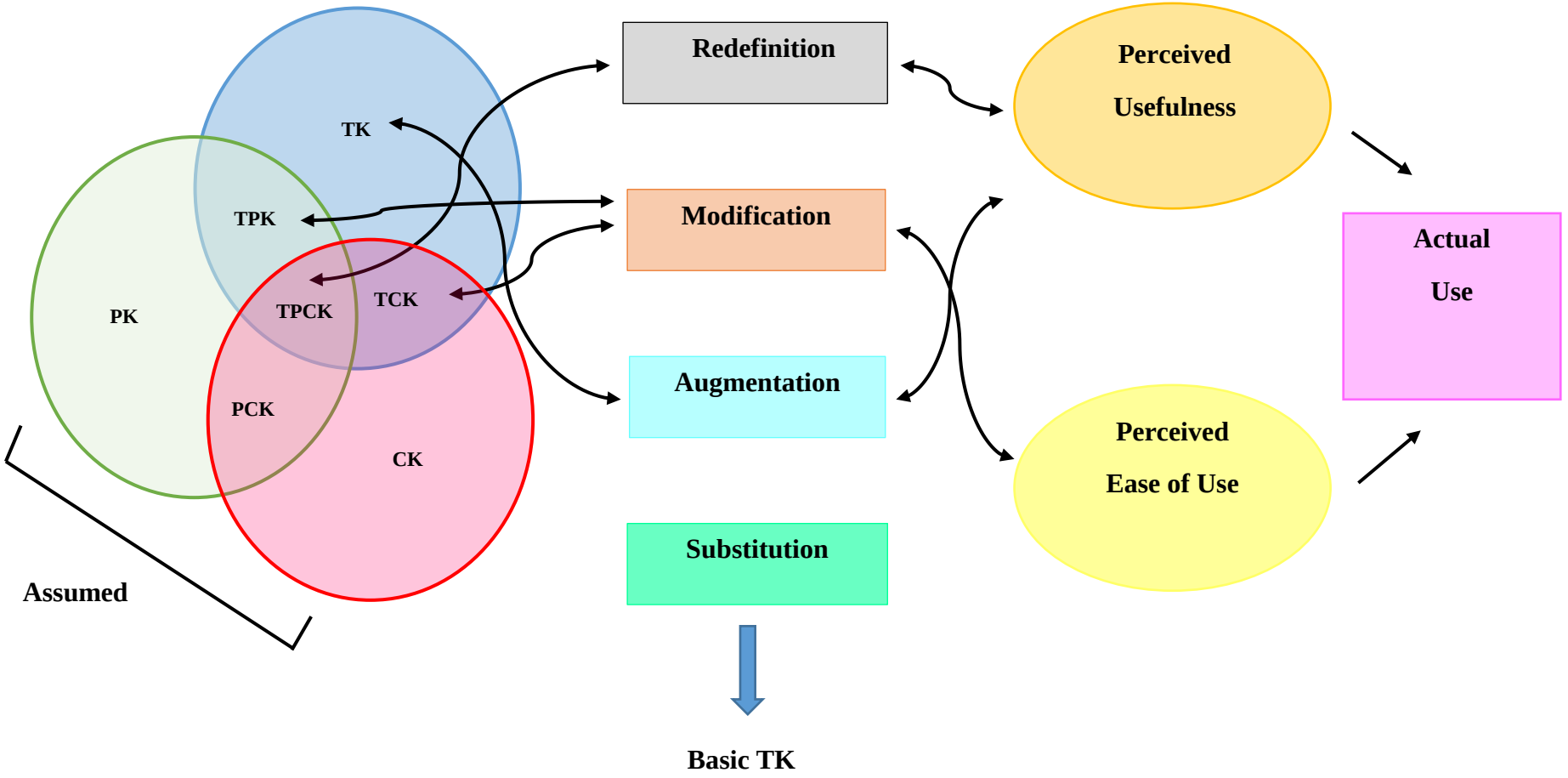


Figure 3.18: Professional Teacher Technical Identity Development Framework 0 (PTTID)

3.6 Conclusion

After studying the TPCK, TAM and SAMR models given in this chapter it was evident that the methodology of this study needed to be structured in such a way that the link between the three models could be identified. These models were most relevant to the study as they could test the knowledge of TPCK, the acceptance of technology (TAM) and identify levels of SAMR reached in order to trace the growth and development of professional teacher technical identity. This involved the careful designing of a well-structured methodology which is discussed in Chapter 4.

Chapter 4

Research Methodology

"Teachers are expected to reach unattainable goals with inadequate tools. The miracle is that at times they accomplish this impossible task"

Dr. Haim Ginott

4.1 Introduction

Research methodology is defined by Schwardt (2007) as a theory of how an inquiry should proceed. McMillan and Schumacher (2006) define research methods as, "the procedures used to collect and analyse data." It can then be said, that research methodology is the analysis of theories, assumptions, and models to select a suitable research design for a study. Educational research in particular is known as a critical inquiry that informs critical judgements with the aim of improving decisions and actions (Foreman-Peck & Winch, 2010).

The research design as defined by McMillan and Schumacher (2001, p599) "is the plan that describes the conditions and procedures for collecting and analysing data". In order to choose the most appropriate research design it is important to consider "…aims, uses, purposes, intentions and plans within the practical constraint of location, time and money" (Hakim, 2000. p. 1). This requires the researcher to question knowledge claimed and theoretical perspectives and reflect on the strategies used in the research to avoid bias that the researcher may bring into the study (Cresswell, 2014).

The Research Process Onion presented by (Saunders, Lewis, & Thornhill, 2003) in Figure 4.1 emphasises the layered research process that was used for this study. Each layer discusses a different aspect of the process of the research. The first layer discussed the research philosophy, the second layer the approach towards the study, the third layer explained the research strategies, the fourth layer discussed the time horizons and the fifth layer explained the primary and secondary data collection methods.

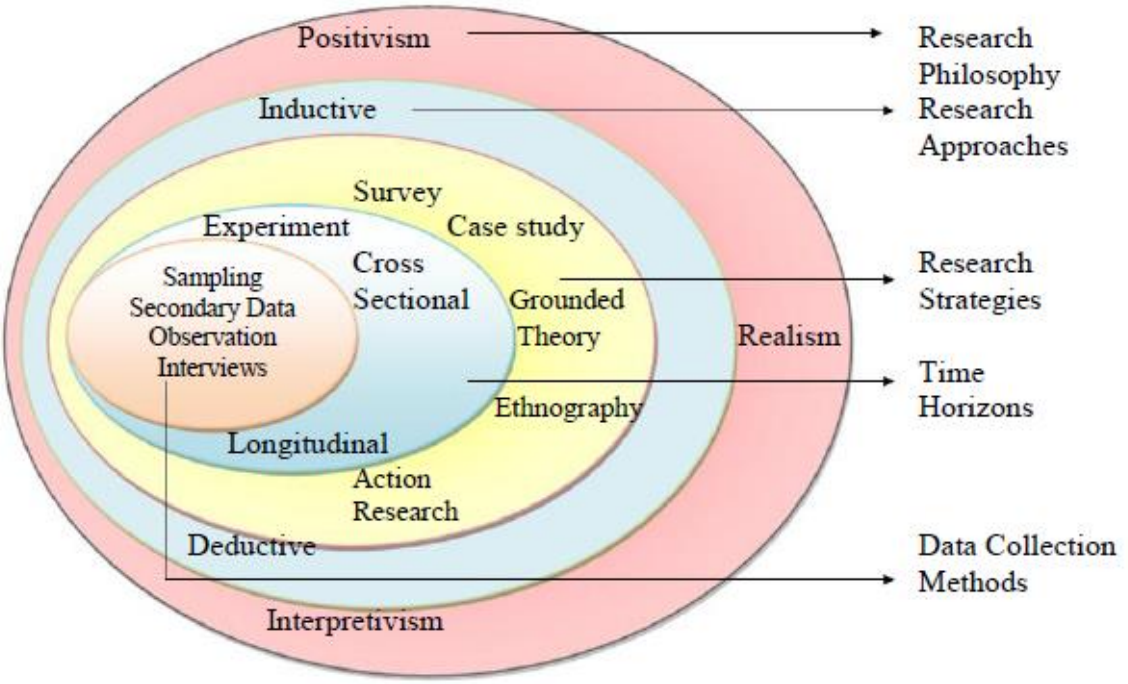


Figure 4.1: Research Process "onion"

Saunders et al., (2003)

4.2 Philosophy: Interpretivism

At the onset of any research study, a researcher may have some underlying philosophical stance concerning the phenomenon. This acts as a basic concept underpinning a particular sphere of knowledge. The study will follow an interpretivist philosophy. This philosophy is best suited for the study as it emphasises the meaningful nature of people's participation in social and cultural life (Hayes, 2004). According to Burrell and Morgan (2005) interpretivism involves the researcher attempting to observe and understand the on-going processes of individual behaviour and the spiritual nature of the world. Saunders and Tosey (2013) describe it as the study of people rather than objects in their natural environment. This captures the researcher's perception of reality (ontology) and how it is linked to knowledge (epistemology) to create meaning (Audi, 2010). Different researchers will have different ways in which they view the world and therefore their meta-theoretical paradigm will influence their methodological paradigm. The social-constructivism paradigm was adopted for this study. "Social constructivists believe that individuals seek understanding of the world in which they live and work" (Cresswell, 2014). They develop subjective meanings based on their experiences towards certain objects or

things, in this case technology use. The researcher focuses on the complexity of these beliefs of the participant and finds a way to construct meaning using a subjective approach through discussions, open ended questioning and interaction with the participants.

The design is a causal research study, whereby the effect of one factor on another is used to forecast, with the help of results, that which will be influenced in the future. In this case the variable that is bringing about change is technology and the factor that is being influenced is classroom practice and teacher identity. The influence of technology on classroom practice highlights the causal relationship. The descriptive nature to the research study serves to help the researcher design the causal research study.

4.3 Approach: Mixed method and Deductive

In examining the variables related to the implementation of mobile technology in the classroom and the growth and development of teacher identity a mixed method of research was chosen. A mixed method approach was best suited for this study as it allowed for empirical research that would involve the analysis and collection of data from both quantitative and qualitative methods. This would sanction for a greater degree of understanding and that would not have been possible if a single approach was used (Cresswell, 2014).

Mixed method can be defined as involving “the collection of both qualitative and quantitative data in response to research questions or hypotheses” (Yildirim & Simsek, 2006. cited by Cresswell, 2014 p. 217). This approach lends itself to three levels of research. A *general* level that allows for the strengthening of data from quantitative and qualitative research. A *practical* level which provides a complex and sophisticated forefront for research procedures. A *procedural* level which is a useful strategy to understand research problems and questions.

The qualitative aspect of the research would allow for deep understanding and exploring which is necessary for the study in order to fully identify and track professional teacher technical identity. According to Patton (2002. p39) qualitative research is described as:

> *…an approach that uses a naturalistic approach which seeks to understand phenomena in context-specific settings, such as real world settings, where the researcher does not attempt to manipulate the phenomena of interest…it is any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification, but instead the kind of research that produces findings derived at from real-world settings where the phenomena of interest unfold naturally.*

Qualitative research is known as an umbrella concept that covers several forms of inquiry to help a researcher understand and explain the meaning of social phenomena that will cause little to no disruption to the natural environment (Merriam, 1998). Cresswell (2014) further elaborates that qualitative research is a deep description of a phenomena as it unfolds with an intent of understanding that phenomena. This involves careful observation of people, actions, words and experiences. Therefore, it "seeks to discover and understand a phenomenon, a process or the perspectives and world views of people involved" (Merriam, 1998.p. 11). Qualitative research employs an interconnectedness of various techniques in order to identify patterns in the words and actions of people as they experience and construct meaning of a specific phenomenon (Denzin & Lincoln, 2011). As a qualitative researcher there is some concern with identifying patterns in the experiences and perceptions of teachers as they try to implement mobile technology in their classrooms and how these experiences and perceptions shape their technical professional identity.

Quantitative research is described as a method of employing quantitative measures to test hypothetical generalisations using experimental methods (Golafshani, 2003). This can be in the form of charts, graphs, surveys, polls, etc. As a quantitative researcher it will be possible to attempt to delimit and fragment phenomena into categories that are measurable. It allows for perspectives and experiences of people to be assigned to a specific category and tests the replicability or repeatability of responses. This technique of data collection is significant to the study as it provides insight into the change in professional teacher technical identity development.

The quantitative aspect of the study would allow for a more objective reality that is independent of any observations (Rovai, Baker, & Ponton, 2014). Statistical data can be collected and a generalisation of groups of people can be made. This is gathered from the online questionnaire and the written questionnaire discussed further in the chapter.

Due to the debate regarding mixed methods having paradigmatic inconsistencies (Creswell and Plano Clark, 2011) a triangulation mixed method design was chosen. The triangulation mixed method design described by Creswell and Plano Clark (2007) was envisioned and prompted the gathering of complimentary data on the same topic that was distinctly different. The analysis and interpretation of such data would require a considerable amount of effort and expertise to draw together and create potential for further research (Alamaki, 2016).

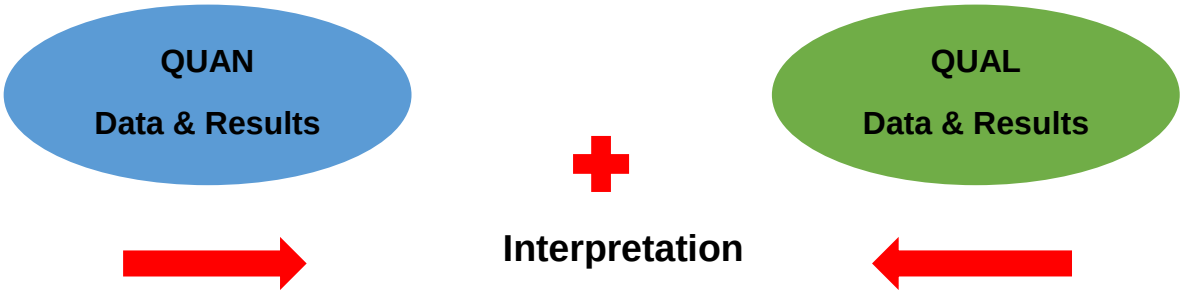


Figure 4.2: Mixed method design

Using this mixed method lens informs a deductive and inductive approach to the study. Deductive reasoning as explained by Cresswell (2014) requires the researcher to look at the data collected from the themes and determine if more evidence can support each theme or whether additional information is required. The research starts with the question of the influence of mobile technology on teacher development and classroom practice and the study serves to answers this question. The thought process behind a deductive approach moves from theory to a research question, data collection and findings that will either reject or confirm the research question. Deductive reasoning as defined by (Gibilsco, 2013), “is a logical process in which a conclusion is based on the concordance of multiple premises that are generally assumed to be true.” Pre-determined themes that have been evident in similar studies in the literature will be used at the onset.

Inductive reasoning is seen as an exploratory and emergent approach to fieldwork whereby decisions and discoveries are made on the way (Saldana, 2015). In order to think inductively the researcher needs to have an investigative and open-minded attitude to identify patterns/trends in the participant's behaviour or response. Meaning is constructed from these experiences and is used deductively for the next step in the research. The constant interchangeability of inductive and deductive reasoning for this study allows for an action research design.

4.4 Strategy: Practical Action Research

Action research is the most appropriate method of investigation in this study as it allows the researcher to work directly with the participants in the development of the indicators of engagement. Action research allows the researcher and participants to engage "in a collaborative process of critical inquiry into problems of social practice in a learning context" (Argyris, Putnam, & Smith, 1985. p. 236). Action research was first employed by Lewin in 1951 as learning through changing and has since been conducted by educational specialists as a method for "systemic data collection and analysis to understand and solve an existing problem or a problem that appeared during the implementation of research" (Isik, Askun, & Ozden, 2011. p. 56).

Action research defined by McMillan and Schumacher (2006) is "studies undertaken by practitioners in schools to address an actual problem or issue in the school or classroom." Various definitions have been given to accommodate the flexibility of research for this approach (Kindon, Pain, & Kesby, 2008; McIntyre, 2008). It is regarded as a collaboration of action and reflection whereby people or communities are affected by a problem and knowledge production helps foster opportunities to empower those involved (Kindon et al., 2008). There is a focus on change that requires commitment by the participant to improve the world by changing it (McIntyre, 2008). It may require an iterative cycle of research through action and reflection even though it is not always clear how this happens in practice (Kindon et al., 2008). Knowledge is generated through inquiry and the collective efforts and actions of the participants. There are two types of action research: practical and participatory. Since the study involves the team-based effort of implementation and focuses on teacher development and student learning, practical action research was chosen. Figure 4.3 below indicates the difference between the two types of action research.

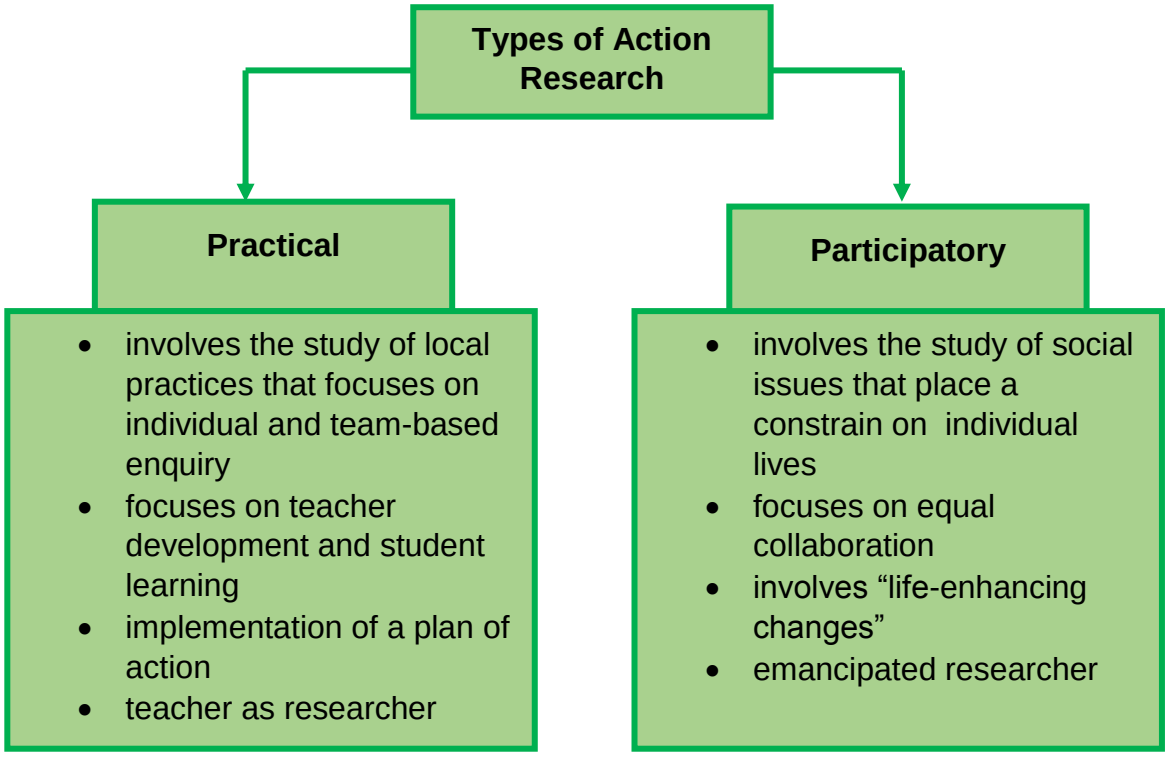


Figure 4.3: Types of Action Research

(Cresswell, 2014)

This approach is best suited for this study as it involves the implementation of mobile technology in the classroom with the aid of formal training and focus group sessions over a five week period. Each participant will be treated as a subunit in the research as they are from different learning areas, keeping the focus on the development of teacher identity through mobile technology. The action research spiral of Sanders will be used to show the cyclic and iterative process of four stages as shown in Figure 4.4.

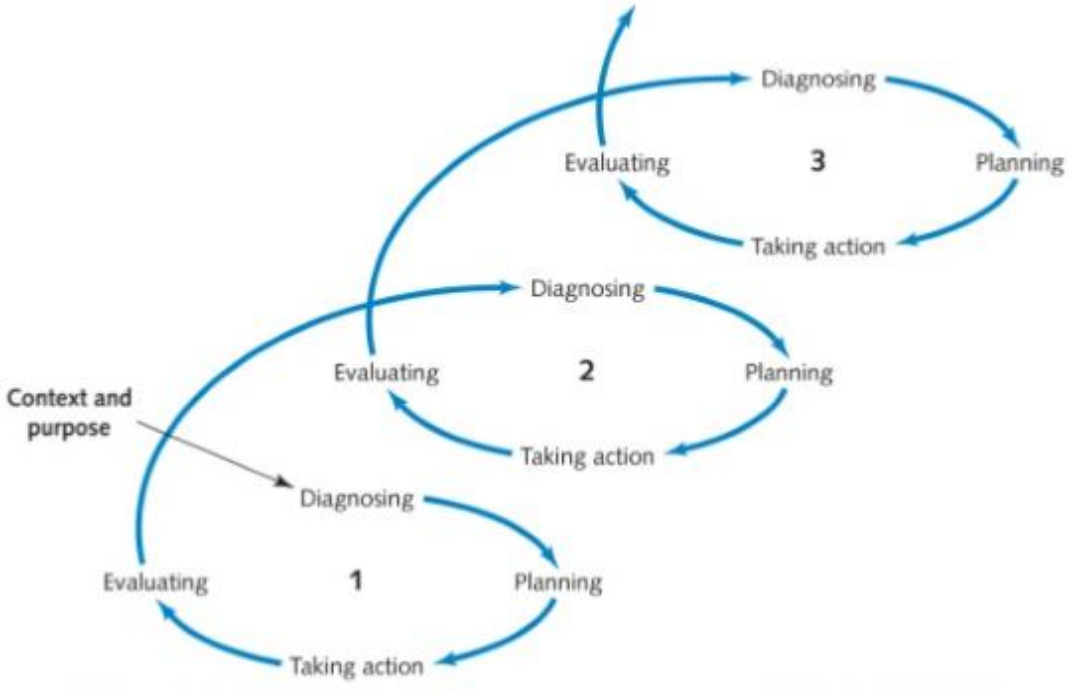


Figure 4.4: The Action Research Spiral (Saunders et al., 2003).

The context and purpose of the study can be explained by the vast amount of literature available about the implementation of mobile technology in classrooms. The study aimed to observe and understand the growth and development of teacher technical professional identity. Phase 2 is used as an example to explain the spiral nature. The **diagnosis** was made by an initial questionnaire being used to get a general idea of how technically literate the teachers were at the start of the study and also their beliefs and ideas around mobile technology and pedagogy in classrooms. Once this was established the **planning** for support to aid and develop their skills prior to implementation was done. This was the organising of an existing mobile learning workshop which would serve as formal training. The "**taking action**" would be the delivery of the workshop by a trained expert within the field and the use of the knowledge gained from the workshop to present lessons with mobile technology. After careful **evaluation** of the data obtained during the training the next phase of the research was planned. The framework was redesigned with the new findings present and the cycle would start again. The next stage involved continuous reflections and focus group sessions to ensure support and guidance to the teachers during the implementation process. After every week the emotions, perceptions, experiences, challenges and successes that occurred were discussed. Support would be provided to assist teachers in their planning, enhancing their productivity and ability to take

action again in the classroom. An evaluation of the data obtained probed the redesign of the framework. The final stage of the research involved in-depth interviews with four of the participants to evaluate the process of action research and identify and confirm any aspects of growth and change in teacher technical identity development.

4.4.1 Literature Study

The first form of action was an extensive literature study where the researcher looked at several aspects related to technology acceptance and their relationship to identity development. Approximately 326 literature sources were used to obtain a holistic understanding of mobile technology acceptance and teacher identity development. An elaborate account of this can be found in Chapters 2 and 3.

4.4.2 Mobile learning workshop

The second form of action was to provide the teachers with some form of formal training on technology, most specifically mobile technology in the classroom. This was done during Phase 2 of the study. The participants were invited to attend the mobile learning workshop. The workshop ran over three days where they were taught how to incorporate different types of technology into their lessons, what technology was available, how to evaluate and choose relevant technology and which technologies work best for their learning areas. The workshop was run by the university and administered by an expert in the field of mobile learning. Teachers were required to bring along their own tablet and participate in various different hands-on, interactive activities that were facilitated and supported by the facilitator. The mobile learning workshops also aimed to create awareness and understanding about what was necessary for a paradigm shift towards the use of mobile technology. According to Royle et al., (2014. p35) there were five key tasks that teachers need to fulfil for successful implementation.

- “Implement digital tools in learning and reflect on their use.
- Understand the match or fit between existing curricula and the emerging digital capabilities of learners and how these might be leveraged for learning purposes.
- Understand the potential for change in teachers’ roles and identities.
- Use different pedagogical approaches that increase learner agency.

- Use digital tools in context in reflective practice-based teacher education."

The content of the workshop covered several aspects. Each aspect was broken down and either explained, demonstrated or done interactively to give the teachers the experience of teaching and learning with mobile technology. A brief description of the topics covered is given below to demonstrate the depth of the training.

Mobile devices- which entailed the basic use of the tablet, features, management and wider teaching practice uses such as administration, planning and communication.

Planning- this involved the use of TPCK and the backward design model, elements of constructive alignment and designing interactions for the teachers.

Management- this was relevant theory on Learning Management Systems (LMS), software management, in-class management and device/technical management.

Teaching- which included several different strategies such as role play, jigsaw, scavenger hunt, learning stations, in class groups, gallery walk, cooperative learning, normal group technique, game-based learning and gamification. e- and m-learning principles were discussed. Theories such as constructivism, learning theories, Bloom's taxonomy and interactive theories were explained.

Assessment- both continuous and formative assessment were presented. Management of assessments were displayed and key concepts of why and how to do these assessments were explained.

Productivity- information on the added value of m-learning, create/share content tools, open education, open education resources and open source were discussed. Teachers had to find content that was appropriate for their teaching context, and technically sound and evaluate these resources.

Ethics- around copyright issues, such as plagiarism, closed copyright and common core were discussed. Safety on stalking/bullying, personal info, phishing and internet were demonstrated. Mobiquette and digital identity/footprint were illustrated.

Social learning- in terms of teaching cooperatively/collaboratively, global learning communities, Web 2.0 sharing, social learning and public learning environments and their categories were demonstrated.

E- and m-learning topics- such as globalisation, digital divide and 21st century skills were discussed, with reference to challenges, advancements and management.

E-resources- in terms of teaching with apps were interactively demonstrated, sourcing or subject specific and generic apps such as simulations, content, quizzes, tutorials and games. Sourcing of e-resources such as e-books, enhanced e-books and interactive e-books, content in terms of educational software, videos, podcasts and photos, resources for assessment, management and content were all demonstrated.

4.4.3 Focus group discussions

During phase three the third form of action involved focus group discussions. The participants had the opportunity to discuss and share their experiences with one another and comment on the response from the learners and how they felt they have grown. The importance of this was to create a reflective practice that would enable the teachers to share critical incidents that made them stop and think remotely with others. It formed a wider contextual network of practice where they could share pedagogy, make comparisons and find new constructs for teaching and learning (Royle et al., 2014). Also known as a Professional Learning Community it "includes the group of persons who share or discuss, through critical question, daily life work practice, reflection of work practice and collaborated work practice focusing on learning as well as teachers' professional progress" (Spompong, Erawan, & Dharm-tad-sa-na-non, 2015). This feedback was important because their reflection showed how they grew from week to week and what they learnt. This allowed the teachers to "develop a greater level of self-awareness, about the nature and impact of their performance, an awareness that creates opportunities for professional growth and development" (Osterman & Kottkamp, 1993. p.2). These sessions were carefully structured to maximise the quality of the session and monitor the progress and development that the teachers had made during the course of the study. The focus group discussions ensured proper support for the teachers and discussions were voice recorded. A reflective journal for each participant was kept to observe any

change in emotions, perceptions, experiences, challenges and successes, etc. that the participants experienced during the time. Teachers could comment on how they handled technical difficulties and how this made them feel about their lessons. This phase of the research was crucial as it emphasised the importance of reflective practice.

4.5 Time horizons

This study follows a longitudinal design because it concentrates on the events and behaviour of a concentrated sample over a longer period of time. The study was started in 2015 with an in-depth study of literature most specifically within the South African context. It was crucial for the researcher to understand the context and prior research within the field. After a rigorous literature review the researcher was able to develop a Framework 0 using three existing models to explain aspects of professional teacher technical identity development. This was the basis of the study and helped to design the next step of action. Ethical clearance was received by the end of April 2015 which proved to be perfect as the teachers were then able to start with the research in the 3rd quarter of the school year. This was the second phase of the study.

Arrangements with the school and the participants were made for the teachers to attend a mobile learning workshop. This workshop was held at the university and afforded the teachers a certificate of competence in 21st century skills for teaching. The teachers were then given the opportunity to explore and find different software and hardware that they could use and plan for their teaching in the 3rd quarter. This allowed for the second phase of the study to be completed. Data was collected and analysed in the form of a written questionnaire and reflective journal.

In August of 2015 the teachers had to integrate the technology into to their teaching. They were given five weeks where they were expected to teach at least one lesson a week using technology. They attended focus group discussions where they shared their experiences and challenges and were also offered support by the researcher in the form of advice to overcome these challenges. Four of the teachers were then interviewed approximately two years later to find out if the teachers still used technology and if their experiences differed then. Various instruments were used to collect data and this completed the 3rd phase of the data collection.

The time line shown in Figure 4.4 indicates the time frame in which the study was done.

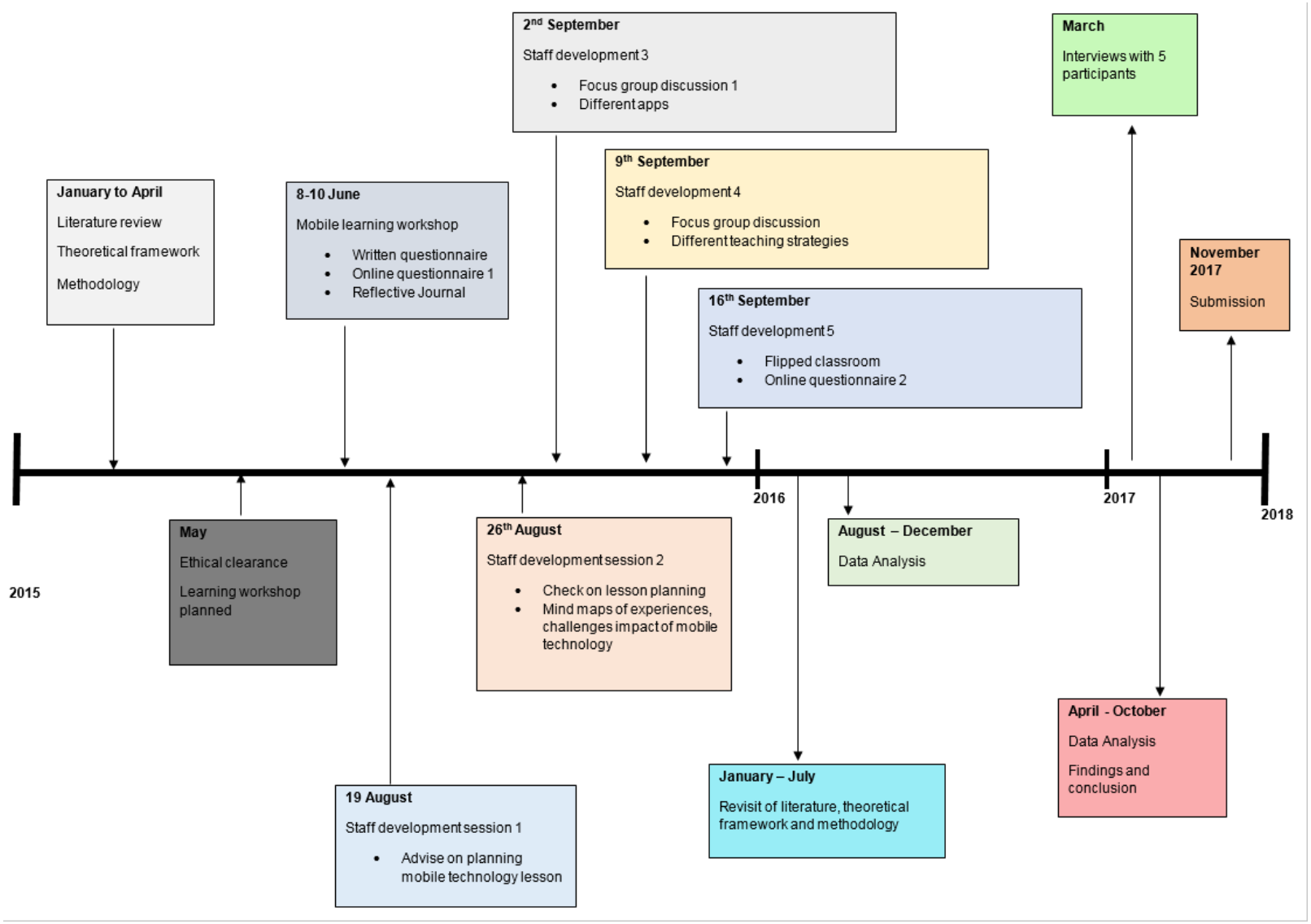


Figure 4.5: Timeline

4.6 Data collection

The data collection process consisted of three phases. Qualitative research is concerned with rich data of opinions, ideas and descriptions. Quantitative research seeks to find numerical or statistical trends in these opinions, ideas, and descriptions. Data was collected during Phase 2 and 3 of the study. The participants were seen for three consecutive days during the workshop and for five consecutive Wednesday's for an hour for focus group discussions. Prior to the data collection all ethical procedures were followed to ensure that the participants were aware that their role was completely voluntary, that they could withdraw from the study at any stage; that the data received was totally confidential and they would remain anonymous throughout and after the study.

Figure 4.6 illustrates the cyclic nature of the study and demarcates the process of the study. It is important to note that by tracking the teachers' emotions, perceptions, experiences, challenges, and successes using the proposed theoretical framework, one would be able to identify factors that impact on the implementation of mobile learning, hence impacting on professional teacher technical identity and shaping the framework for professional teacher technical identity development. This being the proposed outcome of the study is reliant on several aspects during the data collection.

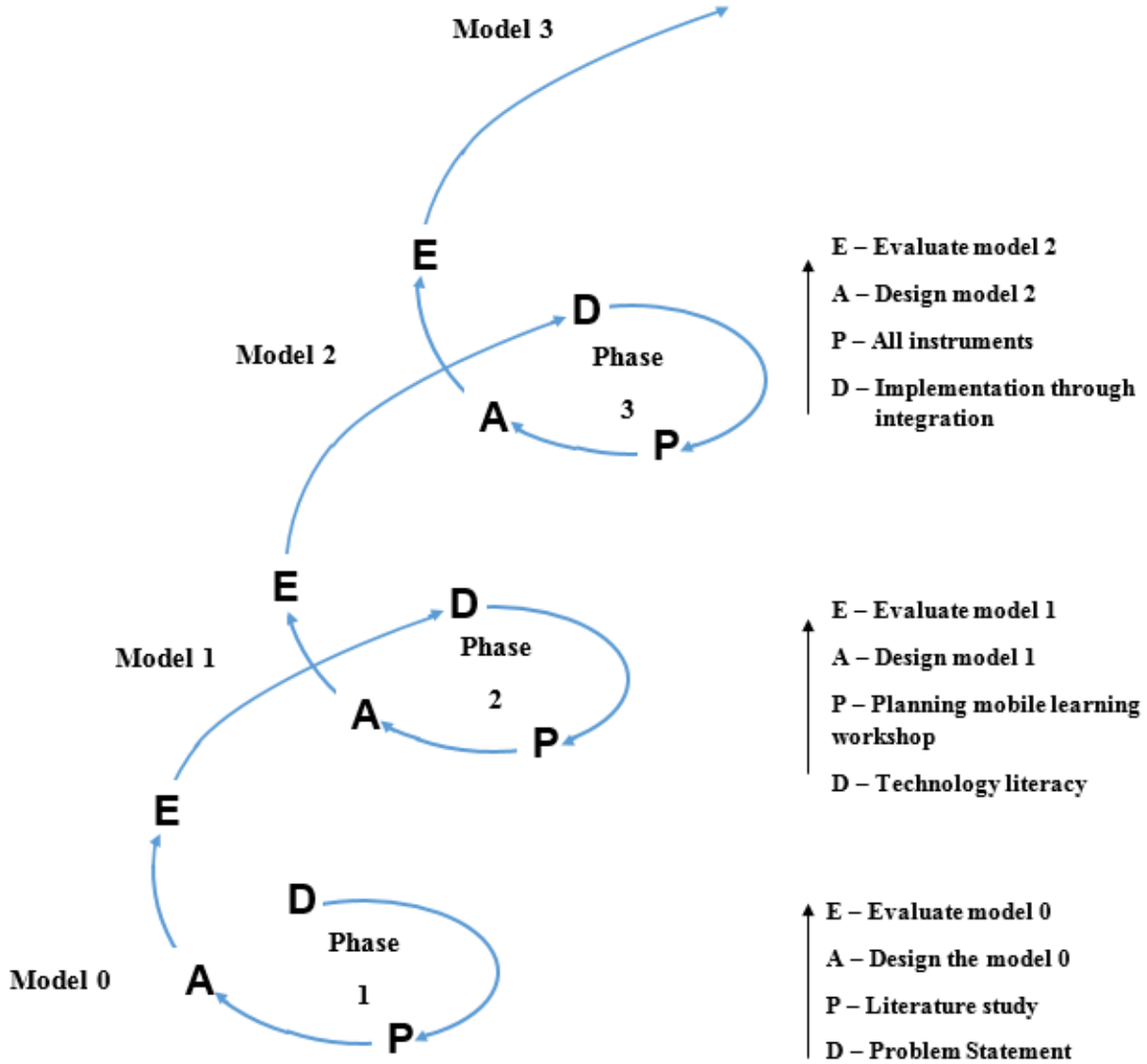


Figure 4.6: Research Design

4.6.1 Sampling

The researcher was subjective when choosing participants in the sense of purposeful sampling. “In purposeful sampling the researcher selects particular elements from the population that will be representative or informative about the topic of interest” (Mcmillan & Schumacher, 2006. p. 126). Hoyle, Harris, and Judd (2002. p. 187) substantiate that “one can handpick the cases to be included and thus develop samples that are satisfactory in relation to our needs.” They are supported by Bless and Higson-Smith (1995. p. 94) that further elaborate that it is the judgement of the researcher of a representative sample that will be most informative to the study.

The researcher makes a judgement as to whether these participants will provide the best information to address the purpose of the research. There was a specific criteria required for choosing the participants in order to collect the intended data. This was done so that the researcher could form some form of comparison between the responses when interpreting the data. The data was collected during the formal training, the five week focus group sessions and the interviews. The study had no intent of personal or professional ridicule nor did it aim to test the ability of the teacher to teach or the knowledge the teacher had

The sample consisted of fifteen teachers from a local government high school in the Pretoria area. Each was carefully selected according to the following criteria:

- Qualifications – This was necessary since the study assumed that all teachers in the study had the necessary PCK to teach their subject. All teachers that were chosen held an undergraduate degree that contained sufficient content to enable then to teach that specific subject.
- Years of experience – This was necessary because the researcher wanted to check if there was any variance in how the teacher identity changed and if so whether experience may have played a role in it. This is also to avoid any generalisation of technology use by novice teachers or experienced teachers. Furthermore, it was found to be an added benefit to the study as it may also add some rigour to the study.
- Subject specialisation – This was to give teachers of all learning areas the opportunity to be a part of the study and not create an assumption that technology use is only effective in certain subjects. It also made it possible for teachers to learn to collaborate, learn from one another and share ideas which they can then adapt and apply to their own subject. It is the researcher's belief that they would be able to share knowledge in terms of teaching methodology/pedagogy and technology.

This criteria was necessary as it allowed for a range in experience, a range in qualifications and a range of learning areas. This was regarded as necessary for the study by the researcher as it would take into consideration these factors when assessing any change or absence of change in teacher identity. The study followed a cyclic approach as it required many sessions of action and reflection to analyse the

data and evaluate what further research was needed. During implementation it cannot be taken for granted that the process will be deemed successful immediately. “Implementation is the carrying out, execution, or practice of a plan, a method, or any design, idea, model, specification, standard or policy for doing something. As such, implementation is the action that must follow any preliminary thinking in order for something to actually happen” (Ehrens, 2015). Since the study focuses on identity, in order for identity change to be evident, the study needed to unpack the emotions, perceptions, experiences, challenges and successes that the teachers faced over a period of time.

The sample was based on the teachers’ willingness to participate in the study. All teachers were known to me and shared a working relationship with me as the study was conducted at the school that the researcher taught in at the time. This was done for convenience as it fitted well in the plan of professional development at the school and the school had the necessary resources available for the study to be carried out swiftly. These resources included:

- Wi-Fi – this was necessary so that all teachers and learners could access online information at any time and any place in the school and preferably at home too. It ensured that the lessons that were planned and required internet access would run smoothly and eluded any technical issues.
- Teacher computers in all classrooms - this was necessary so that the teachers had the necessary equipment to plan, prepare and present these lessons without the hassle of not having their own computers or mobile devices.
- Learners with mobile devices - it was necessary for learners to have their own mobile devices so that they could participate in the lessons that were planned and none of the learners were disadvantaged because of the technology used.

A mixed method approach suggests that there will be more than one data collection technique. These instruments in the form of interviews, questionnaires, reflective journals and community of practice will serve as a variety of associated analysis procedures to determine the relative frequency of factors or themes that emerge from the data.

4.7 Instruments

Six instruments were used to collect data. During Phase 1 of the study there was no data collection as the researcher studied the literature to gain insight of what prior research was done in the field. During Phase 2 of the study data was collected by means of a written questionnaire and a reflective journal which were kept during the mobile learning workshop. During Phase 3 data was collected by means of an online questionnaire, reflective journal during the implementation process, lesson reflections from the teachers and four interview transcripts. A detailed account of these instruments is provided below and can be found in the appendices.

4.7.1 Written questionnaire

Firstly the participants were given a questionnaire which had items that were adapted from a similar study. Questionnaires ensure that all participants have the same questions and can ensure anonymity (McMillan & Schumacher, 2006.p. 196). The questionnaire was adapted from Mac Callum et al. (2014) and included:

- Scaled items – these were used to allow for "fairly accurate assessments of opinions and beliefs" (McMillan & Schumacher, 2006). The Likert scale was used as it is the most widely used scale item appropriate for the study.
- Ranked items – this was used to check what level of importance the teachers gave to technology use in classroom practice and also how they would rate themselves in terms of proficiency in technology. Some aspects of attitudes were also assessed to help triangulate data from other instruments.
- Checklist items – this was used to give the teachers an idea of all the different applications that they had on their mobile devices and to see how many of them they actually used and whether or not they were aware of these apps on their mobile devices.

This questionnaire aimed to investigate the ICT anxiety, ICT ability, ICT attitude, perceived usefulness and perceived ease of use of technology. The questions were structured to identify emotions, perceptions, experiences, challenges and successes of the teachers and whether they found it easy to use technology at the start of the study. This instrument would serve to triangulate data and also as a base line for

each teacher's understanding of mobile technology. This was to get an understanding of their willingness at the start of the study to adopt mobile technology and showed the link to the TAM model from the start and an indication of where each teacher may or may not be in the levels of the SAMR model.

The reliability of the questionnaire was tested by computing Cronbach Alpha values by making use of SPSS and the results are illustrated in Table 4.1. A Cronbach Alpha value above 0.5 is regarded as reliable (Goforth (2015)). Since all Cronbach's Alpha values in Table 4.1 are above 0.5 the constructs are deemed to be reliable. In fact, three of the constructs have Cronbach Alpha values above 0.8 indicating high reliability within these constructs.

Table 4.1: Cronbach's Alpha statistics for reliability of written questionnaire.

Table number	Themes	Cronbach's Alpha
Table 5.3	ICT Anxiety	0.83
Table 5.5	ICT Ability	0.86
Table 5.7 and Table 5.8	ICT Attitude	0.52
Table 5.9	Perceived usefulness	0.60
Table 5.11 and Table 5.12	Perceived ease of use	0.85

It should be noted that Pearson correlations were computed for the written questionnaire (Questionnaire 1), since the age and years' experience on that questionnaire are both continuous variables. In addition to being continuous, the variables age and years' experience are normally distributed. The test for normality, for sample sizes less than 50, is the Shapiro-Wilk test (Field, 2014, page 184). If the p-value is greater than 0.05, then normality is assumed. The p-values for age and years' experience equal 0.057 and 0.506, respectively, confirming normality and, accordingly, the well-known Pearson correlation was used.

4.7.2 Reflective journal

During this workshop a reflective journal was kept to monitor the teacher's behaviour, interaction and willingness to try the new approach to teaching. This relates to the TPCK model as the teachers now have the TK necessary for teaching and learning. This TK is seen as sufficient as the teachers were only required to do one lesson a week using mobile technology as a gradual method to implementation. They would need to use this TK and construct their own TCK and TPK for their learning area. The reflective journal served as a means to relate their experiences to the TAM model once again.

A second reflective journal was kept during the five week implementation process to observe and monitor the teachers' response to integrating technology into their teaching. This also served as a means to confirm the data received during focus group discussions and lesson reflections. The researcher was subjective in keeping this journal as it was based on the observations and/or behaviour and the type of comments that the teachers made about technology use.

4.7.3 Online questionnaire

There was further data collected during an online questionnaire during the workshop which monitored the teacher's development of teacher identity. This online questionnaire discussed aspects of technical support, perceived usefulness, perceived ease of use, and experiences of planning, teaching and reflection of technology use. The online questionnaire was done during staff development. The data collected from this instrument consisted of both quantitative and qualitative questions ranging from open ended questions to scaled and ranked questions. This questionnaire provided a range of data for the study covering various aspects that would also confirm or reject data from other instruments. This questionnaire was designed as part of an Honours project at the university and was tested for reliability by computing Cronbach Alpha values. The first section looked at biographical information. Section 2 consisted of ranked items. Table 4.2 below provides the Cronbach Alpha values and it can be seen that all Cronbach Alpha values are satisfactory since they are all above 0.5. In fact, four of the constructs have Cronbach Alpha values above 0.8 indicating high reliability within these constructs. The

questionnaire was administered using Qualitrics software, which is a web-based survey tool, and cleaned for analysis on SPSS a statistical software package.

Table 4.2: Cronbach's Alpha for online questionnaire – Section 2.

Themes for Table 5.10	Cronbach's Alpha
Perceived usefulness	0.89
Perceived ease of use	0.80
Facilitating conditions	0.67
Subjective norm	0.60
Attitude	0.82
Voluntariness	0.76
Ability	0.81
Anxiety	0.65

Section 3 consisted of ranked items which were represented graphically in Section 5.9. Section 4 addressed open ended questions on teacher identity and was summarised in Figure 5.13.

For the online questionnaire (Questionnaire 2) it is different, for age, the participants had to select between the categories of 20-29, 30-39, 40-49, 50-59 and 60 years or older, and for years' experience the participants had to select between the categories less than one year, 1 – 3 years, 4 – 8 years, 9 – 15 years, more than 15 years. Since age and years' experience are not categorised, Spearman correlation is used instead of the more well-known Pearson correlation.

4.7.4 Lesson reflection

Teaches were expected to submit lesson reflections during the five week implementation. This was done once a week on a Wednesday morning for an hour where the teachers needed to submit a lesson reflection on what technology they used and how they experienced using it. Teacher reflection is crucial and is emphasised by John Dewey (1910. p. 13) as "to turn the thing over in mind, to reflect, means to hunt for additional evidence, for new data that will develop the suggestion, and will either, we say, bear it out or else make obvious its absurdity and irrelevance." Self-reflection involves an intention and process by which teachers develop a high

level of self-awareness about the nature and impact of their performance and create awareness of opportunities of professional development (Royle et al., 2014). This would confirm what was discussed in the focus group discussions or include anything that teachers failed to mention.

4.7.5 Focus group discussions

The researcher chose this method because “reflection is recognised as a key means by which teachers can become more in tune with their sense of self and with a deep understanding of how this self fits into a larger context which involves others; in other words, reflection is a factor in the shaping of identity” (Beauchamp & Thomas, 2009. p. 182). The role of reflection in developing teacher identity has been acknowledged by many as the core of effective teaching (Korthagen, Kessels, Koster, Lagerwerf, & Wubbels, 2001; Larrivee, 2000; Rodgers, 2002). Reflection can be seen as a way of teaching in the future and could inform teacher development (Conway, 2001). This notion of reflection could suggest a change in future teaching and provide a way of shaping identity by establishing a goal or a vision of the ‘ideal’ self (Urzua & Vasquez, 2008). According to the topology of reflection developed by Luttenberg and Bergen (2008), illustrated in Figure 4.7, reflection can be seen in the ethical domain as touching upon a teacher’s self-understanding, identity and/or manner of living.

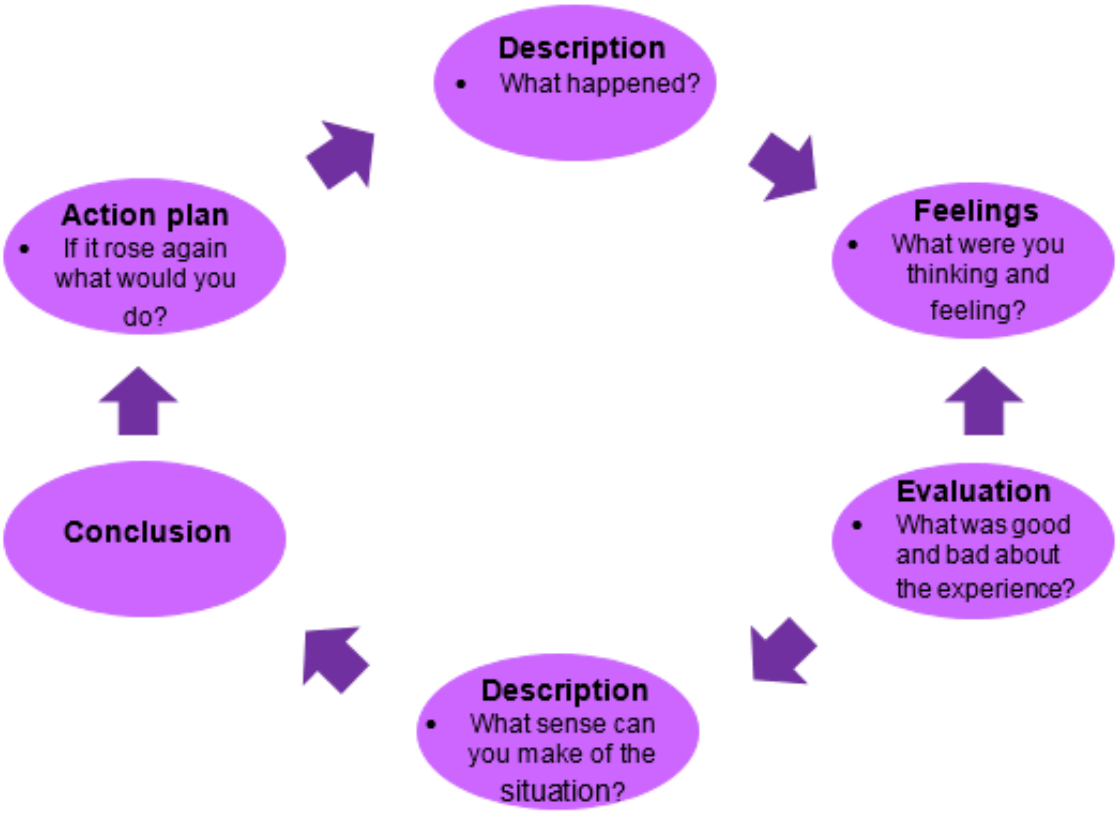


Figure 4.7: Process of Reflection

It is expected that for teachers the process of making a change in their initial perception of how well a certain technology can work, is to show them how this technology can fit in with their existing pedagogical approaches and curricula. Then only will they consider the use of it. Once they realise the potential of the digital tool they may take the first step to reconceptualising how teaching and learning can occur and then possibly reconfigure their identity as a teacher.

This instrument should give a clear outlook on how teachers change their lessons to implement mobile technology. From the focus group discussions one would be able to classify the technology as being used as an enhancing tool for the lesson or if the lesson was significantly modified using the technology in order to teach the lesson. It is assumed that the researcher would be able to classify the lessons using the SAMR model and Bloom's taxonomy. This should give an indication of any professional teacher technical identity development that took place.

4.7.6 Semi-structured interviews

The last stage of the data collection is semi-structured interviews that will be conducted two years after the training and focus group sessions. Interviews can be regarded as vocal questionnaires, however, interviews allow for flexibility and adaptability (McMillan & Schumacher, 2006). “Responses can be probed, followed up, clarified and elaborated to achieve specific accurate responses (McMillan & Schumacher, 2006. p. 203).” An advantage to interviews is that it probes what is *in* someone else’s mind and what is *on* someone else’s mind (Batchelor, 2001). These interviews were conducted with four of the fifteen teachers chosen. The aim of these interviews was to find out what change has taken place over the last year in their teaching and how has the workshop or study impacted on their professional identity and teaching. Lincoln and Guba (1985. p. 268) identify five outcomes of interviewing:

- Here and now construction - the participant’s explanations of emotions, perceptions, experiences, challenges and successes.
- Reconstruction – the participant’s explanation of past emotions, perceptions, experiences, challenges and successes.
- Projections – the participants’ explanation of anticipated, emotions, perceptions, experiences, challenges and successes.
- Triangulation – clarification and verification of other data.
- Member checking – clarification and verification of findings by the researcher.

It will also be used to map out the change in identity, if any by each teacher.

The interview covered five different aspects:

- Perceptions of technology
- Challenges of technology
- Usefulness of technology and resources
- Impact of technology on teaching and professional development
- Impact of technology on professional identity

These interviews are expected to help consolidate and validate the data received to ensure the credibility and trustworthiness of the research. It will also emphasise any underlying aspects that were not considered or were possibly unnoticed. Interviews will not be done with all the participants due to time constraints. The diagram below depicts the data collection phases.

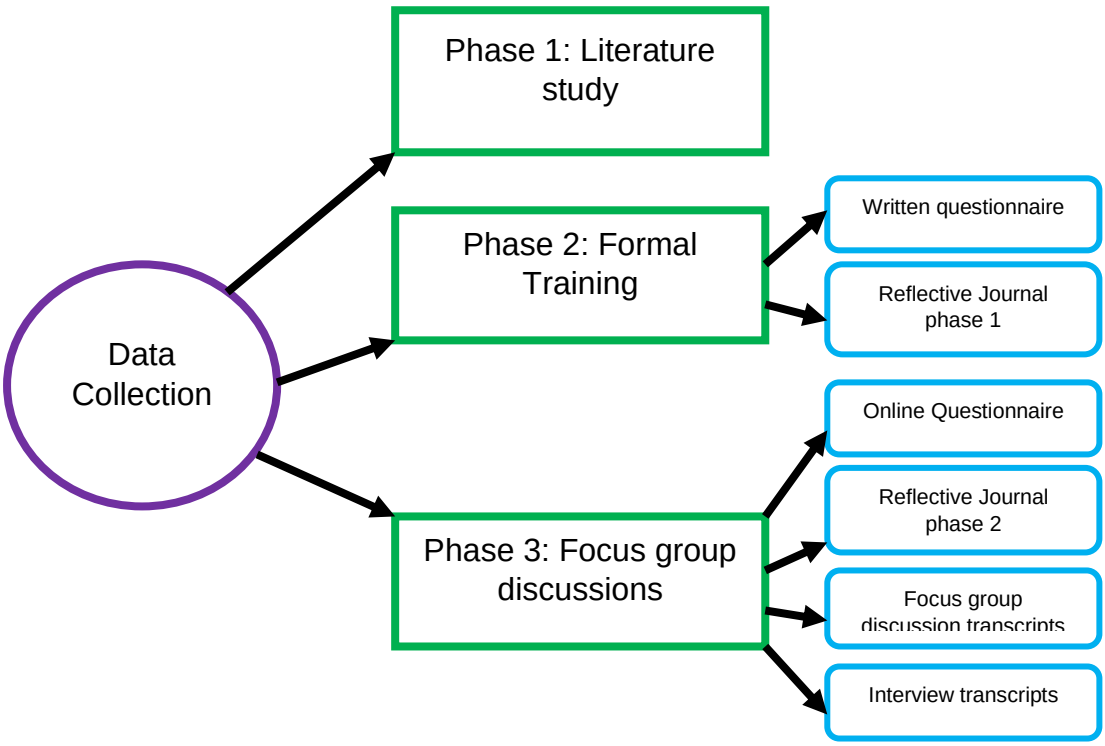


Figure 4.8. Data collection design

To ensure that the study was planned and all research questions could be answered with sufficient data, the following table was created to align the instruments, research questions, and theoretical framework. This also illustrates the complexity and degree of thought put into the planning of the data collection to provide fruitful results.

Table 4.3: Data collection instruments.

Main Research Question: How does mobile technology acceptance advancements shape professional teacher technical identity development?					
Data Collection Instrument	**Research Question**	**Theoretical Framework**			**Appendix**
		TPCK	**TAM**	**SAMR**	
Written Questionnaire	RQ1, RQ4, RQ5	X			1
Online Questionnaire	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	2
Lesson Reflections	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	3
Reflective Journal	RQ1, RQ2, RQ4, RQ5		X		4
Focus Group Discussions	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	5
Semi-structured Interviews	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	6

4.8 Data analysis

The data was analysed on a continuous basis throughout the data collection process to ensure that proper planning was done for the next cycle. The data analysis involved quantitative, qualitative and triangulation of data. The data was analysed using an integrated Framework of the TPACK, TAM and SAMR models to show the cause and effect nature of mobile technology on teacher identity and identify any new relationships or new factors that have contributed to the creation of the professional teacher technical identity development framework. The experiences of teachers as a measure of personal and professional growth were considered throughout the data collection process.

4.8.1 Qualitative and quantitative data analysis

The data received from the written questionnaire and online questionnaire contributed to the quantitative aspects of the study. The reflective journals, lesson

reflections, focus group discussions and interviews formed part of the qualitative aspects of the study. These are both discussed together as they were conducted parallel to one another in the study and not one after the other. The purpose of this was to provide the cyclic nature of the study and to also ensure reliability and trustworthiness of the data. It also allowed for a saturation of data and made the triangulation process easier.

Data was analysed using content analysis. Content analysis involves examining the occurrences of patterns or themes (Stemler, 2001) that emerge throughout the data collection process. It is a method that summarises any form of content by identifying and counting various aspects of the content. Schreier (2012) and Elo et al. (2014) describe it as a means of systemic and objective quantifying of phenomena. A conventional content analysis was chosen as it is appropriate for the study and aims to describe and explore a phenomenon, in this case professional teacher technical identity development. This allows for predetermined categories and emerging themes (Kondracki & Wellman, 2002). There are three main phases of conventional content analysis.

- Preparation
    - Data collection process - content analysis.
    - A sampling strategy - that will provide the most informative data for the study and provide a saturation of data.
    - The unit of analysis - that ensures that the phenomenon being explored is not too broad.

These were all catered for when the sample was chosen. Fifteen teachers allowed for saturation of data and the phenomenon of mobile technology use in classrooms was not too broad to investigate.

- Organisation
    - Categorisation and abstraction - which focus on how the categorises where created, the number of concepts and the overlapping of concepts.
    - Interpretation – involves the degree of interpretation and the accuracy in terms of making sure that the information represented is provided by the participants.

- Representativeness – focuses on how trustworthiness will be ensured during analysis and throughout the data as a whole.

This was most evident in the quantitative aspects of the data analysis. The data collected from the online questionnaire and written questionnaire was cleaned and analysed using SPSS software. The questionnaires were tested for trustworthiness and received Cronbach alpha values of above 0.5. The data was then represented using Minitab software to clearly indicate the teachers' responses. This also assisted in finding new emerging themes allowing for inductive reasoning.

- Reporting
  - Reporting results – focus on the logical and systemic flow of the data and the results, the clarity of content and concepts for the transferability of results and the comparisons between categories are systemic and cover all data.
  - Reporting analysis process – is necessary for a full description of the data that is discussed based on the trustworthiness of the content analysis.

This method ties in well with the deductive reasoning approach as it involves categorisation matrix development which allows for the reviewing of content and coding of correspondence or exemplification of the identified and predetermined categories (Elo et al., 2014; Polit & Beck, 2012). The predetermined categories are those categories that have been identified by the theoretical framework (i.e. perceptions of technology, challenges of technology, usefulness of technology and resources, impact of technology on teaching and professional development, impact of technology on professional identity). The emerging themes will be identified from the careful analysis from coding and categorisation of data. Categories are regarded as abstract entities that represent similar topics (McMillan & Schumacher, 2006). By forming codes a researcher is required to think more abstractly. Cresswell (2014. p. 197) describes coding as "the process of organizing the data by bracketing chunks and writing a word representing a category in the margins." A combination of both predetermined categories and emerging themes will be used. It was anticipated that patterns will arise from categorisation and this will help to consolidate the data. A pattern is a relationship between categories that seeks to examine data in as many

ways as possible (McMillan & Schumacher, 2006). Below is an illustration of the data analysis process.

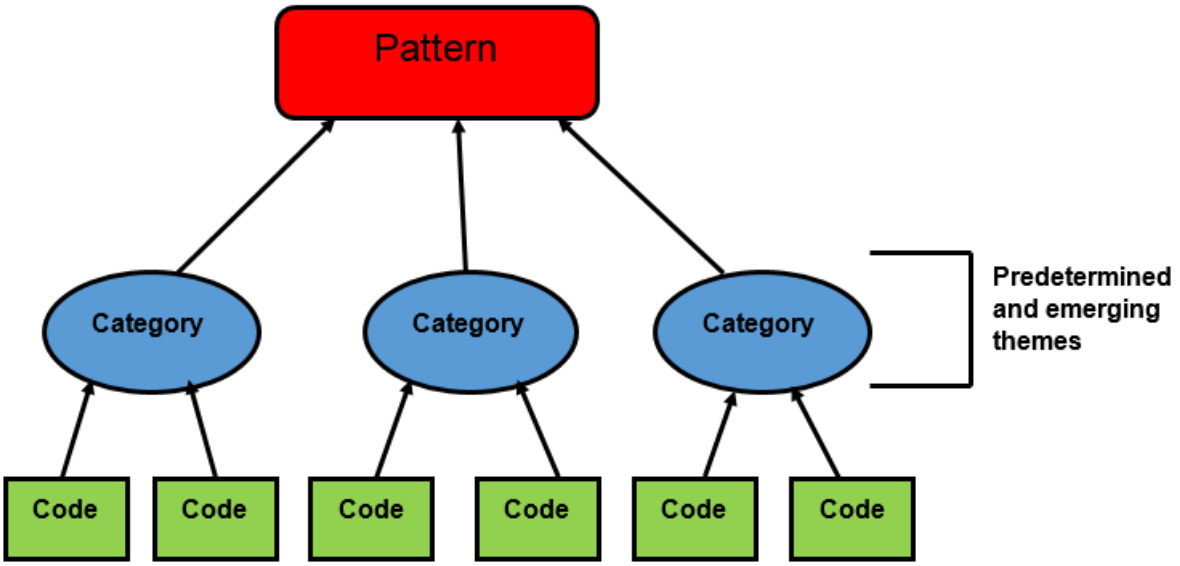


Figure 4.9: Diagram representing data analysis process.

4.8.2 Triangulation

The data was triangulated by comparing the responses that teachers gave in different instruments. It was also possible to identify change in responses and unpack what brought about this change. Several questions were asked testing the same aspect to confirm that the teacher was in fact answering truthfully without any bias. The written questionnaire tested the pre-existing themes and categories as explained in the literature. This was also qualitatively recorded in the first reflective journal that was kept during the formal mobile learning workshop to observe the behaviour and response of teachers to technology use. This allowed for the proper planning of the next phases which involved the implementation of technology and the focus group discussions to provide support. The second reflection journal was kept during the focus group discussion to again monitor the behaviour and response of teachers to the technology implementation and integration at this time. The online questionnaire was used to now identify any emerging themes from the teacher's experiences and how they responded to it. The lesson reflections were used to check if the teachers did in fact do proper planning and if they encountered problems in the planning of lessons with technology. The lesson reflections and the focus group discussion transcripts were used to confirm the teachers' experiences from just after the lesson

to the discussion and therefore often mention similar experiences if not the same thing. This was also a method of ensuring feedback from the teachers even if they did not contribute much in the focus group discussion. The interviews that were conducted at the end of the study were to check if the teachers still used technology and if they had shown progress in their technology integration. These interviews were only done with four of the participants as it also served as a means to confirm the data that was already collected and to ensure the reliability of it.

A summary of the methodology using the Research Process Onion for this study is given below in Figure 4.10. It illustrates each layer and the necessary aspects of the research process for this study. The study aimed to find a framework that can be used to assist teachers to integrate technology into their teaching and highlights the factors that need to be considered when implementation takes place.

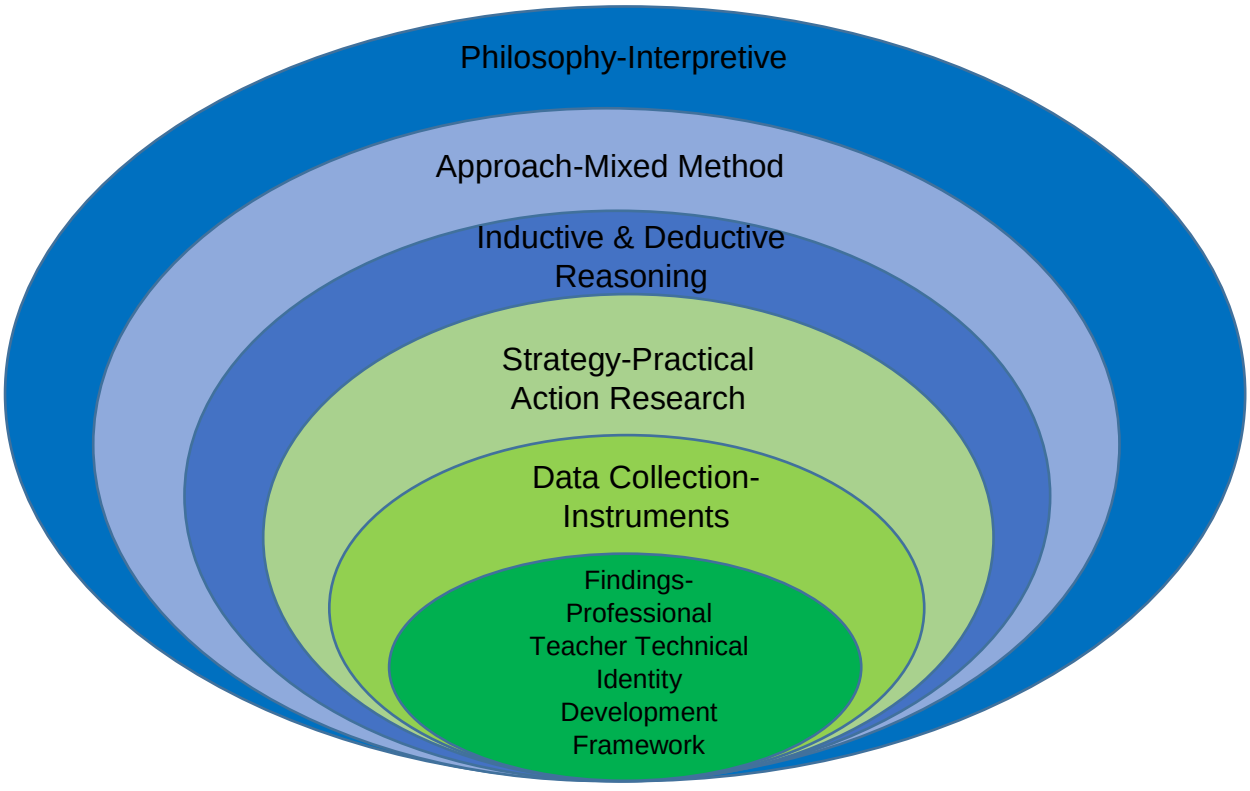


Figure 4.10: The research process "onion" for this study.

4.9 Methodological norms

While qualitative researchers make use of trustworthiness to ensure rigour, quantitative researchers makes use of reliability and validity to do this. These are discussed in detail next.

4.9.1 Qualitative data

Researchers have used qualitative criteria in order to validate aspects of content analysis (Elo et al., 2014). The term trustworthiness seems to best captivate the criteria and supports the inquiry of findings that are “worth paying attention to” (Lincoln & Guba, 1985). According to Elo et al. (2014) trustworthiness is assessed through:

- Credibility – refers to participants in the research being identified and described accurately. All participants that were identified in the study were accurately described and a summary of their biographical details representing the criteria for purposeful sampling is given in Section 4.6.1.
- Dependability – refers to ensuring the stability of data throughout the study and under different conditions. The data analysis will emphasise the study condition and will ensure the stability of data throughout the research process.
- Conformability – refers to the objectivity and the congruency of the data in terms of accuracy, relevance and meaning. The researcher and supervisor are both involved in the data analysis to ensure the congruency and objectivity of the data.
- Transferability – refers to the results being generalised and compared to other groups and settings with reasoning. Due to the in-depth literature review, data will be confirmed and compared before any generalisation can be made and it will be fully documented as to how this generalisation was derived.
- Authenticity – this refers to how various researchers show a range of realities fairly and faithfully. For the purpose of this study the research will only be exploring the results according to the interpretivist philosophy following a socio-constructivist paradigm.

4.9.2 Quantitative data

Quantitative data is best described by the terms validity and reliability as it captures the measurability and replicability of predetermined categories. It is based on facts

and behaviours that influence those facts (Bogdan & Biklen, 1998). These behaviours are quantified and summarised by mathematically analysing data to expose some statistical terminologies (Charles, 1995).

- Reliability – refers to the consistency of results when repeatedly measured, the stability of those measurements over a period of time and the similarity of measurement that are done over a period of time. Due to the Action research approach the participant's acceptance of technology over a period of time will determine their professional teacher technical identity development.
- Validity – refers to whether or not the instruments used truly measure what it intended to measure. The validity of the quantitative instruments are tested using the Cronbach Alpha to ensure that the data collected is valid.

(Goforth, 2015; Golafshani, 2003)

4.10 Ethics

Ethical procedures were followed via the University of Pretoria. The study fell under a larger project on mobile technology integration supervised and managed by one of the academics. The necessary amendments to the ethical application for this study to be conducted were followed.

4.10.1 Application process

A brief description of the research project and a fairly detailed design of the methodology was presented. This involved the acknowledgement by the researcher of the procedure of working with human participants. It was highlighted that the study was of a low vulnerability status and that any participant over the legal age with teaching qualifications and experience could be used. Institutional support for ethical clearance from the Gauteng Department of Education, University of Pretoria and the School Governing Body was obtained prior to data collection. A detailed description of the venue and activities were outlined and produced as well as an approximation of the number of hours required by the participants. Both quantitative and qualitative aspects of data collection were explained.

4.10.2 Ethical principles regarding human participants

Participants were briefed on the procedure and were given consent forms. These included forms to the headmaster and the participants to pursue the research study at the school. All data was treated confidentially and reported anonymously to ensure the participants' privacy. No incentives were given to impact the responses of the participants. Participation was voluntary and all participants were free to withdraw from the study during the data collection process. To reduce possible bias, the researcher avoided any conversation regarding the study and data other than that given in the focus group support sessions. Safe keeping of the data was ensured according to the university ethics committee after the study was completed. The participants were aware that the findings of the study would be presented at conferences, in articles, seminars etc. to contribute to the body of research. Participants were also made aware that a debriefing of the study would be done should it be required.

4.11 Limitations

As with all studies there are limitations. Although there are many optional methodological approaches to the study, a practical action research with continuous reflective practice for an identity development framework is most suitable (Cresswell, 2014; Rodgers & Scott, 2008). The study following an interpretivist philosophy and does not ensure a definite possible outcome. This was to be determined by the effectiveness of the training workshop and the willingness and ability of the teachers to implement mobile learning in the classroom. Class visits were not possible due to the number of hours required, therefore the instruments were not designed to involve classroom practice. Since this is a small sample and the research is conducted at one school the results obtained are not a reflection or generalisation of South African teachers itself. It is merely an illustration of the outcome of such a study if external social and environmental factors such as resources, poverty, unqualified teachers, etc. are eliminated from the implementation of mobile learning.

4.12 Conclusion

This chapter summarises the outline of the research process used in this study. The research philosophy that informs this study is outlined. A rationale for selecting a

mixed method investigating a case study in an action research is presented. A descriptive framework of the instruments and data collection process ensuring trustworthiness is provided. The ethical procedures and limitations of the study are expressed to provide the reader with an accurate account of how the research was planned and executed. The data analysis methods discussed in this chapter are presented in the next chapter.

Chapter 5

Results & Findings

"Tell me and I forget, teach me and I remember, involve me and I learn"

Benjamin Franklin

5.1 Introduction

The data analysis was incessant throughout the research process as the data received from each phase of the research shaped the planning for the next. The results and findings are presented by Phase and each instrument was analysed separately and the findings reported at the end of each Phase. These findings are triangulated and reported, aiming to address the research questions in the final chapter.

Action research being a method of practically looking at work and reflecting on it required a three phase approach to the study. Figure 5.1 illustrates the research design and how the researcher took action within the study to develop a conceptual framework. The study is open ended and allows for the developmental process of an idea, through continual reflections (McNiff, 2011).

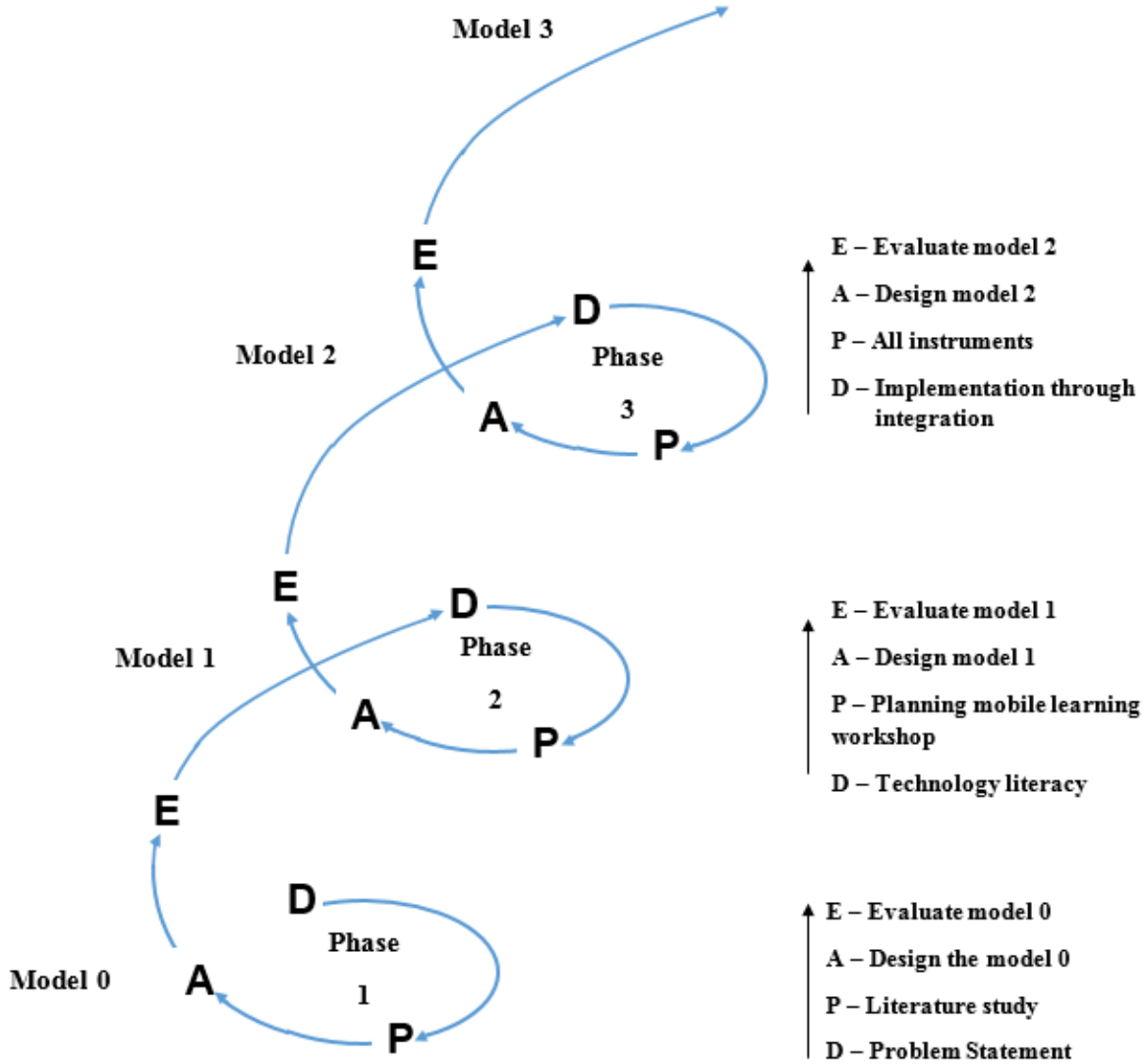


Figure 5.1: Research Design

The 1st Phase of the study consisted of a rigorous literature review of various topics around technology use and teacher acceptance of technology use. The literature focused on the current challenges identified and possible solutions for these challenges. Several gaps in the studies on technology implementation through integration were found.

With these gaps being identified the study was designed to focus mainly on the teachers and provide all the necessary infrastructure needed in order for teachers to successfully implement technology through integration. The 2nd Phase of the study aimed to identify the level of technology literacy that the teachers had and their beliefs of technology use.

At the onset of the study the participants were given a questionnaire that aimed to get a general idea of their perceptions and knowledge of technology in general. This questionnaire addressed five aspects that were found in the literature to influence ICT use. These five aspects are discussed in Section 4.7.1. An example of the questionnaire can be found in Appendix A. Even though the questionnaire did not have a direct impact on the mobile learning workshop, it provided guidance as to what level of teaching and support was needed during the workshop.

The workshop was designed to introduce teachers to different platforms, apps, websites and uses of their mobile devices, show them how to use these platforms, apps and websites and give examples of how it can be used to teach. The intention behind this workshop was to develop the digital and technical skills of the teachers and initiate and inspire a change in teaching practice (see Section 4.4.2). During the workshop the researcher kept a reflective journal to gather information and identify any changes in emotions, perception, experiences, challenges or successes that took place.

After the workshop the teachers were then required to teach technology-based lessons and provide feedback in the form of lesson reflections. An example of the format in which the reflections were done can be seen in Appendix D. The intention behind this was to seek any pattern of technology identity development from lesson to lesson. A community of practice was formed where the teachers met once a week for five weeks to share what they had done with each other and share ideas of how others can apply certain technology approaches in their classrooms. During these sessions the teachers shared different software, planning techniques and advice on how to overcome technology challenges in the classroom. The importance of this is explained in Section 4.7.5.

During the time of these focus group sessions the researcher kept a reflective journal and observed the emotions, perceptions, experiences, challenges and successes of the teachers. This was vital as the emotions, perceptions, experiences, challenges and successes that the teachers had about the use of technology played a big role in how their identity may or may not have changed. Two of the focus group discussions were recorded and transcribed to critically analyse the teachers' experiences of teaching with technology. These were the first and fourth session as

it would then be possible to see a change in how the teachers experience technology implementation. The second and fifth session focused on discussions of different types of software, Wi-Fi access, planning and learner response. In the third focus group discussion the teachers completed an online questionnaire.

The responses to the online questionnaire provided much of the data and are described in Section 4.7.3. An example of the questions can be found in Appendix B. This questionnaire looked at several aspects that collectively play a role in technology integration and implementation. This data was analysed and helped the planning and shaping of the interview questions that followed in the 3rd Phase of the study.

The interviews with the teachers were done two years later. This was to determine how their perceptions of using technology in teaching and learning changed their teaching practice. This was, however, conducted with four of the teachers and showed interesting results.

The data for each instrument was analysed separately and a discussion of the findings is provided. This is to ensure that all the data is considered and synthesised in a manner that was easier to understand. Due to the cyclic nature of the study the data is analysed in three different phases. The findings from each Phase shape the data collection method for the next phase. This chapter therefore includes the results and findings.

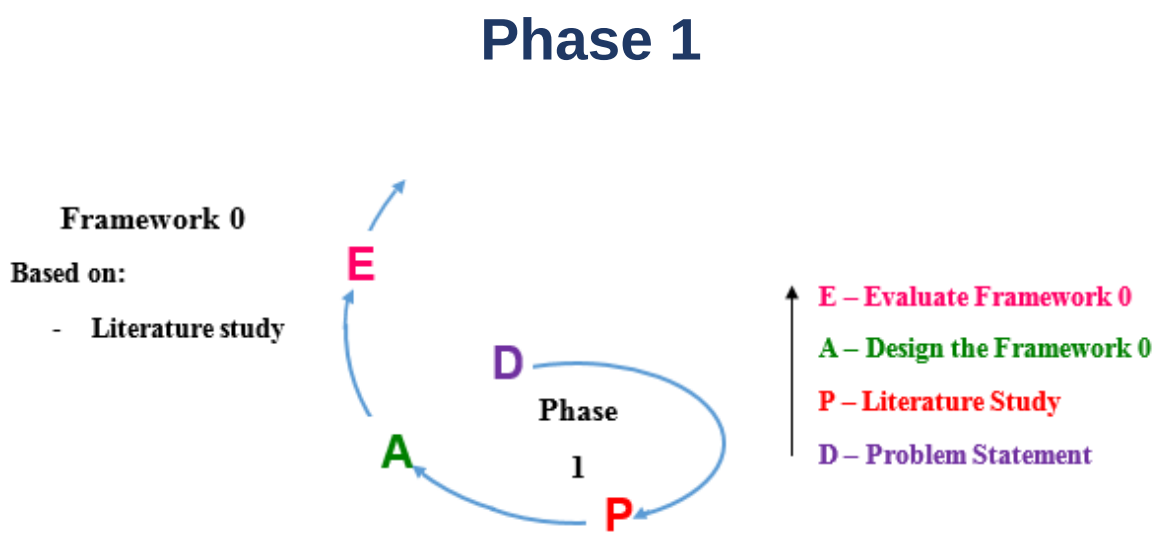


Figure 5.2: Phase 1 of Research design.

Figure 5.2 shows the first Phase of the study. A **Diagnosis** of the problem statement was made to design and develop a theoretical framework for the implementation of

mobile technology. The **Planning** involved an in-depth study of the literature that found that there is a need to create a framework that assists teachers to adopt a technical way of teaching. Section 5.1 illustrates some of the current limitations to mobile technology integration found in the literature. The **Action** taken was done by taking three models and designing a Framework to illustrate the relationship between each model (see Figure 3.18). These models were carefully chosen and the researcher found that they were best suited to collaboratively address the technology acceptance of teachers (see Chapter 3). After some consideration and **Evaluation** it was decided that more research needed to be done to confirm or adapt this **Framework 0 to Framework 1**.

5.2 Findings – Phases 1

The key findings from the literature study are provided below. These can be summarised as

- policies created but not implemented (Evoh, 2011)
- no framework globally accepted for technology implementation for teachers (Kihoza et al., 2016)
- no m-learning theory (Traxler, 2012)
- infrastructure available but not used (Makoe, 2013)
- technology used for non-instructional purposes (Gray et al., 2010)
- teachers' lack of professional development and technology skills (Cinque, 2013)
- lack of technological and pedagogical support (Blignaut et al., 2010; Summey, 2013)
- teachers' resistance to change due to socio-context and beliefs (McClure, 2011)
- Implementation through integration (Nkula & Krauss, 2014)

These key points motivated the need for such a study and allowed for the design of a framework using an action research approach.

The use of technology is highly dependent on a number of factors as mentioned in the literature (Carle et al., 2009; Idris & Nor, 2010; Liu et al., 2014; Molins-Ruano et al., 2014). These factors and the relation between the models outlined in Chapter 3 drove this study. The study initially assumed Framework 0 as a proposed conceptual

Framework of professional teacher technical identity development. Following the research design as outlined in the methodology this framework was adapted three times to find the most appropriate representation of a conceptual framework for professional teacher technical identity development.

5.3 Professional Teacher Technical Identity Development Framework 0

As the researcher interrogated the literature it was found that there was a relationship between TPCK and SAMR as claimed by Kihoza et al. (2016) and indicated in Table 3.1. Kihoza et al. (2016) give guided examples in their study of how the TPCK model and the SAMR model could be linked. These examples are extremely important as they provide a very structured approach to preparation and delivery of lessons and this is necessary to achieve a certain level on the SAMR. As discussed in Section 3.4 the change in delivery of the same concept can achieve different levels on the SAMR. The teachers' TPCK knowledge is therefore the driving force of what level they will achieve. The type of knowledge required and how that knowledge is used during the implementation of technology will determine the success. Kihoza et al. (2016) further explain that TK, TPK and Modification are all dependent on how easy the teacher finds technology is to use. If teachers find it easy to use technology they will be inclined to use their technology knowledge and integrate it into their teaching methods in such a way that the lesson will be modified. In order for the lesson to be modified there has to be significant task design which requires not only TK but also TPK. TK, TPCK Modification and Redefinition are dependent on how useful the teacher finds technology. If teachers find technology to be useful in their teaching the teachers are inclined to use this TK coupled with PCK, therefore TPCK and either modify or redefine their teaching. This will transform the lesson to an extent that the lesson would not be able to be completed without the use of technology. Mac Callum et al. (2014) further explained that the actual use of technology is dependent on whether the teacher found technology easy to use and useful. This provided the link of TPCK, SAMR and the TAM model and led the researcher to the design of Framework 0.

The initial **Framework 0** drew from the literature and represented an idea of how technology use, the level of technology use and the actual use of technology were understood. It was assumed that if a teacher held all three elements of knowledge,

collectively they would be able to implement technology use but on different levels due to their technology literacy and acceptance. The levels of implementation were dependent on whether the teachers found technology useful or easy to use. This would then determine the actual use of technology. This completed the first cycle of the study and the evaluation of Framework 0.

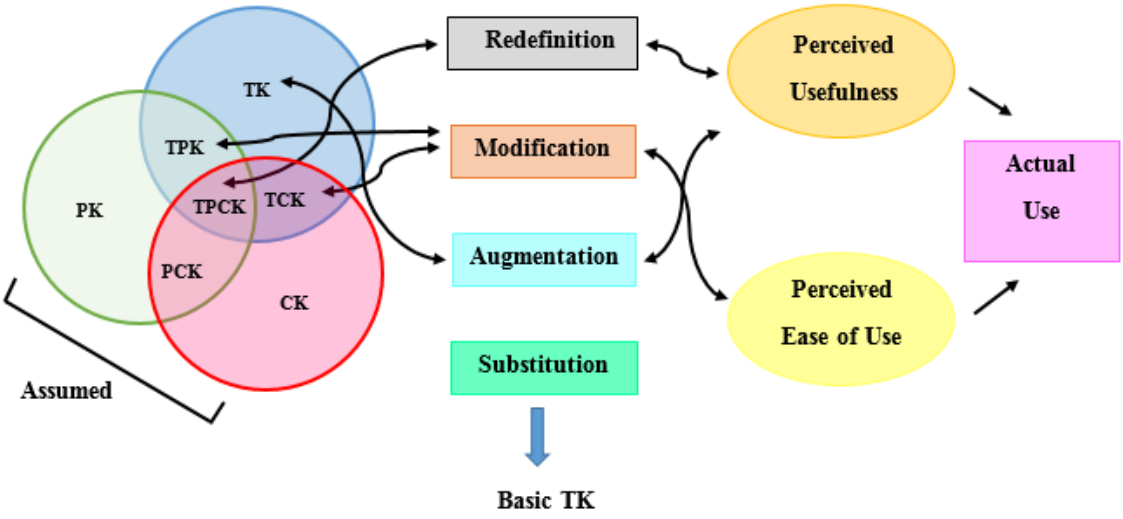


Figure 5.3: Professional Teacher Technical Identity Development (PTTID) Framework 0

For the purposes of clarity and understanding codes are used in the data analysis and are representative of the relationship between factors during the design process of the Framework. **(T)** is used to represent findings related to the theoretical contribution whereas **(P)** is used to represent findings related to the practical contribution. For the theoretical contributions, Phase 2 codes will appear in **blue** and for Phase 3 the codes will appear in **green**. For the practical contributions, Phase 2 will appear in **purple** and Phase 3 in **pink**.

Phase 2

Phase 2 of the study started with the careful **Diagnosis** of a new problem being teachers' technology literacy. After evaluating the Framework 1 and the findings of Phase 1 the study needed to address some of the critical aspects through some form of intervention. A mobile learning workshop **(P1)** was **Planned** to assist the teachers in understanding how to use technology in their teaching and provide them with the hands-on experience of it. The workshop provided the teachers with the basic skills

they require for implementing mobile technology and also made them aware of planning techniques and methods to implement the technology (see Section 4.4.2). This workshop aimed to address the shortcomings found by Cinque, (2013) and Gray et al. (2010). Teachers' would be provided with professional development that taught them how to teach with technology (see Section 4.4.2). During the workshop data was collected through the use of a written questionnaire and a reflection journal. The workshop and the data analysis was the new **Action** taken to develop Framework 1. Data from the written questionnaire identified the teachers' current perceptions of technology use. The reflective journal monitored the teachers' behaviour and acceptance of technology during the course. Framework 1 was then **Evaluated** and more research and data were needed to confirm and adapt the findings.

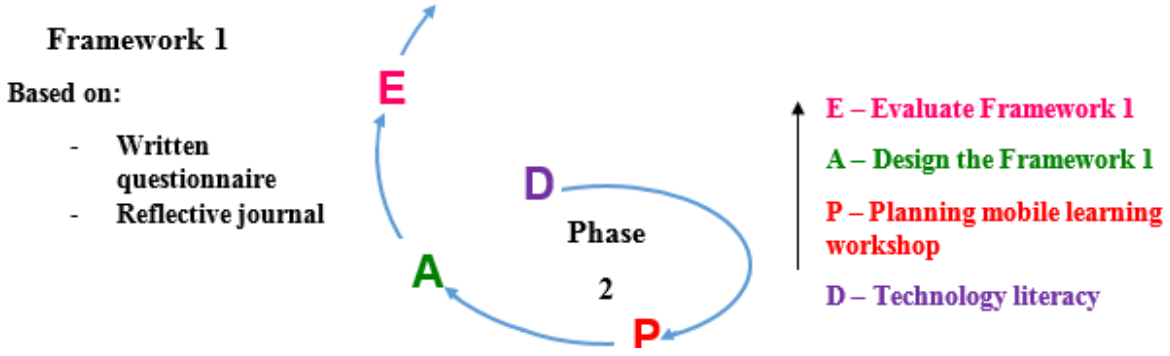


Figure 5.4. Phase 2 of Research design

The data collected from this Phase is analysed and reported on below. The findings from this Phase of the study is then used to shape the third Phase of the study.

5.4 Biographical information

Table 5.1 is a summary of the biographical information of all fifteen participants in the study. It has been categorised into age, gender, educational qualifications and years of experience. This formed Section 1 of the written questionnaire.

Table 5.1: Biographical information of participants.

Name	Pseudo name	Age	Gender	Qualifications	Subject	Years of Experience
Anna	A	59	Female	BSc (Hons) Chemistry, HDE	Science	35
Brenda	B	55	Female	BA, HDE	Afrikaans	29
Carol	C	44	Female	BA (FA)	Art	8
Dora	D	33	Female	BEd (Economic & Management Sciences)	Accounting	9
Elize	E	53	Female	MSc (Mathematical Statistics)	Information Technology	17
Fred	F	52	Male	BA, HDE	Geography	30
Gail	G	56	Female	BA, HDE	French	22
Heidi	H	57	Female	BA, HDE	Afrikaans	25
Jill	J	25	Female	BEd (FET) German	German	2
Kevin	K	38	Male	HDE	Engineering, Graphics and Design	15
Liam	L	28	Male	MMus (RNCM), UTLM, Dip (ABRSM)	Music	10
Mary	M	42	Female	BA, HDE	Mathematics	15
Nina	N	55	Female	BA (Hons)	English	28
Owen	O	23	Male	BSec Ed (Science)	Science	1
Pam	P	29	Female	BEd (FET) Natural Sciences	Biology	6

From Table 5.1 it can be said that all the participants have sufficient content knowledge as they all have some level of tertiary education necessary to teach their subject. The experience of participants range from less than ten years' experience (33%), between 10-25 years' experience (33%) and more than 25 years' experience (33%). This throws light on the age of the participant and the era in which they started teaching. What is also of particular importance to note is that since the participants held degrees in their subject and had experience of teaching, it can be assumed that their level of PCK was sufficient and adequate. The study included four males and eleven females. Gender played no role in the study. This criteria was merely to ensure that the school received training for one staff member per learning area (see Section 4.6.1). This added rigour to the study as it was a good way to observe the applications of mobile technology in different learning areas and not only in one specific area.

By running some descriptive statistics on the age and years of experience, it was found that the average age was 43.3 years (standard deviation = 12.98) and the

average years of experience was 16.8 (standard deviation = 10.86). The ages ranged from 23 to 59. The average years of experience being almost seventeen years informs the level of understanding in terms of content and pedagogy allowing for the introduction of technology to teaching and learning.

The data for Phase 2 of the study is analysed and consolidated below. Each instrument is analysed separately to ensure transparency and validity of data.

5.5 Results of Written Questionnaire

Section 2 of the written questionnaire focused on the participant's use of mobile devices and their perceptions of technology use. Table 5.2 illustrates the different technologies used by the participants prior to the mobile learning workshop. This gives an indication of the familiarity of teachers with digital technology skills specifically with the use of a tablet or mobile phone. Twenty four different uses of the mobile device were given. Only the number of uses for the mobile device is given. For the purpose of the tables to follow only the first letter of each participant's pseudonym is given.

Table 5.2: Participant's use of mobile devices.

	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
I use my mobile phone or tablet to:															
• Send/receive emails	X	X	X	X		X	X	X	X	X	X	X	X	X	X
• Send/receive text messages	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
• Listen to music	X	X		X			X		X		X	X	X	X	X
• Watch videos	X	X	X	X		X			X	X	X	X		X	X
• Play games		X	X	X		X	X		X		X	X			X
• Keep up with news, weather, careers		X	X	X		X	X		X	X	X	X	X	X	X
• Take photos	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
• Use the internet	X	X	X	X		X	X	X	X	X	X	X	X	X	X
• Keep up with social media (blogs/twitter/Facebook)		X	X	X		X	X	X	X	X	X		X	X	X
• As a navigator		X		X		X	X		X		X	X	X	X	X
• As a diary/calendar/ for time		X	X	X	X	X	X		X	X	X	X	X	X	
• Take notes/view documents/store files		X	X	X		X	X		X	X	X			X	
• Score keeping during sport									X		X				
• Class register						X								X	
• As an interactive teaching tool		X				X					X				
• As a remote for technical resources		X							X					X	X
• Dropbox		X		X					X		X			X	X
• Skype		X		X			X		X	X	X			X	X
• E-portfolios		X												X	
• Webinars		X												X	
• Scoop it		X													
• Moodle		X	X	X		X								X	
• Where are you now (WAYN)									X						
• Receive calls	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Total uses of technology (24) Average(12.5)	**7**	**17**	**12**	**16**	**4**	**15**	**13**	**6**	**18**	**11**	**17**	**11**	**10**	**17**	**14**

When comparing the years of experience from Table 5.1. to the technology usage in Table 5.2 it is evident that there is higher usage of technology amongst the younger teachers with fewer years of teaching experience and lower technology usage by the older teachers with more teaching experience, for e.g. Jill has two years of teaching experience but uses 18 of the 24 technologies on her mobile device, whereas Anne has 35 years of teaching experience but only uses seven of 24 available technologies. This is supported by Czerniewicz and Brown (2005) in a similar study

that focused on tertiary education and lecturers in South Africa. This highlights the factor age in the adoption process of technology. S.H Liu et al. (2014) explain this as experienced teachers expressing fixed teaching philosophies that lack technological skills.

Since Likert-type items are classified as ordinal data, descriptive statistics such as the mean (for central tendency) and standard deviation (for variability) are not recommended. Descriptive statistics appropriate for ordinal data are the mode or the median (for central tendency) and the frequencies (for variability). Tables 5.3 to 5.14 deal with ICT anxiety, ICT ability and ICT attitude. The participants were given several statements with three possible options to choose from: never (coded as (1)), sometimes (coded as (2)) and always (coded as (3)). The reader is reminded that only the first letter of the participant's pseudonym is given.

Table 5.3: Participants' perception of their own ICT anxiety.

First letter of participant's pseudonym	ICT is difficult to use	ICT frustrates me	I feel insecure about my ability to use ICT	I need someone to show me the best way to use ICT in my teaching	Median (participant)
A	2	3	2	3	**2.5**
B	1	2	2	2	**2**
C		1	1	2	**1**
D	1	1	3	2	**1.5**
E	2	2	1	3	**2**
F	2	2	2	2	**2**
G	2	2	2	3	**2**
H	2	2	2	2	**2**
J	1	1	1	2	**1**
K	1	1	1	1	**1**
L	2	2	2	3	**2**
M	2	2	2	2	**2**
N	3	3	3	3	**3**
O	1	1	1	2	**1**
P	2	1	1	2	**1.5**
Median (item)	**2**	**2**	**2**	**2**	

It should be noted that the statements for ICT anxiety are all negative statements, thus, participants responding *never* (1) have low ICT anxiety and participants responding *always* (3) have high ICT anxiety.

Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. A discussion of the individual responses is summarised. From Figure H1 it can be seen that the majority of participants (8 out of 15) feel that ICT is sometimes difficult to use. This is similar to the findings of Phelps and Ellis (2002) where there a is huge disparity between technological competence and the amount of learning required to use technology effectively. Figure H2 shows that the majority of participants (seven out of fifteen feel that ICT sometimes frustrates them. Similar feelings associated with this are fear of looking foolish, insecurity and inadequacy (Nunan & Wong, 2005). In Figure H3 it can be seen that the majority of participants (seven out of fifteen) feel insecure about their ability to use ICT sometimes. Teachers' perception of their ability to use technology in class plays a crucial role in technology adoption (Albion, 2001; Mac Callum, 2010). If a teacher perceives technology use as easy then the teacher is known to have a high self-efficacy resulting in enjoyment and a feeling of control whilst using technology to teach (Hammond et al., 2011; Sang et al., 2010). From Figure H4 it can be seen that the majority of participants (nine out of fifteen) sometimes need someone to show them the best way to use ICT in their teaching. Teachers often receive training as a once off dissemination of knowledge (Garet et al., 2001) however due to their different ICT abilities some teachers may require on-going support to assist them with the implementation process (Shohel & Power, 2010; Summey, 2013).

Next, individual results of participants are discussed. It is evident that there appears to be some ICT anxiety with Nina (median = 3) having the highest ICT anxiety followed by Anne (median = 2.5). On the other hand, Carol (median = 1), Jill (median = 1), Kevin (median = 1) and Owen (median = 1) and claim to have little to no ICT anxiety. It is important to note that this is teachers' perceived ICT anxiety as they have not started implementing technology in their teaching yet.

Earlier it was mentioned that since Likert-type items are classified as ordinal data, descriptive statistics such as the mean (for central tendency) and standard deviation (for variability) are not recommended. However, Likert scale items, which have an interval measurement scale, can be created by calculating a composite score (which can include an average and/or a sum) for several Likert-type ordinal items. Once this

has been done, descriptive statistics such as the mean (for central tendency) and the standard deviation (a measure of spread) can be computed. Associations can also be investigated using Pearson's correlation coefficients. For example, the correlation between age and years' experience equals 0.907, with a p-value of 0.000003, indicating that the strong positive correlation between these two variables are statistically significant. This is typically the case in most studies, as more experienced teachers would typically be older and less experienced teachers would typically be younger.

For the factor *anxiety*, a composite score was computed for the four items. For this composite score, which is of interval measurement scale, the mean, standard deviation and histogram is given in Figure 5.5. Please note that due to the software used to create these graphs "N" will represent the sample size, even though "n" is more commonly used.

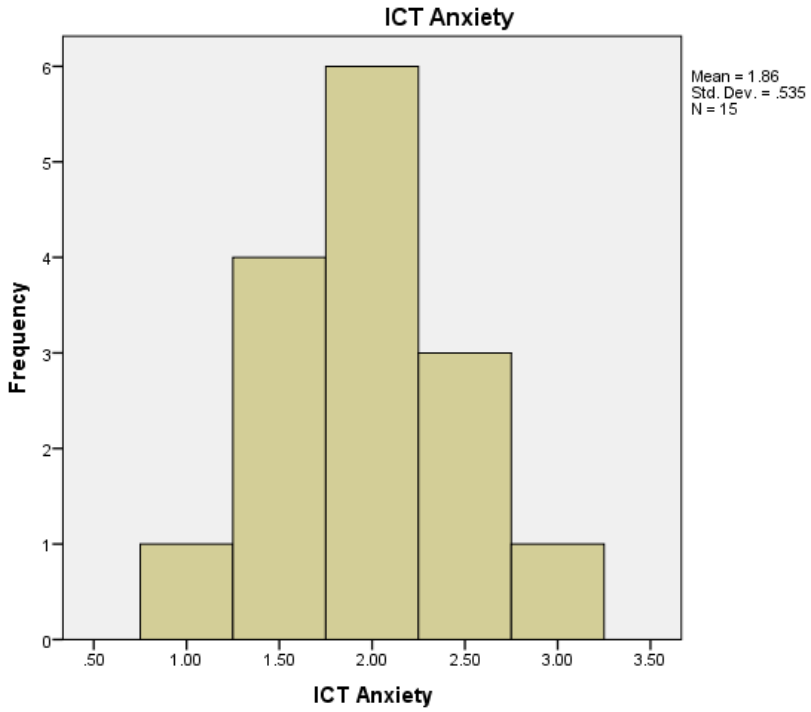


Figure 5.5: Histogram for the composite score of the factor 'anxiety'

From Figure 5.5 It can be seen that the majority of the responses are on the left side of the histogram (causing the histogram to be slightly skewed to the right), indicating that the participants' responses slightly leaned more towards 'never'. This is also

evident from the fact that the mean is less than the midpoint of two. This suggests that the ICT anxiety amongst the teachers is low overall.

Next, the correlation between the participants' age and ICT anxiety and the participants' years of experience and ICT anxiety was considered.

Table 5.4: Correlation between participants' age and ICT anxiety and the participants' years of experience and ICT anxiety.

Variables	Correlation	p-value	Significant
Age & ICT Anxiety	0.611	0.016	Yes, at a 5% level of significance
Years' experience & ICT Anxiety	0.647	0.006	Yes, at a 1% level of significance

In order to see whether there is a correlation between the participants' age, years of experience and ICT anxiety, Pearson correlation coefficients were calculated in SPSS and the output is presented in Table 5.4. It is interesting to note that all correlations are positive, i.e. the older the participants are and the more experience they have, the higher their ICT anxiety is. And vice versa, less experienced teachers will have lower ICT anxiety. This is supported by the studies of (M. Cox, Preston, & Cox, 1999) and (Mueller et al., 2008). The correlation between age and ICT anxiety ($r = 0.611$) is statistically significant at a 5% level of significance ($p\text{-value} = 0.016 < 0.05$) and the correlation between years of experience and ICT anxiety ($r = 0.674$) is statistically significant at a 1% level of significance ($p\text{-value} = 0.006 < 0.01$). Next, the participants' ICT ability is investigated.

Table 5.5: Participants' perception of their own ICT ability.

First letter of participant's pseudonym	I see ICT as tools that can complement my teaching	ICT provides a variety in instruction and in content	ICT allows me to bring current information to the class	ICT provides opportunities for individualised instruction	Median (participant)
A	2	2	2	2	**2**
B	2	2	2	2	**2**
C	2	2	2	2	**2**
D	3	2	2	3	**2.5**
E	3	3	3	2	**3**
F	3	3	3	2	**3**
G	3	3	3	3	**3**
H	2	1	1	1	**1**
J	3	3	3	2	**3**
K	3	2	3	2	**2.5**
L	2	2	3	2	**2**
M	3	2	3	2	**2.5**
N	3	3	3	3	**3**
O	3	3	3	3	**3**
P	3	3	3	2	**3**
Median (item)	**3**	**2**	**3**	**2**	

It should be noted that the statements for ICT ability are all positive statements, thus, participants responding never (1) have low ICT ability and participants responding always (3) have high ICT ability. Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. A discussion of the individual responses is summarised. Figure H5 shows that the majority of participants (10 of 15) always see ICT as tools that can complement their teaching. It is interesting to note that none of the participants responded "never" to this statement and this suggests that the teachers are familiar with technology use. Mac Callum et al. (2014) emphasise that if teachers find teaching with technology to be beneficial they are more likely to put in effort into using it. In Figure H6 it can be seen that there is a tie between the number of participants that stated that ICT provides them with a variety in instruction and in content. The tie is between "sometimes" and "always" (seven participants each) and only one participant stated that ICT never provides a variety in instruction and in content. This again suggests that the teachers understood the pedagogical usefulness of technology in teaching. This is supported by Benedek (2007) and Ding (2010). Figure H7 shows that the majority of participants (10 of 15) feel that ICT always allows them to bring current information into the classroom. This is necessary as it allows the teacher to teach according to the context and use examples that the learners can associate with. Summey (2013) describes this as unique needs in terms of

technology, proficiency, instructional context and learning environment. Van Eck (2006) claims that this is necessary to address the demands of learners by providing multiple streams of information, inductive reasoning, frequent and quick interactions with content, exceptional literacy skills and games that can offer insight to the context. From Figure H8 it can be seen that the majority of participants (10 of 15) stated that ICT sometimes provide opportunities for individualised instruction. This personalised form of instruction is supported by Romrell et al. (2014) and Wu et al. (2012).

From Table 5.5, showing the individual responses, it is illustrated that most participants scored moderate to good ICT ability except for Heidi (median = 1) who claimed to struggle somewhat with ICT. This time Elize (median = 3), Fred (median = 3), Gail (median = 3), Jill (median = 3), Nina (median = 3), Owen (median = 3) and Pam (median = 3) claim to have the highest ICT ability. It is interesting to note that Elize is an IT teacher. Another important aspect is that most of the teachers have the ability to use technology, however it is not evident if they do make use of it in their teaching.

For the factor *ability*, a composite score was computed for the four items. For this composite score, which is of interval measurement scale, the mean, standard deviation and histogram is given in Figure 5.6.

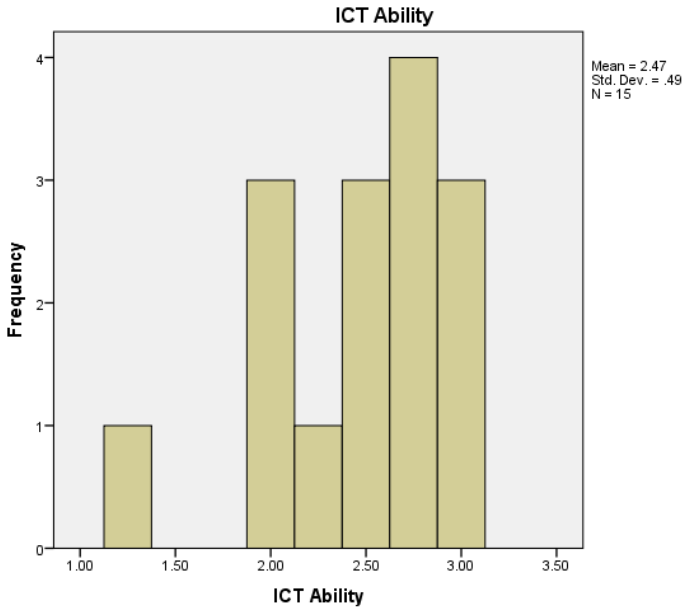


Figure 5.6: Histogram for the composite score of the factor 'ability'

From Figure 5.6 it can be seen that the majority of the responses are spread to the right of the histogram (causing the histogram to be slightly skewed to the left), indicating that the participants' responses slightly leaned more towards 'always'. This is also evident from the fact that the mean is greater than the midpoint of two. Next, the correlation between the participants' age and ICT ability and the participants' years of experience and ICT ability is considered.

Table 5.6: Correlation between participants' age and ICT ability and the participants' years of experience and ICT ability.

Variables	Correlation	p-value	Significant
Age & ICT Ability	-0.324	0.238	No
Years' experience & ICT Ability	-0.297	0.283	No

In order to see whether there is a correlation between the age, years of experience and ICT ability, Pearson correlation coefficients were calculated in SPSS and the output is presented in Table 5.6. The correlation between age and ICT ability is not statistically significant (p-value = 0.238 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and ICT ability in that it is not statistically significant (p-value = 0.283 > 0.05). This is similar to the findings of Teo and Milutinovic (2015) and (Teo et al., 2011) and can be attributed to the global trends within societies where males and females have equal opportunities to be exposed to the access of learning with technology.

Next, the participants' attitude towards ICT is investigated. For Table 5.7 the reader is reminded that the coding is as follows: never (coded as (1)), sometimes (coded as (2)) and always (coded as (3)).

Table 5.7: Participants' attitude towards ICT (original data).

First letter of participant's pseudonym	I feel frustrated more often when I use ICT in my class than when I don't use it	I have positive ICT experiences in my classroom	I had positive experiences with computers previously	I feel I am trained well enough to use a variety of ICT tools when teaching
A	2	2	2	
B	2	2	2	2
C	1	1	1	1
D	2	2	3	2
E	2	1	3	2
F	2	1	2	2
G	2	2	2	1
H	1	1	1	1
J	1	3	2	2
K	1	3	3	3
L	2	2	2	2
M	1	3	3	1
N	3	2	3	1
O	1	3	3	3
P	1	3	3	3

Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. This will be followed by a discussion on the individual responses. A discussion of the individual responses is summarised. Figure H9 shows that there is a tie between the number of participants when answering a statement about frustration and ICT. The tie is between "never" and "sometimes" (seven participants each) with only one participant stating that he/she is always frustrated when ICT is used in the classroom. Frustration with ICT is often coupled with ICT ability and determines the use of technology (Nunan & Wong, 2005). However it is not clearly indicated in the data if the teachers that have ICT anxiety are the same teachers that have poor ICT ability. In Figure H10 it can be seen that the majority of participants (6 of 15) stated that they sometimes have positive experiences with ICT in their classrooms. This is closely followed by "always" (5 of 15) and "never" (4 of 15). Positive experiences of ICT are dependent on several factors that are necessary for 21st century teaching. This is elaborated on by Tondeur et al. (2013) and Anderson et al. (2005). From Figure H11 it can be seen that the majority of participants (7 of 15) stated that they always had positive experiences with computers previously. This is closely followed by sometimes having positive experiences (6 of 10). The self-efficacy of a teacher is often determined by their past experiences in computers which in turn will result in their use of technology (Albion, 2001; Sang et al., 2010). Figure H12 shows that the majority of participants (6 of 15) stated that they only sometimes feel that they are trained well enough to use

a variety of ICT tools when teaching. Surprisingly five of the fifteen participants responded that they never feel trained enough. This can be substantiated by the findings of Lee and Lee (2014) and Liu et al. (2014) as teaches may receive training however the training does not provide the opportunity to apply the knowledge nor are the courses consistent in terms of content. Ally, Grimus, and Ebner (2014) explain that training needs to include formal and informal instruction, mentoring, opportunities for collaboration and teamwork, on-going support, online courses, constructive feedback, flexibility of training sessions with regards to time and place and it needs to be frequent.

In order to compute an interpretable median, the one statement that is negatively phrased, i.e. “I feel frustrated more often when I use ICT in my class than when I don’t use it” had to be reversed scored. This is illustrated in Table 5.8 where the medians are also presented.

Table 5.8: Participant’s attitude towards ICT (one variable reverse scored).

First letter of participant’s pseudonym	I feel frustrated more often when I use ICT in my class than when I don’t use it	I have positive ICT experiences in my classroom	I had positive experiences with computers previously	I *feel I am trained well enough to use a variety of ICT tools when* teaching	Median (participant)
A	2	2	2		**2**
B	2	2	2	2	**2**
C	3	1	1	1	**1**
D	2	2	3	2	**2**
E	2	1	3	2	**2**
F	2	1	2	2	**2**
G	2	2	2	1	**2**
H	3	1	1	1	**1**
J	3	3	2	2	**2.5**
K	3	3	3	3	**3**
L	2	2	2	2	**2**
M	3	3	3	1	**3**
N	1	2	3	1	**1.5**
O	3	3	3	3	**3**
P	3	3	3	3	**3**
Median (item)	**2**	**2**	**2**	**2**	

In Table 5.7 participants that held a positive attitude towards ICT use, scored closer to three whereas participants that had negative attitudes towards ICT use, scored closer to one. Kevin (median = 3), Owen (median = 3) and Pam (median = 3) display positive attitudes towards ICT use whereas Carol (median = 1) and Heidi (median = 1) display negative attitudes toward ICT use. It is interesting to note that Carol claims

she has little to no ICT anxiety yet she has a negative attitude towards using technology.

For the factor *attitude*, a composite score was computed for the four items. For this composite score, which is of interval measurement scale, the mean, standard deviation and histogram are given in Figure 5.7.

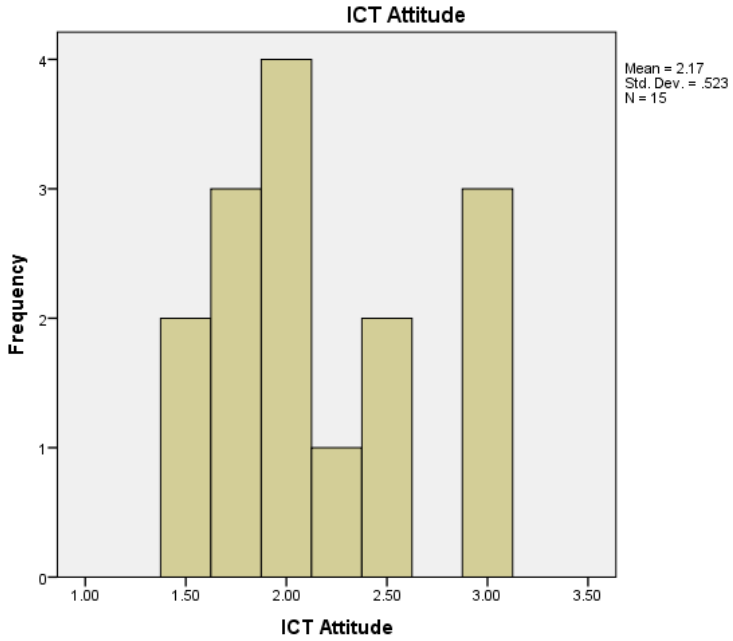


Figure 5.7: Histogram for the composite score of the factor 'attitude'

Since the shape of the histogram in Figure 5.7 Is difficult to interpret, we focus mainly on the mean. The fact that the mean is greater than the midpoint of two shows that the responses of the participants leaned slightly more to 'always'. Next, the correlation between the participants' age and attitude towards ICT and the participants' years of experience and attitude towards ICT is considered.

Table 5.9: Correlation between participants' age and attitude towards ICT and the participants' years of experience and attitude towards ICT.

Variables	Correlation	p-value	Significant
Age & ICT Attitude	-0.711	0.003	Yes, at a 1% level of significance
Years' experience & ICT Attitude	-0.575	0.025	Yes, at a 5% level of significance

In order to see whether there is a correlation between the participants' age, years of experience and attitude towards ICT, Pearson correlation coefficients were calculated in SPSS and the output is presented in Table 5.9. It is interesting to note that the correlation between age and attitude towards ICT ability is negatively

correlated and significant (r = -0.711, p-value = 0.003), thus, the older the participant, the more negative their attitude is towards ICT. Vice versa, the younger the participant, the more positive attitude they have. Younger teachers are often more proficient in technology use and they tend to hold a more positive attitude towards technology use (Mac Callum et al., 2014). The correlation between years of experience and attitude towards ICT is also negative and significant (r = -0.575, p-value = 0.025) indicating that the more experienced you are, the more negative the attitude. Vice versa, the more inexperienced teachers have a more positive attitude towards ICT.

Tables 5.10 to 5.14 reflect specifically the perceived usefulness and perceived ease of use of mobile technology that the teachers had before the course. Three options were given: disagree (coded as (1)), neutral (coded as (2)) and agree (coded as (3)).

Table 5.10: Participants' perceived usefulness of mobile technology.

First letter of participant's pseudonym	Mobile technology will make teaching and learning more interesting	I see ML as a way of encouraging more interaction between teachers and learners	I see ML as a way to improve student learning as it allows students to access learning content anywhere and anytime	I see ML as a way to enhance / encourage my students' self-directed learning	Median (participant)
A	3	3	3	2	**3**
B	3	3	3	3	**3**
C	3	2	3	3	**3**
D	3	3	3	3	**3**
E	2	3	3	2	**2.5**
F	3	3	3	3	**3**
G	3	3	3	3	**3**
H	3	3	3	3	**3**
J	3	2	3	3	**3**
K	3	2	2	1	**2**
L	3	3	2	2	**2.5**
M	3	3	3	3	**3**
N	3	3	3	3	**3**
O	3	3	3	3	**3**
P	3	3	3	3	**3**
Median (item)	**3**	**3**	**3**	**3**	

Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. A discussion of the individual responses is summarised. In Figure H13 it can be seen that almost all of the participants (all except for one) agreed that mobile technology makes teaching and learning more interesting. These are similar to the findings of Venkatesh et al. (2003a) and Mac Callum et al. (2014). Figure H14 shows that the majority of participants (12 of 15) agreed that they see mobile learning as a ways of encouraging more interaction between teachers and learners. This is supported by the studies of Nias (1989) and Haddad and Draxler (2002). In Figure H15 it can be seen that the majority of participants (13 of 15) agreed that they see mobile learning as a way to improve student learning as it allows students to access learning content at any time and at any place. The importance of this is emphasised by Rajasingham (2011) and Derakhshan and Khodabakhshzadeh (2011). Figure H16 shows that the majority of participants (11 of 15) agreed that they see mobile learning as a way to enhance and

encourage their students' self-directed learning. This is supported by Lee, Tsai, Chai, and Kph (2014).

Table 5.11 emphasises the participant's perceived usefulness of mobile technology. Participants scoring closer to three believe that mobile technology is beneficial and those scoring closer to one believe that it is not beneficial. It is evident that, at the onset of the study, participants perceived mobile technology to be useful in teaching and learning to enhance learner activity and encourage and promote self-directed learning. In Table 5.11 a similar pattern is found where the responses of the majority of participants have a median value of three.

For the factor *perceived usefulness*, a composite score was computed for the four items. For this composite score, which is of interval measurement scale, the mean, standard deviation and histogram is given in Figure 5.8.

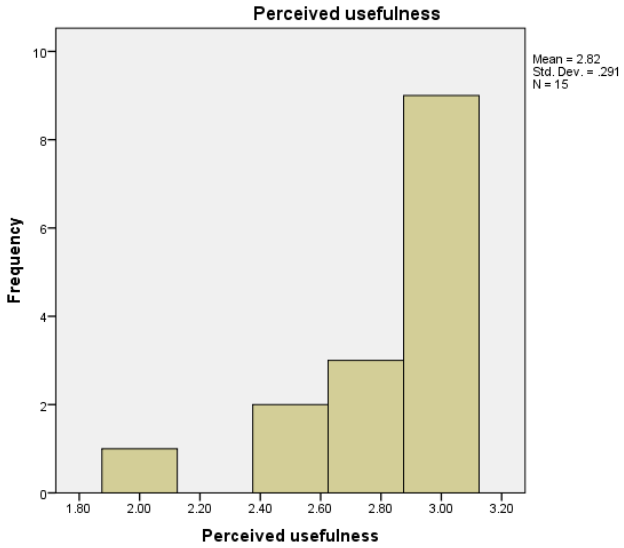


Figure 5.8: Histogram for the composite score of the factor 'perceived usefulness'

From Figure 5.8 It can be seen that the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree'. This is also evident from the fact that the mean is greater than the midpoint of two.

Next, the correlation between the participants' age and perceived usefulness of mobile technology and the participants' years of experience and perceived usefulness of mobile technology is considered.

Table 5.11: Correlation between participants' age and perceived usefulness of mobile technology and the participants' years of experience and perceived usefulness of mobile technology.

Variables	Correlation	p-value	Significant
Age & Perceived usefulness	0.160	0.568	No
Years' experience & Perceived usefulness	0.146	0.604	No

From Table 5.11 it can be seen that there is no significant correlation between age and perceived usefulness of mobile technology nor between the participants' years of experience and perceived usefulness of mobile technology. Next the perceived ease of use is considered. This is similar to the findings of Czerniewicz and Brown (2005).

Table 5.12: Participants' perceived ease of use of mobile technology (original data).

First letter of participant's pseudonym	I would be anxious about having to use my mobile device to support my teaching	I think it might take me a while to get comfortable with using a mobile device for teaching	I believe I would find it easy to use a mobile device to support my teaching	I feel that I would have the knowledge necessary to implement and use mobile technology in my teaching	I would be anxious about having to use my mobile device to help support my teaching
A	3	3	1	1	3
B	2	2	3	2	2
C	1	1	3	3	1
D	1	1	2	3	1
E	2	3	2	2	3
F	1	2	3	2	1
G	2	3	2	2	2
H	3	3	1	1	1
J	1	2	3	3	1
K	1	1	3	3	1
L	1	2	2	1	2
M	1	1	3	3	1
N	1	3	3	3	3
O	1	1	3	3	3
P	1	2	3	3	1

Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. A discussion of the individual responses is summarised. From Figure H17 it can be seen that the majority of participants (10 of 15) disagreed that they would be anxious about having to use their mobile device to support their teaching. Teo, Lee, and Chai (2008) argue that anxiety is one of the greatest factors that impact on the perceived ease of use of technology. In Figure H18 it can be seen that there is a tie across all categories for the statement that it might take a while to get comfortable with using a mobile device for teaching. This is a necessity in order for teachers to use technology more

frequently and its supported by Summey (2013) and Chuttur (2009). Figure H19 shows that the majority of participants (9 of 15) believed that they would find it easy to use a mobile device to support their teaching. Teachers need to believe that technology will support their teaching and this belief is shaped by their perception of how easy it is to use, as per Mac Callum et al. (2014). In Figure H20 it can be seen that the majority of participants (8 of 15) felt that they have the knowledge necessary to implement and use mobile technology in their teaching. Teachers that show consistency in their own professional development often have the confidence and knowledge to implement technology in their teaching (Crosswell & Beutel, 2017; Mansfield et al., 2016). From Figure H21 it can be seen that the majority of participants (8 of 15) would not be anxious about having to use their mobile devices to support their teaching. This suggested that these teachers are not reluctant to use technology to teach (McClure, 2011).

In order to compute an interpretable median, the three statements that are negatively phrased, i.e. “I would be anxious about having to use my mobile device to support my teaching”, “I think it might take me a while to get comfortable with using a mobile device for teaching” and “I would be anxious about having to use my mobile device to help support my teaching” had to be reversed scored. This is done in Table 5.13 where the medians are also now presented.

Table 5.13: Participants' perceived ease of use of mobile technology (three variables reverse scored).

First letter of participant's pseudonym	I would be anxious about having to use my mobile device to support my teaching	I think it might take me a while to get comfortable with using a mobile device for teaching	I believe I would find it easy to use a mobile device to support my teaching	I feel that I would have the knowledge necessary to implement and use mobile technology in my teaching	I would be anxious about having to use my mobile device to help support my teaching	Median (participant)
A	1	1	1	1	1	**1**
B	2	2	3	2	2	**2**
C	3	3	3	3	3	**3**
D	3	3	2	3	3	**3**
E	2	1	2	2	1	**2**
F	3	2	3	2	3	**3**
G	2	1	2	2	2	**2**
H	1	1	1	1	3	**1**
J	3	2	3	3	3	**3**
K	3	3	3	3	3	**3**
L	3	2	2	1	2	**2**
M	3	3	3	3	3	**3**
N	3	1	3	3	1	**3**
O	3	3	3	3	1	**3**
P	3	2	3	3	3	**3**
Median (item)	**3**	**2**	**3**	**3**	**3**	

For Table 5.13 participants needed to score closer to three to show that they found using mobile technology to be easy and free from effort and score closer to one to show that they found mobile technology to be difficult to use. It can be seen that the majority of participants find mobile technology easy to use with the only exception being Anne (median = 1) and Heidi (median = 1) who seem to find mobile technology difficult to use.

For the factor *perceived ease of use*, a composite score was computed for the four items. For this composite score, which is of interval measurement scale, the mean, standard deviation and histogram are given in Figure 5.9.

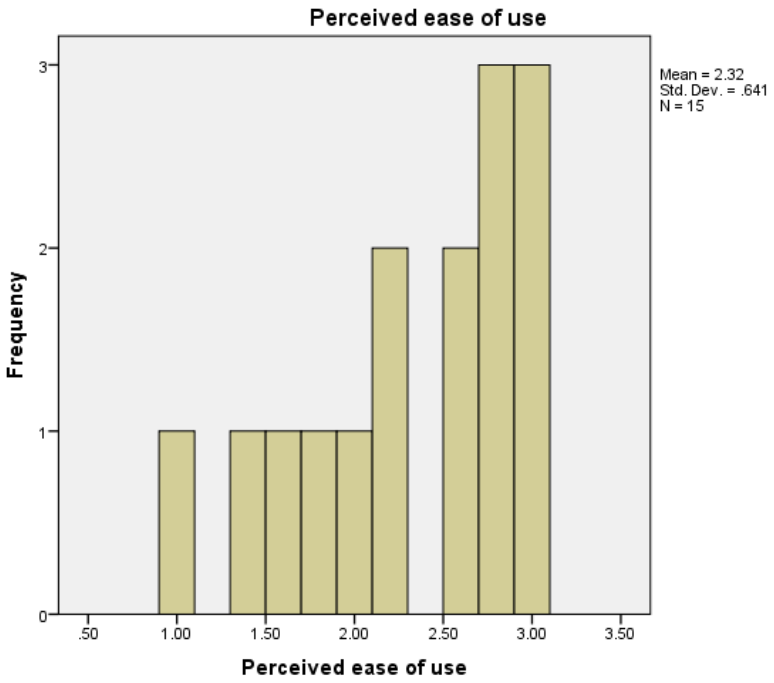


Figure 5.9: Histogram for the composite score of the factor 'perceived ease of use'

From Figure 5.9 it can be seen that the majority of the responses are distributed towards the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree'. This is also evident from the fact that the mean is greater than the midpoint of two. Next, the correlation between the participants' age and perceived usefulness of mobile technology and the participants' years of experience and perceived ease of use of mobile technology is considered.

Table 5.14: Correlation between participants' age and perceived ease of use of mobile technology and the participants' years of experience and perceived ease of use of mobile technology.

Variables	Correlation	p-value	Significant
Age & Perceived ease of use	-0.624	0.013	Yes, at a 5% level of significance
Years' experience & Perceived ease of use	-0.619	0.014	Yes, at a 5% level of significance

In order to see whether there is a correlation between the age, years of experience and perceived ease of use of mobile technology, Pearson correlation coefficients were calculated in SPSS and the output is presented in Table 5.14. It is interesting to note that the correlation between age and perceived ease of use of mobile technology is negatively correlated and significant (r = -0.624, p-value = 0.013), thus, the older the participant, the more difficult they find it to use technology. Vice versa -

the younger the participant, the easier they find it. The correlation between years of experience and perceived ease of use of mobile technology is also negative and significant (r = -0619, p-value = 0.014) indicating that the more years of experience a participant has, the more difficult they find it to use technology. Vice versa - the more inexperienced teachers find it easier to work with technology.

Overall, it is interesting to see that Anne has a neutral attitude towards technology use, she displays high ICT anxiety and she finds technology difficult to use. Carol on the other hand shows low ICT anxiety, a negative attitude towards technology use even though she finds it easy to use and useful. Kevin finds technology easy to use and has a positive attitude, with no anxiety and high technology ability but is unsure of its usefulness.

5.6 Results of Part 1- Reflective Journal

The workshop was carried out over three days by an expert in the field. Aspects that were covered involved, how to use a mobile device, generic apps for teaching, subject specific apps, technology integration in teaching, some useful theory and examples of how to transform and enhance lessons. A summary of each teacher will be given based on the reflective journal.

Anne

Anne became very discouraged, frustrated and demotivated during the workshop. She cried every day because she was unable to do the activities and felt she could not keep up with the rest of the participants. She complained because she was unable to use her tablet and tended to discourage those around her. She showed signs of wanting to use the technology but great difficulty in using the technology. She did not seem open to change in terms of using a mobile device to teach even though she received help form Fred. She felt she needed constant individual assistance.

Brenda

Brenda seemed excited and eager to use the technology. She displayed a positive attitude throughout the workshop thinking of ways that she could use the tablet in the library and offer guidance to the learners. She loved playing around and looking for

apps for different subjects and showed a sound knowledge of computer related technology.

Carol

Carol had an eager and excited attitude throughout the workshop. She interacted in discussions explaining how technology lends itself to art and how she could incorporate it into her lessons. She already uses certain aspects of technology and maintains this positive attitude throughout the workshop.

Dora

Dora is passionate and knowledgeable about her subject. She is eager and ready to learn how she can incorporate technology into her subject. She has found accounting apps that she would like to try and she understands the planning that is required for the lessons. She has a positive attitude and is ready to try it out.

Elize

Elize is interested to find out how she can use technology in her lessons. She does feel that technology lends itself more to some subjects than others. She gives positive feedback during discussions but she is concerned that she may not be able to use it in IT. She raises the issues of Wi-Fi and learners' difficulties of completing tasks on a tablet and different software. She has a positive attitude and willing to try but is concerned about their software programming.

Fred

Fred is the most enthusiastic and positive participant, sharing ideas, helping others and eager to learn. He is passionate about his subject and about technology use. Fred already uses technology in most of his lessons but not mobile technology. He manages to complete all the tasks easily and motivates those around him to participate and keep trying. He shares his experiences and explains what he learnt and how he will adapt and change his lessons. He speaks of flipped classrooms and his belief that it is the way forward for teaching and how technology lessons need to be carefully structured. He cannot wait to try out all that he has learnt.

Gail

Gail was anxious and less confident about her ability to use a tablet to teach. She is concerned that her age and ability may hinder her progress. With the help of Kevin she managed to complete all the tasks and maintained a positive attitude throughout the workshop and is eager and willing to try to do her own lesson with mobile technology. Her only concern is that she remembers how to use the apps when she is in class.

Heidi

Heidi is excited and willing to try. She is unsure about her ability in ICT use but with assistance from Kevin she was able to complete all the tasks. She is also worried about whether she will remember how to use the apps and is interested to see how her learners respond. She has a positive attitude.

Jill

Jill completed all the tasks with ease. She was attentive, constantly taking notes on various activities she could do. She offers sufficient feedback in the sessions and participates in the discussions. She has a positive attitude throughout the workshop.

Kevin

Kevin has a sound knowledge of technology use and tablet use. He is eager and offers help to those around him. He encourages the others and maintains an enthusiastic attitude throughout the workshop. He is motivated and ready to implement tablet use and thinks the learners will enjoy it.

Liam

Liam seems positive but only responds if probed. He found music apps for teaching music theory but it isn't clear as to whether he will in fact use the apps.

Mary

Mary believes that technology is the way to go. She is enthusiastic and willing to learn. She is concerned about how to use it in her subject and is hoping to be able to use the apps in her mathematics teaching. She maintains a positive attitude but it

appears that she will use technology more for homework and assignments and not actual classroom use.

Nina

Nina is excited and eager to participate but struggles to use her tablet. She becomes easily discouraged and struggles to complete activities. She becomes disinterested but seems more confident if she uses her laptop instead. She is interested to see how her learners respond to technology use and is willing to try. Nina wants to find an app to create speech bubbles and comic strips so that her learners can make their own comics.

Owen

Owen is the youngest and completes all the tasks with ease. He finds the workshop to be a bit slow paced and finds more apps. He immediately thinks of how he will use it in class and wants to find an electricity app.

Pam

Pam has a positive attitude and is anxious to share her knowledge with the members in her department. She takes notes and finds it easy to use her tablet and complete all the tasks. She is eager to use mobile technology.

5.7 Findings - Phases 2

At the end of Phase 2 it can be said that attitude and voluntariness are necessary for technology adoption as evident from the participant's behaviour and interaction during the mobile learning workshop **(P1)**. Anne is the only participant that seems to have had a negative attitude and she is also the oldest participant. She scored for low perceived ease of use of mobile technology but low ICT anxiety which is clearly the opposite of what occurred during the workshop. Heidi, Gail and Nina want to try but they struggle with using a tablet, however Heidi is the only one that claims to have low ICT ability as shown in Table 5.5. Heidi displays a low ICT attitude in Table 5.7. In Table 5.12 Nina perceived mobile technology as easy to use yet she struggles to actually use it during the workshop bringing in an aspect of teaching self-efficacy as mentioned by Mac Callum et al. (2014). Liam, Elize and Mary seem uncertain about how to use technology in their subject. One could say that factors such as attitude,

behaviour, ICT anxiety, ICT ability/digital literacy, and teacher self-efficacy/perceived ease of use and perceived usefulness play a vital role in mobile technology adoption.

The findings from the written questionnaire and reflective journal can be summarised as follows:

Table 5.2 indicates that teachers are familiar with technology use. This confirms that it may be possible that they use some of this knowledge in their teaching suggesting TPK **(T1)** and TCK **(T3)**. Table 5.1 indicates that the teachers have teaching experience and the appropriate qualifications. This confirms that there is a level of TPK (experience) **(T4)** and TCK (qualifications) **(T5)**. Essentially TK and all its components create TPCK **(T2, T4, T5)**.

The reflective journal suggests that teachers that use technology in their teaching do so just to enhance the lesson (E.g. Fred, Kevin) **(T6)**. Fred clearly expresses that if TPK and TCK are used it is possible to somewhat transform lessons **(T7, T9)**. The discrepancy between the four levels of the SAMR, brought about the deduction of Transformation and Enhancement. This was drawn from the reflections of Brenda, Carol, Fred, Gail, Kevin, Nina and Owen. Table 5.3 shows the relationship between Attitude, Anxiety and Ability with the perceived ease of use and perceived usefulness **(T13, T14, T15, T16)**. The effect of ICT attitude on perceived ease of use and perceived usefulness is further confirmed by Carol, Elize, Gail, Fred, Jill, Kevin, Liam and Nina. The effect of ICT anxiety on perceived ease of use and perceived usefulness is confirmed by Anne, Brenda, Carol and Gail. The effect of ICT ability is confirmed by Fred, Owen, Jill and Pam. In order for lessons to be transformed teachers needed to find technology easy to use and useful (Fred, Kevin, Owen) **(T11, T12)**. However to enhance lessons teachers needed to find technology easy to use (Brenda, Carol Gail, Nina) **(T10)**. H4, H11 and H12 recognise factors of facilitating conditions, subjective norm and voluntariness. These factors were not considered in Phase 2's design of the Framework as more evidence was needed to confirm their impact.

Table 5.15: Data analysis of written questionnaire

Histogram	Relationship	Framework code
H1	Anxiety → PEU	**T14,T16**
H2	Anxiety → PEU → PU	**T14,T16**
H3	Ability → Anxiety → PEU	**T14, T15**
H4	SN → PU	
H5	Ability → PEU → PU	**T14, T16**
H6	PEU → PU	**T16**
H7	Ability → PEU → PU	**T14, T16**
H8	PEU → PU	**T16**
H9	Ability → PEU	**T15**
H10	Ability → PEU → PU	**T14, T16**
H11	Voluntariness → PU	
H12	FC and SN → PU	
H13	Attitude → PEU → PU	**T13, T16**
H14	Attitude → PEU → PU	**T13, T16**
H15	Attitude → PEU → PU	**T13, T16**
H16	Attitude → PEU → PU	**T13, T16**
H17	Anxiety → PEU → PU	**T14,T16**
H18	Anxiety → PEU → PU	**T14,T16**
H19	PEU → PU	**T16**
H20	Ability → PEU → PU	**T14, T16**
H21	Ability → PEU → PU	**T14, T16**

These results lead to the development of Framework 1.

5.8 Professional Teacher Technical Identity Development – Framework 1

Framework 1 represents only the technology aspects of the TPCK model as this was the addition to the original PCK. It was found that implementing technology, pedagogy and content caused such an overlap that in order to use technology in teaching effectively, it would not be possible to separate the one from the other. This was identified in the reflective journal and observed during the mobile learning workshop. The SAMR model which comprised of four levels was reduced to transformation of teaching and enhancement of teaching as the relationship between substitution and augmentation, and modification and redefinition was so close that teachers battled to decide which level they were on. This was evident during the mobile learning workshop as the teachers struggled to decide if they were doing mere substitution or if there was functional improvement and the lesson was augmented.

They also could not identify if they were modifying with significant task redesign or they were redefining the task so that it could not be done without the use of technology. It was easier to decide if they used technology to enhance their lesson or to transform the lesson completely. The enhancement of a lesson was dependent on the perceived ease of use of technology.

Figure 5.10 illustrates three factors that affected the ease of use of technology, these are Attitude, Anxiety and Ability. These three aspects determined to what extent lessons would be enhanced because if the teacher had difficulty using technology (ability), was anxious to use technology (anxiety) or had a negative attitude towards technology (attitude) he/she would not opt to use it. This was evident from the scores of the written questionnaire. Teachers that held positive attitudes, had good ICT ability, poor ICT anxiety and found it easy to use technology (E.g. Brenda, Fred, Jill). Teachers that found it difficult to use technology, either held a negative attitude, had high ICT anxiety or low ICT ability (E.g. Anne, Nina and Heidi). If the teacher found it easy to use the technology, had a positive attitude, with high ICT ability and no anxiety he/she would find the technology useful and would be urged to transform their lessons and hence use the technology more. The more easily they found the technology to use the more likely they were to use technology and use technology at a higher level. This was evident in Fred and Owen. If they were unsure about the usefulness of the technology as seen in the scores of Kevin and the reflection of Elize, they were less likely to use technology at a higher level but rather just to enhance their lessons. Figure 5.10 illustrates the new Framework 1 following Phase 2 of the research study.

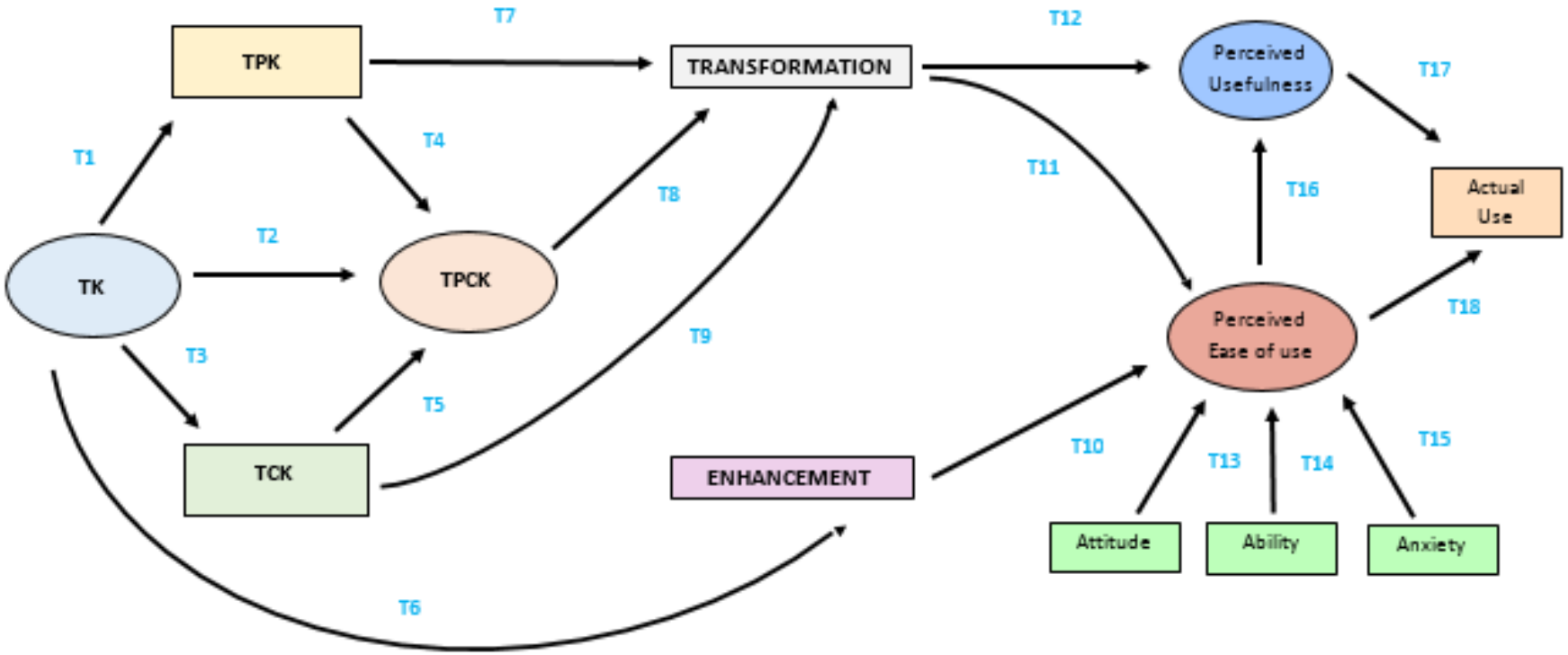


Figure 5.10: Professional Teacher Technical Identity Development Framework 1.

Phase 3

The third Phase of the study commenced with the **Diagnosing** of a new problem being implementation through integration. From the data collected in Phase 2 it was now necessary to investigate if the teachers maintained their perceptions of technology use or whether these perceptions changed as they started to integrate technology into their teaching. The findings of facilitating conditions, subjective norm and voluntariness were also explored. Five week focus group discussions **(P2)** and instruments were **Planned**. This intervention was necessary as it provided technical and pedagogical support to the teachers (Blignaut et al., 2010), tried to identify if teachers resistance to technology changed due to their socio context and beliefs (McClure, 2011), allowed for implementation through integration (Nkula & Krauss, 2014) and to identify the actual use of technology if teachers had all the infrastructure available (Makoe, 2013). During this time the data collected was in the form of an online questionnaire, a reflective journal, lesson reflections and focus group discussions and semi structured interviews with four of the participants to confirm the data obtained in the previous two Phases. The online questionnaire was broad and aimed to find any other factors that influenced technology acceptance as the teachers started implementing it. A reflective journal was kept to confirm data that was received from the focus group discussions and from the lesson reflections. The lesson reflections allowed the teachers to do self-reflection and also included any important data that was not mentioned in the focus group discussions. The focus group discussions provided a community of practice where the teachers could share their experiences and find meaningful ways to assist one another in the implementation process. The **Action** of facilitating the focus group discussions, incorporating all the data obtained and developing the next **Framework 2** was done. Further **Evaluation** was done to assess the identity development of four teachers that were interviewed at the end of the study to ensure that the Framework incorporated all aspects of professional teacher technical identity development.

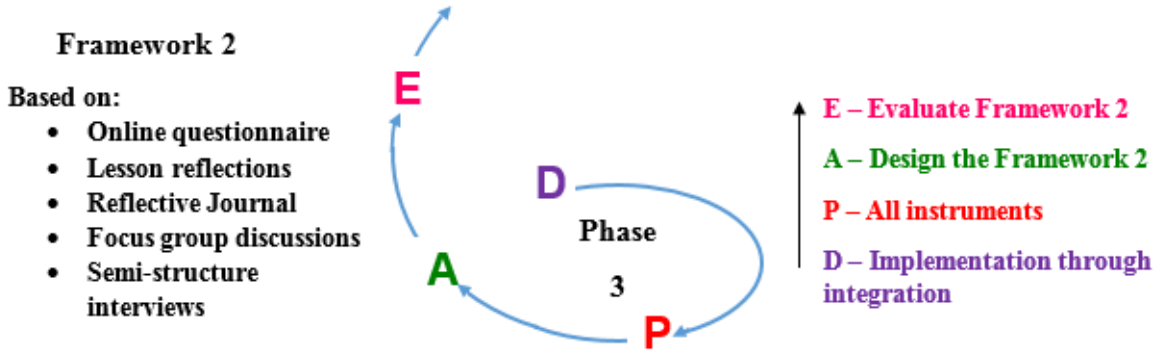


Figure 5.11: Phase 3 of Research design.

5.9 Analysis of Online questionnaire

An online questionnaire was completed during the focus group discussion sessions to identify any pattern or change in the response of the participants as they started the implementation process. The questionnaire consisted of several questions which included as many aspects as possible from the literature that could influence the adoption of mobile technology. These questions ranged from the teachers' perception of mobile technology use, how they used technology, what support they received, which resources were available to them and most importantly how implementation of mobile technology has changed their teacher identity. The aim of such a broad scope of questioning was to bring together all aspects of teaching from planning and preparing to delivery and reflection.

The first section of questions was based on biographical information of the participants to help the researcher identify which participants had completed the questionnaire. The second section consisted of scaled questions. These questions aimed to get a general idea of teachers' perceptions or ideas of teaching with technology.

5.9.1 Section 2

A summary of the responses for Section 2 of the online questionnaire is given in Table 5.16. Thirteen participants completed Section 2. It is important to note that only ten of the fifteen participants completed the whole questionnaire. Many of the teachers that did not complete the questionnaire are resistant to change and find the

traditional methods to work well. This does not imply that they do not find technology useful or easy to use but rather just not necessary.

Table 5.16: Participant's responses to the online questionnaire – Section 2.

Question:	Responses:					
	Strongly disagree	Disagree	Neither agree nor Disagree	Agree	Strongly Agree	Total
Using technology will improve my work				5	8	13
Technology make work more interesting			1	4	8	13
My interaction with technology is clear and understandable			1	10	2	13
When I need help with technology, specialized instruction is available to help me		2	5	4	2	13
Working with technology is fun		1	1	5	6	13
I find it easy to get technology to do what I want it to do		1	2	7	3	13
Using technology will increase my productivity		1		8	4	13
I find technology easy to use			3	5	5	13
When I need help to use technology, a specific person is available to provide assistance	2		1	10		13
People whose opinions I value will encourage me to use technology			3	8	2	13
I like using technology				8	5	13
Using technology will enhance my effectiveness			2	5	6	13
When I need help to use technology, guidance is available to me		1	4	8		13
I find technology a useful tool in my work			1	6	6	13
I look forward to those aspects of my job that require me to use technology			1	6	6	13
I use technology often during the week				4	9	13
When something goes wrong on the technology, I can figure out how to fix it			4	7	2	13
I could complete a task using technology if someone showed me how to do it		1	1	8	3	13
I like the idea of using technology during my classes				7	6	13
I plan to use technology much more in future			1	6	6	13
Time spent to figure out how technology works, is worthwhile		1	1	8	3	13
Time spent to prepare to use technology in class is worthwhile		1	2	7	3	13
The management team of the institution is supportive and enthusiastic about the implementation of technology			2	8	3	13

Bar graphs of the frequencies per statement are presented in Appendix H, since the frequencies give us some measure of variability in Likert-type data. A discussion of the individual responses is summarised below. For questions 2.1 to 2.23 on Questionnaire 2 the participants had to choose options from a 5-point Likert-scale.

1 = Strongly disagree

2 = Disagree

3 = Neither agree nor disagree

4 = Agree

5 = Strongly agree

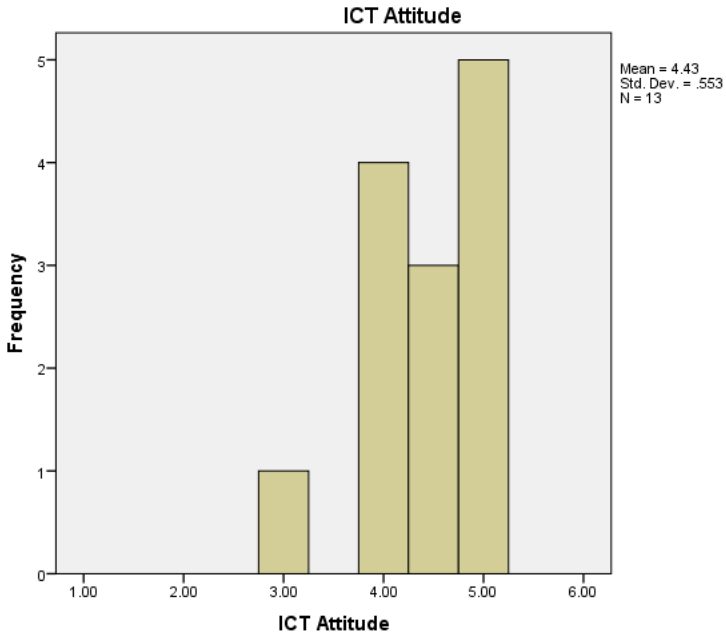


Figure 5.12: Histogram for composite scores of the factor "Attitude"

From Figure 5.12 it appears as if the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint value of three. This suggests that the participants overall attitude towards ICT use was positive. Figure H22, H23, H26, H32 and H36 provide a more detailed representation of the responses for each question linked to attitude.

Recall that composite scores are computed for all the items associated to the same factor. For this composite score, which is of interval measurement scale, correlations can be found with age and years' of experience using a Spearman correlation coefficient.

A composite score was computed for the five items (Questions 2.1, 2.2, 2.5, 2.11 and 2.15) for the factor "ICT attitude". In order to see whether there is a correlation between the age, years of experience and ICT attitude, Spearman correlation coefficients were calculated in SPSS. The output is presented in Table 5.17.

Table 5.17: Participants perception of their own ICT Attitude.

Variables	Correlation	p-value	Significant
Age & ICT Attitude	0.290	0.337	No
Years' experience & ICT Attitude	0.253	0.405	No

The correlation between age and ICT attitude is not statistically significant (p-value = 0.337 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and ICT attitude in that it is not statistically significant (p-value = 0.405 > 0.05).

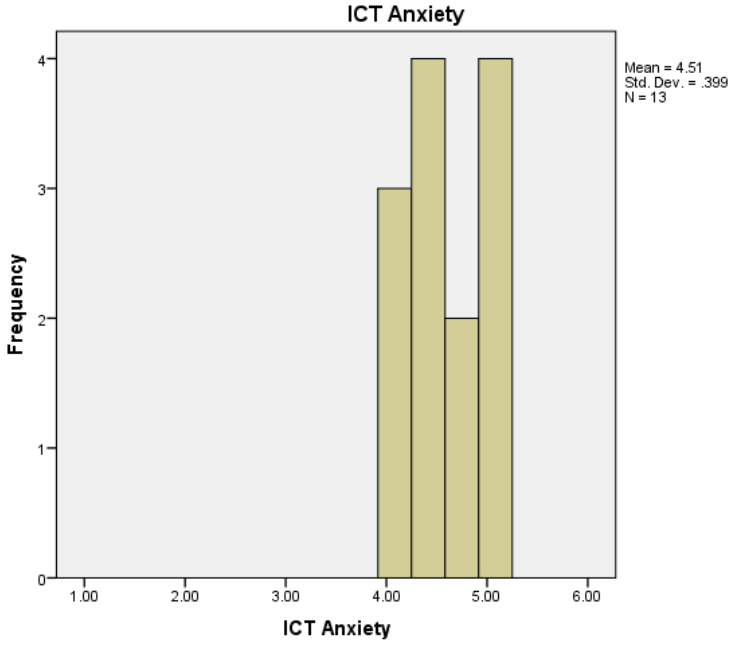


Figure 5.13 Histogram for composite score of the factor "Anxiety"

From Figure 5.13 it can be seen that the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that the participants overall ICT anxiety was low. Figure H32, H37, H40 provide a more detailed representation of the responses for each question linked to anxiety.

For the factor ICT anxiety, a composite score was computed for the three items (Questions 2.11, 2.16 and 2.19). In order to see whether there is a correlation between the age, years of experience and ICT anxiety, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.18.

Table 5.18: Participants perception of their own ICT Anxiety.

Variables	Correlation	p-value	Significant
Age & ICT Anxiety	0.230	0.449	No
Years' experience & ICT Anxiety	0.202	0.508	No

The correlation between age and ICT anxiety is not statistically significant (p-value = 0.449 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and ICT anxiety in that it is not statistically significant (p-value = 0.508 > 0.05).

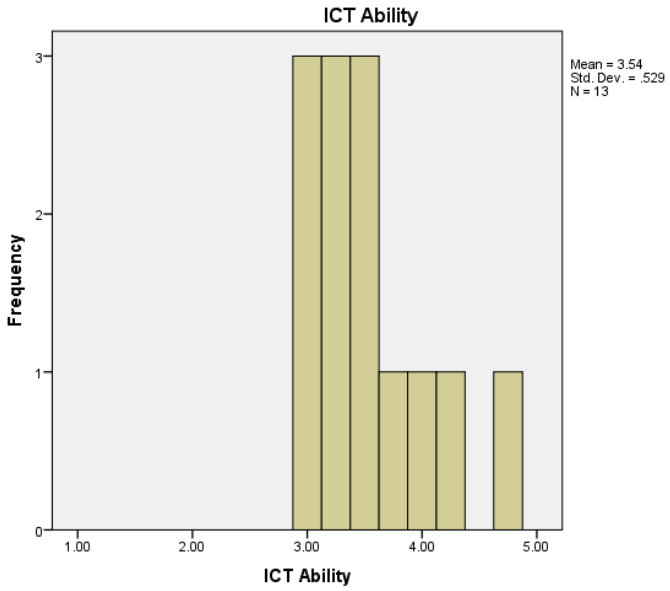


Figure 5.14: Histogram for composite score of the factor "Ability"

From Figure 5.14 it can be seen that the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that the participants overall ICT ability was good. Figures H24, H27, H29 and H39 provide a more detailed representation of the responses for each question linked to ability.

For the factor ICT ability, a composite score was computed for the four items (Questions 2.3, 2.6, 2.8 and 2.18). Note that Question 2.18 had to be reverse-scored since it was negatively phrased. In order to see whether there is a correlation between the age, years of experience and ICT ability, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.19.

Table 5.19: Participants perception of their own ICT Ability.

Variables	Correlation	p-value	Significant
Age & ICT Ability	-0.161	0.598	No
Years' experience & ICT Ability	-0.027	0.929	No

The correlation between age and ICT ability is not statistically significant (p-value = 0.598 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and ICT ability in that it is not statistically significant (p-value = 0.929 > 0.05).

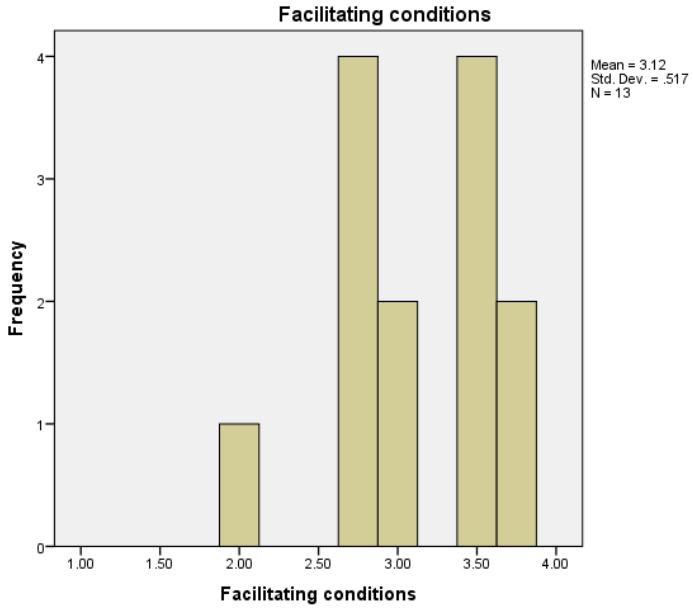


Figure 5.15: Histogram for composite score of the factor "facilitating conditions"

The aspect of facilitating conditions was investigated and is defined as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system (Teo & Milutinovic, 2015). The researcher found that this would be an important aspect to investigate as it may impact the participant's technology use and was highlighted by Makoe (2013) in Phase 1 of the study. From Figure 5.15 it can be seen that the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that the participants felt that most facilitating conditions were catered for and did not restrict them from using technology. Teo and Milutinovic (2015) found that facilitating conditions impact on the perceived usefulness and perceived ease of use. This was a new factor that originated from classifying the results of Figure H25, H30, H34 and H39.

For the factor facilitating conditions, a composite score was computed for the four items (Questions 2.4, 2.9, 2.13 and 2.18). Note that Question 2.18 had to be reverse-scored since it was negatively phrased. In order to see whether there is a correlation between the age, years of experience and facilitating conditions, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.20.

Table 5.20: Participants perception of their own facilitating conditions.

Variables	Correlation	p-value	Significant
Age & facilitating conditions	0.271	0.371	No
Years' experience & facilitating conditions	0.037	0.904	No

The correlation between age and facilitating conditions is not statistically significant (p-value = 0.371 > 0.05) and will not be discussed further. This is due to age having no bearing on the facilitating conditions of this study. A similar finding is found for the correlation between years of experience and facilitating conditions in that it is not statistically significant (p-value = 0.904 > 0.05).

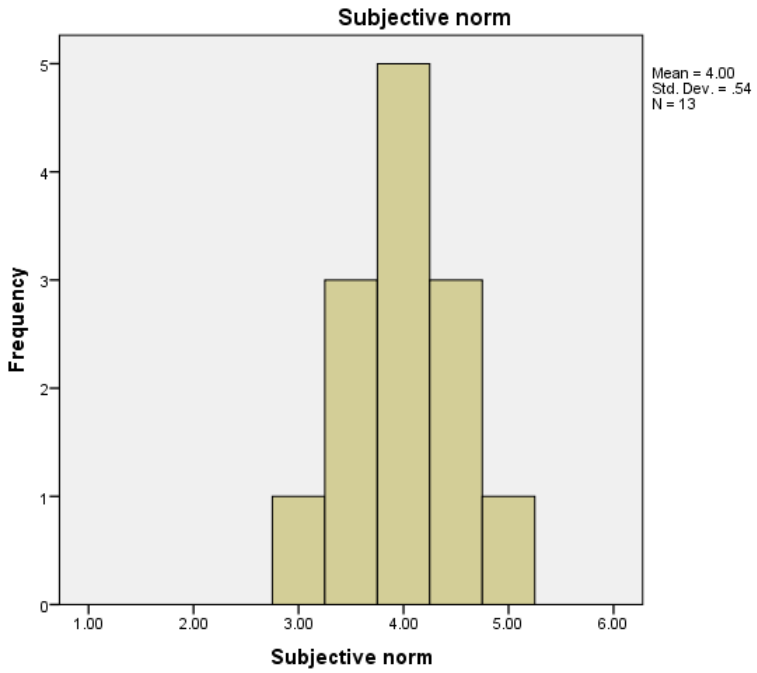


Figure 5.16: Histogram for composite score of the factor "subjective norm"

The subjective norm was investigated as the researcher found that during the workshop the participants were influenced by their colleagues. The subjective norm is defined as a person's perception that most people who are important to him/her think he/her should or should not perform the behaviour in question (Teo & Milutinovic, 2015) (see Reflective Journal Part 1 - Gail and Heidi). Although from Figure 5.16 it seems as if the histogram is symmetric, the majority of responses are above three which indicates that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that the teachers felt that they had the support available to them should they need assistance with using technology. Studies show that subjective norm has a significant influence on the perceived usefulness of technology (Motaghian, Hassanzadeh, & Moghadam, 2013; Teo, 2011; Teo & Milutinovic, 2015). This was a new factor that originated by classifying the results of Figure H31, H44.

For the factor subjective norm, a composite score was computed for the two items (Questions 2.10 and 2.23). In order to see whether there is a correlation between the

age, years of experience and subjective norm, Spearman correlation coefficients were calculated in SPSS[14] and the output is presented in Table 5.21.

Table 5.21: Participants perception of their own subjective norm.

Variables	Correlation	p-value	Significant
Age & subjective norm	0.378	0.202	No
Years' experience & subjective norm	0.056	0.855	No

The correlation between age and subjective norm is not statistically significant (p-value = 0.202 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and subjective norm in that it is not statistically significant (p-value = 0.855 > 0.05).

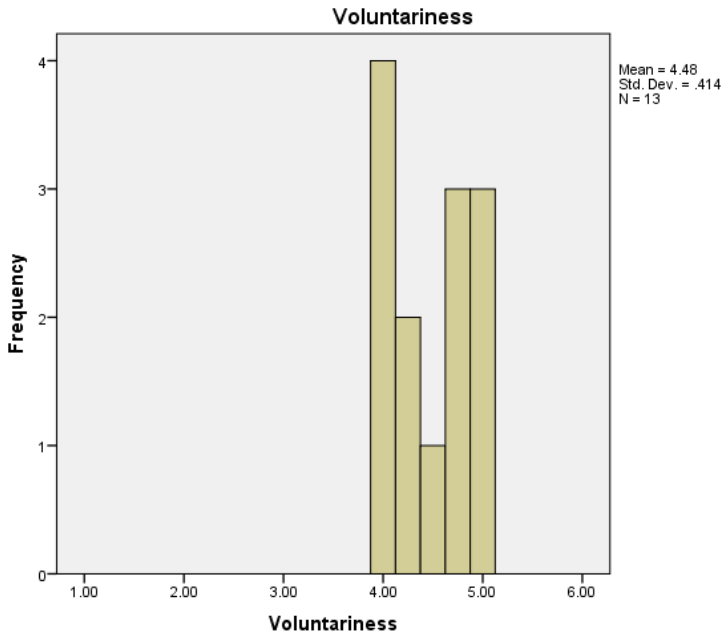


Figure 5.17: Histogram for composite score of the factor "voluntariness"

Voluntariness was another aspect that was investigated as the researcher found that teachers were keen to use technology at the onset of the study and their willingness to try and learn how to implement technology held some value as to how well they would use it (Surendran, 2012). Voluntariness is defined as the extent to which potential adopters perceive the adoption decision to be non-mandatory. Although, from Figure 5.17, it is difficult to interpret the spread of values on the histogram, the majority of responses are above three which indicate that the participants' responses

[14] Statistical Package for Social Sciences

leaned more towards ‘agree’ and ‘strongly agree’. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that teachers were willing to use technology and teach. Surendran (2012) found that technology acceptance needs to be voluntary. Teachers need to be willing and want to use technology to teach. This was a new factor that originated by classifying the results of Figures H32, H37, H40 and H41.

For the factor voluntariness, a composite score was computed for the two items (Questions 2.11, 2.16, 2.19 and 2.20). In order to see whether there is a correlation between the age, years of experience and voluntariness, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.22.

Table 5.22: Participants perception of their own voluntariness.

Variables	Correlation	p-value	Significant
Age & voluntariness	0.167	0.585	No
Years’ experience & voluntariness	0.126	0.681	No

The correlation between age and voluntariness is not statistically significant (p-value = 0.585 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and voluntariness in that it is not statistically significant (p-value = 0.681 > 0.05).

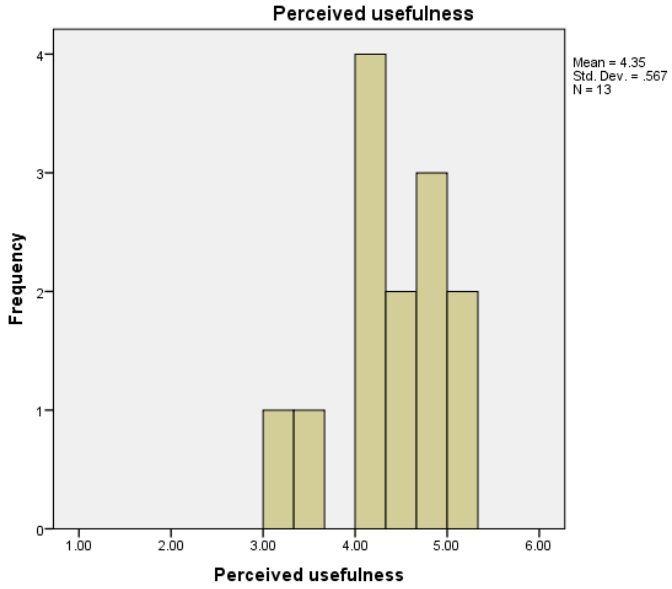


Figure 5.18: Histogram for composite score of the factor "perceived usefulness"

From Figure 5.18 it can be seen that the majority of the responses are on the right side of the histogram (causing the histogram to be skewed to the left), indicating that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that the teachers had an understanding of the added benefits of teaching with technology. These findings are supported by Teo and Milutinovic (2015) and Mac Callum et al. (2014). Figures H22, H26, H28, H32, H33 and H35 provide a more detailed representation of the responses for each question linked to ability.

For the factor perceived usefulness, a composite score was computed for the six items (Questions 2.1, 2.5, 2.7, 2.11, 2.12 and 2.14). In order to see whether there is a correlation between the age, years of experience and perceived usefulness, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.23.

Table 5.23: Participants perception of their own perceived usefulness.

Variables	Correlation	p-value	Significant
Age & perceived usefulness	0.338	0.259	No
Years' experience & perceived usefulness	0.232	0.445	No

The correlation between age and perceived usefulness is not statistically significant (p-value = 0.259 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and perceived usefulness in that it is not statistically significant (p-value = 0.445 > 0.05).

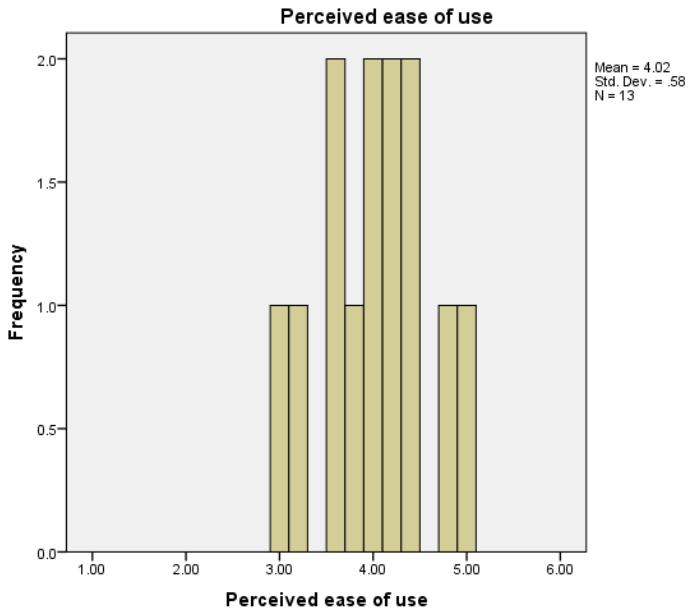


Figure 5.19: Histogram for composite score of the factor "perceived ease of use"

Although from Figure 5.19 it seems as if the histogram is symmetric, the majority of responses are above three which indicate that the participants' responses leaned more towards 'agree' and 'strongly agree'. This is also evident from the fact that the mean is greater than the midpoint of three. This suggests that overall teachers felt that technology was easy to use. These findings are supported by Teo and Milutinovic (2015) and Mac Callum et al. (2014). Figure H24, H27, H29, H42 and H43 provide a more detailed representation of the responses for each question linked to ability.

For the factor perceived ease of use, a composite score was computed for the five items (Questions 2.3, 2.6, 2.8, 2.21 and 2.22). In order to see whether there is a correlation between the age, years of experience and perceived ease of use, Spearman correlation coefficients were calculated in SPSS and the output is presented in Table 5.24.

Table 5.24 Participants perception of their own perceived ease of use.

Variables	Correlation	p-value	Significant
Age & Perceived ease of use	-0.110	0.720	No
Years' experience & Perceived ease of use	-0.115	0.709	No

The correlation between age and perceived ease of use is not statistically significant (p-value = 0.720 > 0.05) and will not be discussed further. A similar finding is found for the correlation between years of experience and perceived ease of use in that it is not statistically significant (p-value = 0.709 > 0.05).

The data obtained from this section of the questionnaire confirmed the data from the written questionnaire. Teachers overall held a positive attitude towards technology use. They had and overall good ICT ability with low ICT anxiety. They found technology useful and easy to use. However, three factors that originated from this questionnaire were facilitating conditions, subjective norm and voluntariness. Cronbach alphas were run for these factors and are represented in Table 4.3. These factors are more prominently seen in Section 3 of the questionnaire.

It should be noted that, for the first questionnaire, there were some significant correlations between some of the variables with age and years' experience. However, for the second questionnaire there were no significant correlations. From this it can be seen that the workshop had some influence / impact on the participants. A detailed comparison between Questionnaire 1 and 2 will be done in Section 5.7.2 in order to investigate what changed.

5.9.2 Comparison between questionnaire 1 and 2

In this section the participants' responses to Questionnaire 1 and 2 are compared. It is important to note that the histograms below should in no way be compared to the histograms in the earlier sections. The reason being two-fold. Firstly, Questionnaire 1 had a 3-point Likert-scale whereas Questionnaire 2 had a 5-point Likert-scale. Thus, some categories of the 5-point Likert-scale had to be combined in order to form a 3-point Likert-scale for the second questionnaire. This was done as follows, the bottom two categories were combined, the middle (neutral) option remained unchanged and the top two categories were combined. Now that both questionnaires are on a 3-point Likert scale, a fair comparison can be done. The second reason why the histograms below should not be compared to the previous histograms is that some of the participants that originally participated before the workshop opted not to participate after the workshop. In order to keep the comparison fair, only participants that answered both questionnaires are included in this comparison (there were twelve in total).

The constructs ICT anxiety, ICT ability, ICT attitude, perceived usefulness and perceived ease of use are considered, since they are the constructs that appear in both questionnaires. The Wilcoxon signed-rank test is used to test whether the differences between the questionnaires are significant or not (Field, 2014). This

nonparametric test is the nonparametric counterpart to the well-known paired t-test and it is used here since the sample sizes are small. The reader is reminded that parametric tests are used with larger data sets and that nonparametric tests are used with smaller data sets.

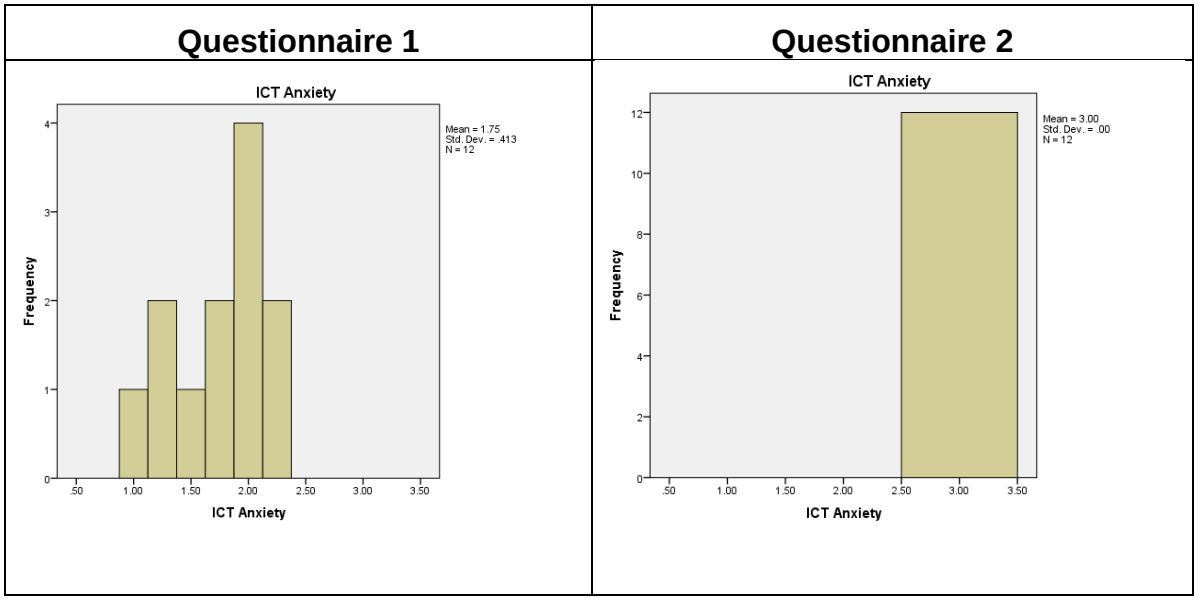


Figure 5.20: Histograms and Histogram for ICT anxiety for both questionnaires

In order to see whether there are any statistically significant differences between the way the participants answered the question on ICT anxiety, a Wilcoxon signed-rank test was performed. Since the Wilcoxon signed-rank test had a p-value < 0.05 (Z = -3.075, p-value = 0.002), there is a statistically significant difference between the responses on ICT anxiety between the questionnaires. For Questionnaire 1 the mean is 1.75 (s = 0.413) and for Questionnaire 2 the mean is 3.00 (s = 0.000) indicating that the participants were more anxious after the workshop. In fact, since the standard deviation for the second questionnaire equals zero, it shows that all participants responded that they were anxious after attending the workshop.

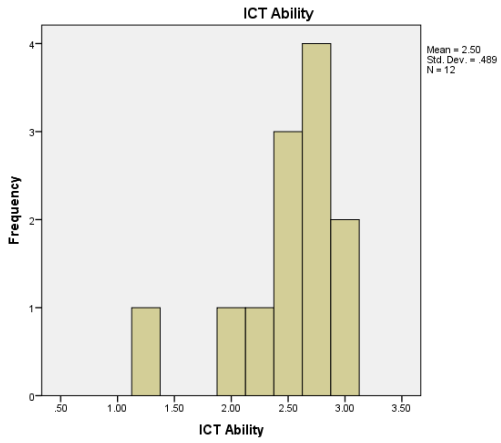
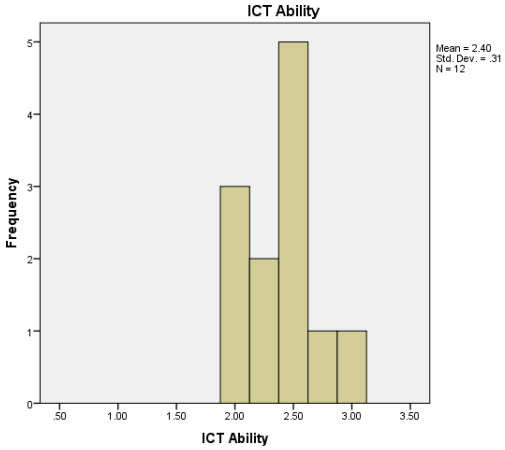
Questionnaire 1	Questionnaire 2
	

Figure 5.21: Histograms and Histogram for ICT ability for both questionnaires

In order to see whether there are any statistically significant differences between the way the participants answered the question on ICT ability, a Wilcoxon signed-rank test was performed. Since the Wilcoxon signed-rank test had a p-value > 0.05 (Z = -1.138, p-value = 0.255), there is a no statistically significant difference between the responses on ICT ability between the questionnaires.

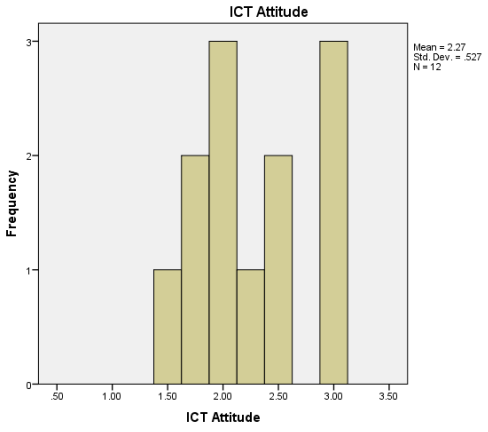
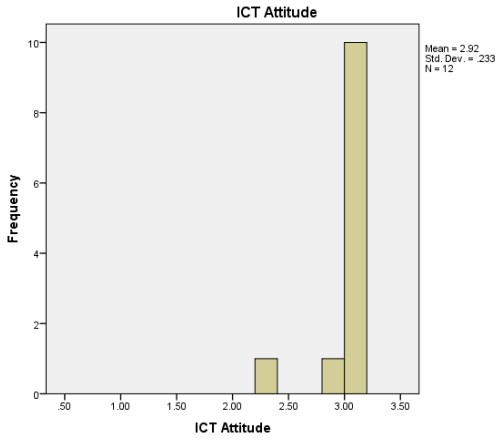
Questionnaire 1	Questionnaire 2
	

Figure 5.22: Histograms and Histogram for ICT attitude for both questionnaires

In order to see whether there are any statistically significant differences between the way the participants answered the question on ICT attitude, a Wilcoxon signed-rank test was performed. Since the Wilcoxon signed-rank test had a p-value < 0.05 (Z = -

2.403, p-value = 0.016), there is a statistically significant difference between the responses on ICT attitude between the questionnaires. For Questionnaire 1 the mean is 2.27 (s = 0.527) and for Questionnaire 2 the mean is 2.92 (s = 0.233) indicating that the participants had a more positive attitude after the workshop.

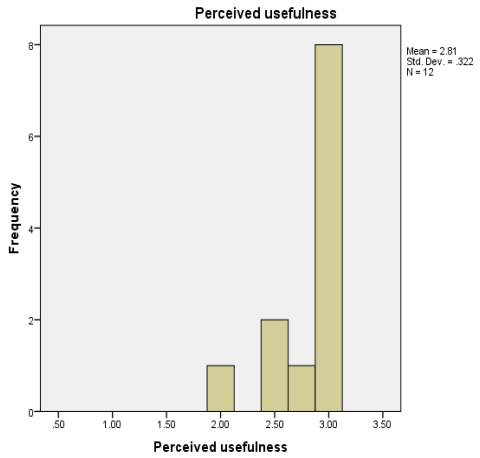
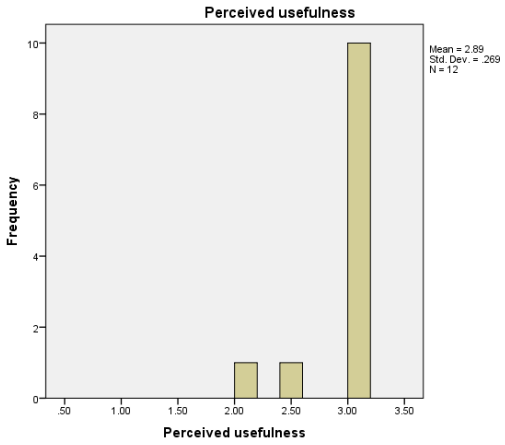
Questionnaire 1	Questionnaire 2
	

Figure 5.23: Histograms and Histogram for perceived usefulness for both questionnaires

In order to see whether there are any statistically significant differences between the way the participants answered the question on perceived usefulness, a Wilcoxon signed-rank test was performed. Since the Wilcoxon signed-rank test had a p-value > 0.05 (Z = -0.530, p-value = 0.596), there is a no statistically significant difference between the responses on perceived usefulness between the questionnaires.

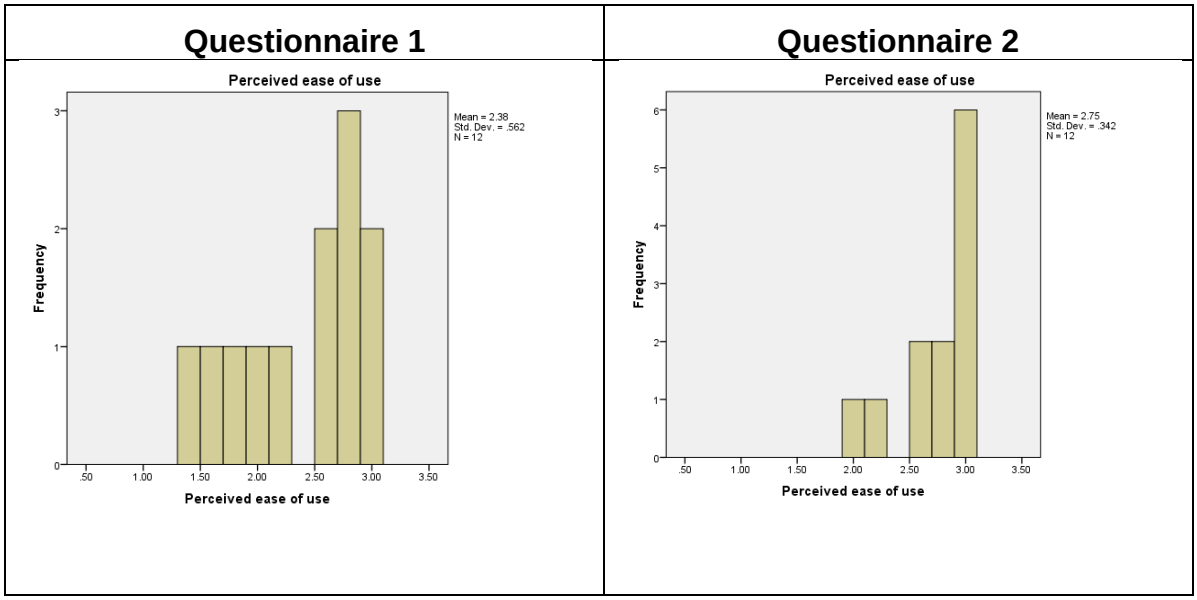


Figure 5.24: Histograms and Histogram for perceived ease of use for both questionnaires

In order to see whether there are any statistically significant differences between the way the participants answered the question on perceived ease of use, a Wilcoxon signed-rank test was performed. Since the Wilcoxon signed-rank test had a p-value > 0.05 (Z = -1.606, p-value = 0.108), there is a no statistically significant difference between the responses on perceived ease of use between the questionnaires.

5.9.3 Section 3

Section 3 of the questionnaire consisted of ranking questions where the teachers needed to rank their perspectives on several different aspects contributing to technology use. The following graphs reflect the teachers' perspectives in terms of importance and ranking to several aspects of mobile technology implementation.

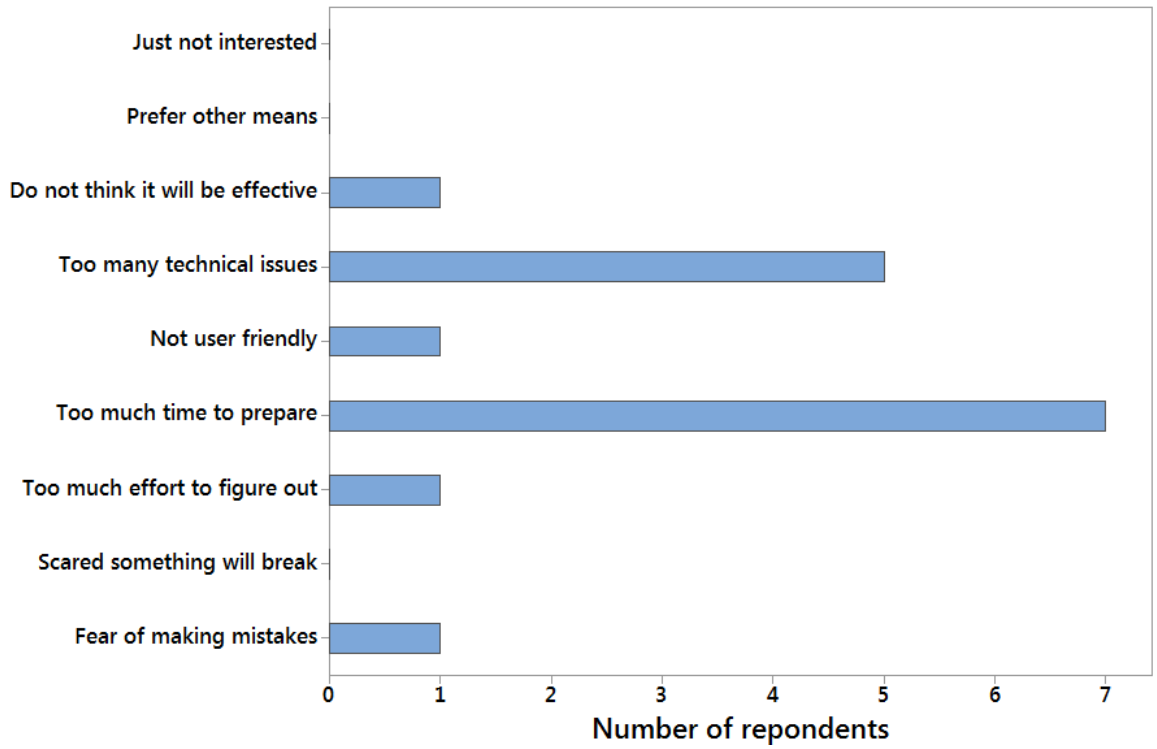


Figure 5.25: Factors preventing teachers from using a specific technology

Most teachers found that time and technical issues are the leading causes preventing them from using technology to teach. This lends itself to facilitating conditions of high workloads and poor technical support that compromises the teacher's willingness to use technology. Aspects of anxiety can be seen by "fear of making mistakes", attitude by "to much effort to figure out", perceived usefulness by "do not think it will be effective" and perceived ease of use by "not user friendly". Similar findings were established by (Nunan & Wong, 2005).

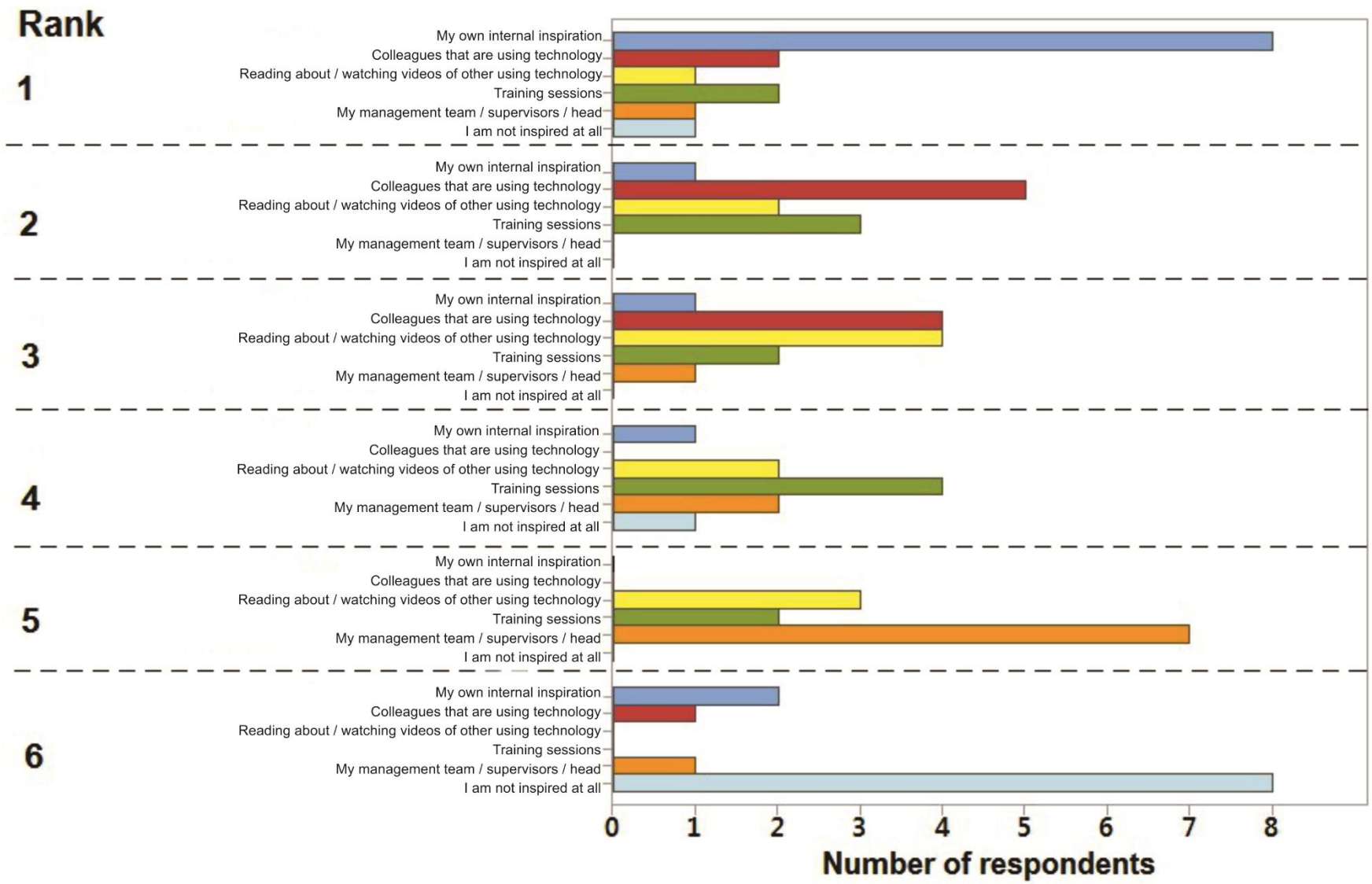


Figure 5.26: Inspiration to teach with technology

From Figure 5.26 it can be seen that teachers' own internal inspiration makes them want to teach with technology. This suggests that teaching with technology is voluntary. Interestingly, teachers find colleagues that use technology to teach to also inspire them suggesting the subject norm that if others find it important they should consider using technology. This highlights the level of support required for implementation as mentioned by Blignaut et al. (2010) and (Summey, 2013).

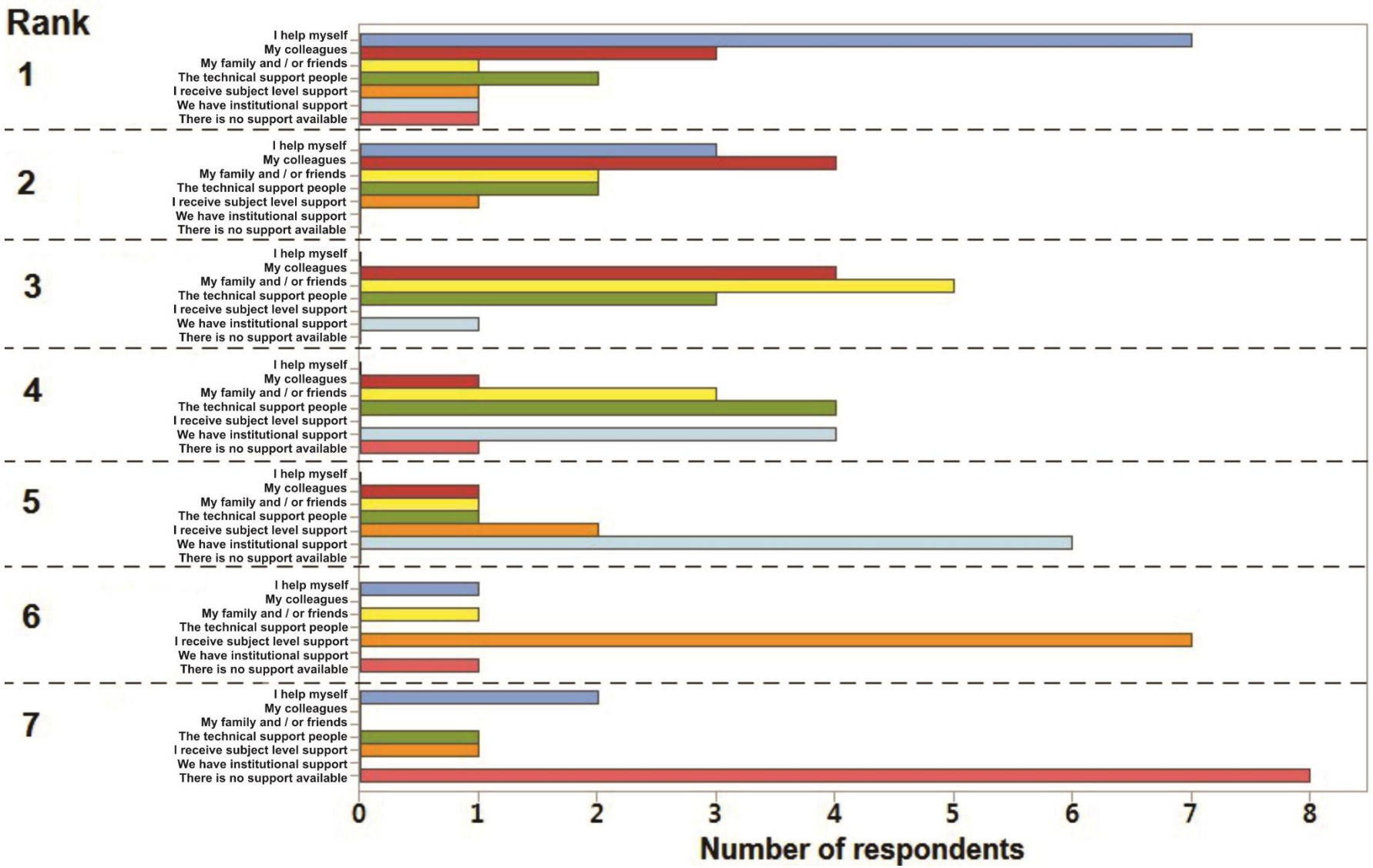


Figure 5.27: Available support to work with technology

The following observations can be made from Figure 5.27 Teachers rank helping themselves the highest, then colleagues and family. It is interesting to see that institutional support, subject level support and technical support are ranked very low. This suggests that teachers take it upon themselves to use technology suggesting voluntariness and that support in terms of facilitating conditions is poor. It further suggests that teachers must hold a positive attitude towards technology use and must find it useful to want to use it.

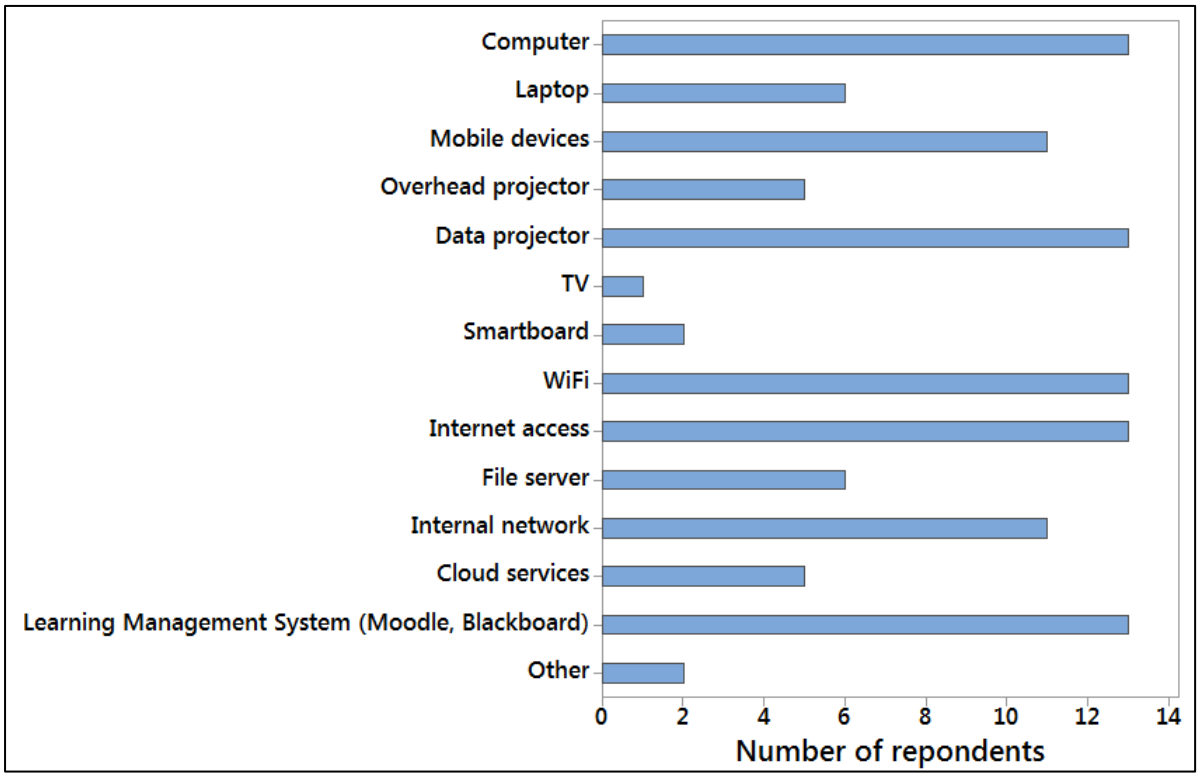


Figure 5.28: The availability of technologies in your environment for teaching

Figure 5.28 serves to confirm that all the participants did in fact have the resources available to them to use and also gives an indication of what technology aside from mobile devices can/are being used. This also confirms that the technology is available, therefore the use of technology is dependent on the teacher.

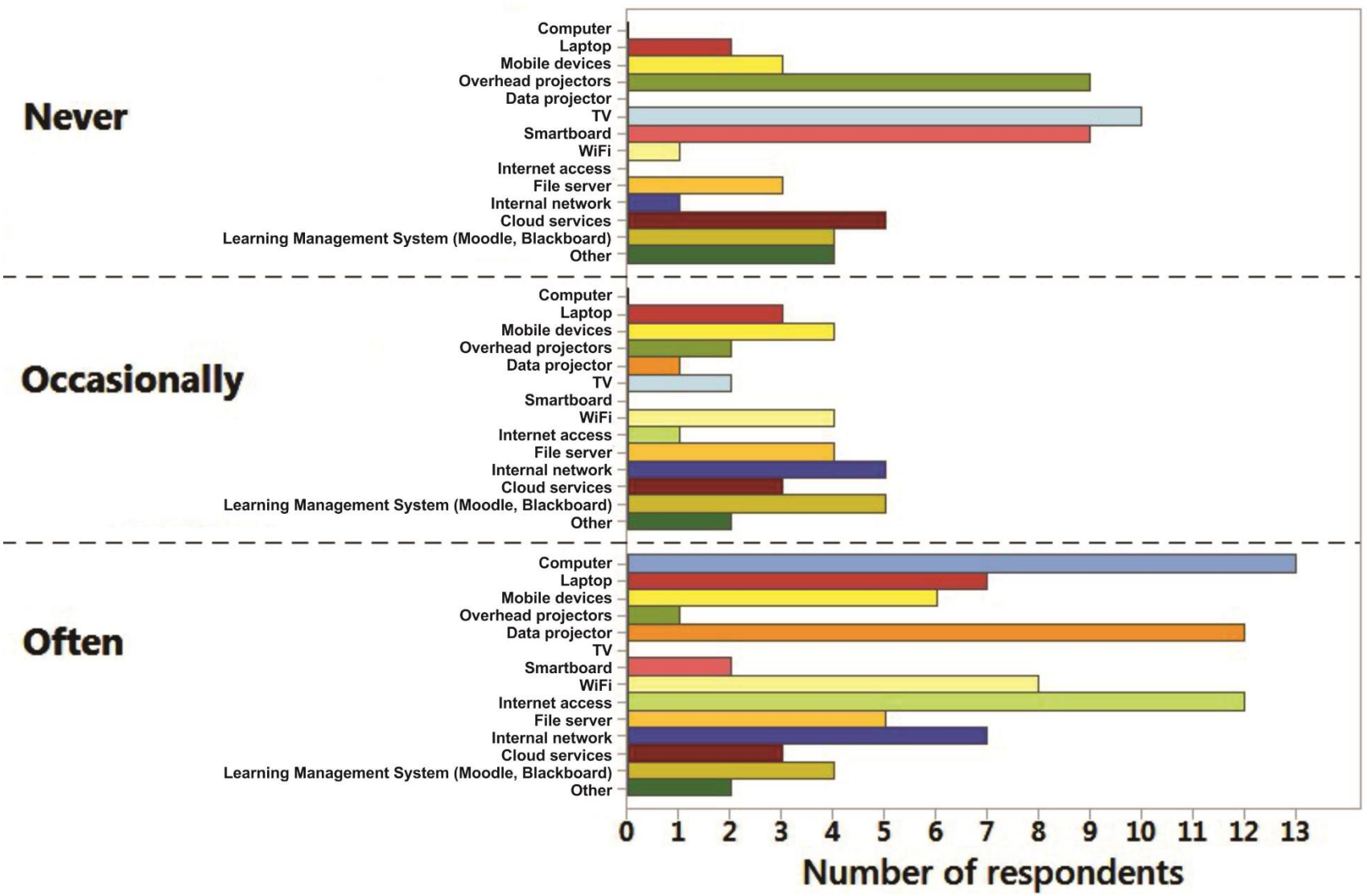


Figure 5.29: Preference of technologies used in teaching and preparation

In Figure 5.29 it can be seen that computers, data projectors and internet are used most frequently but only half of the teachers use mobile devices. It seems that technology is used but more by the teacher only rather than for classroom teaching. This suggests that even though the resources are there teachers choose not to use mobile devices. If we compare this to the results on Table 5.3 teachers only average the use of their mobile device at 12.5 (52%). It is evident that although teachers find mobile technology useful they still do not opt to use it frequently. This is similar to the findings of Gray et al. (2010).

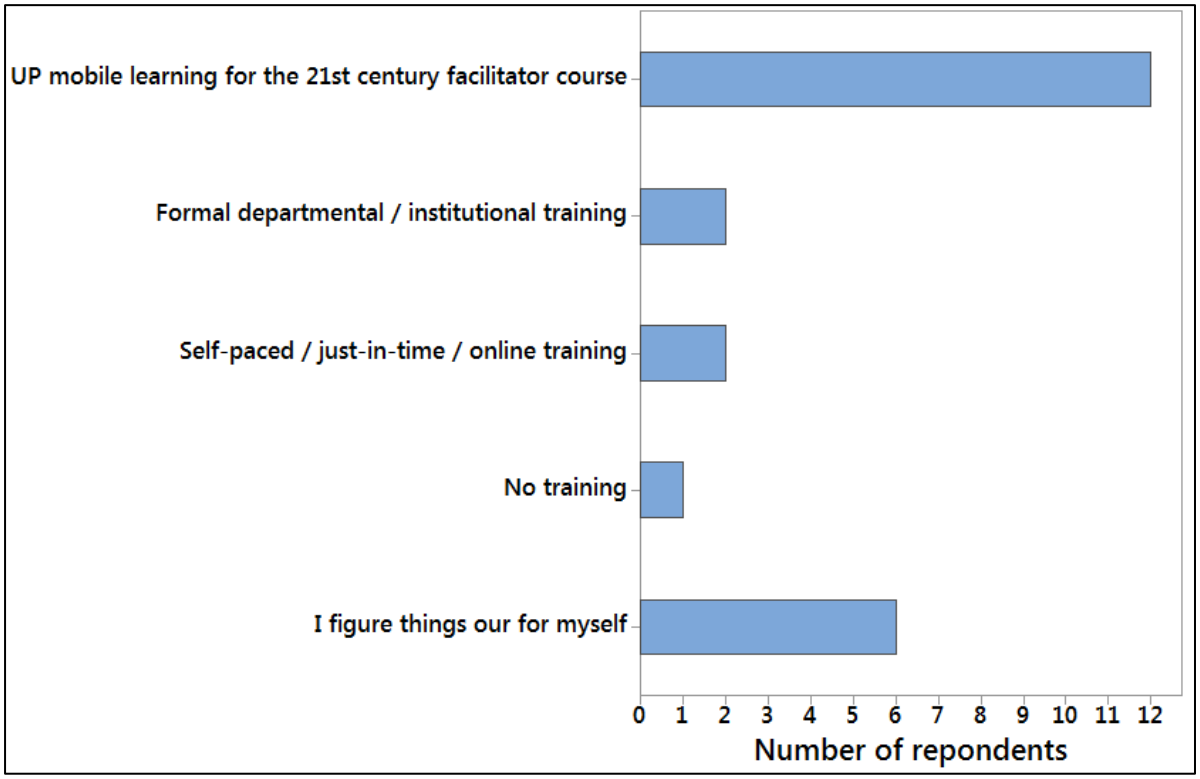


Figure 5.30: Training received/attended to support your development in teaching with technology

Figure 5.30 confirms that most of the teachers only received training from the mobile learning workshop. Almost half of the teachers try to figure out things on their own again suggesting the voluntary and willingness nature to learn and use technology but little to no training is available at institutional/departmental level. This advocates poor professional development for in-service teachers to adopt mobile technology in their teaching. Blignaut et al. (2010), Summey (2013) and Cinque (2013) also found that support and professional development are needed.

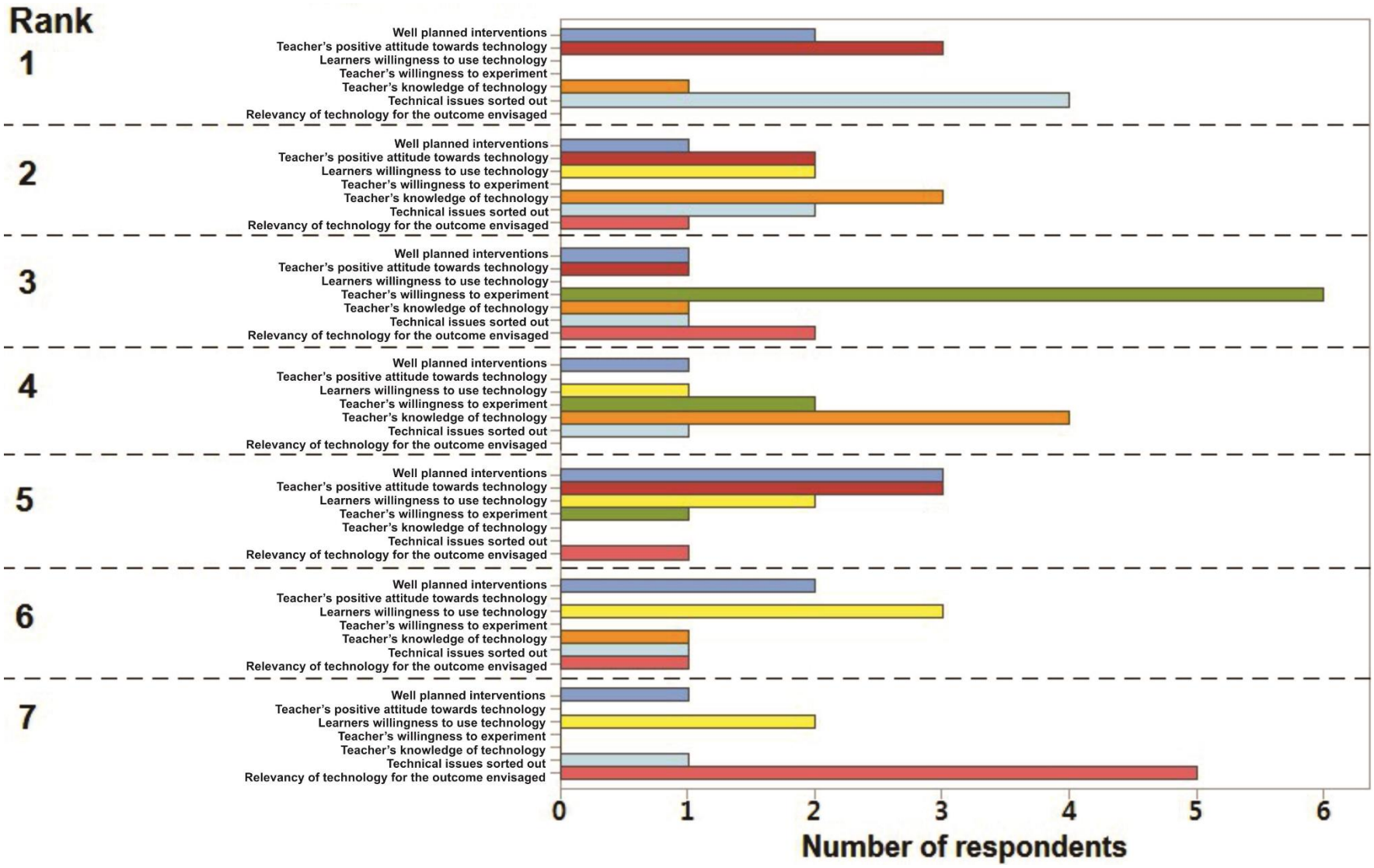


Figure 5.31: Aspects impacting most on the success of the use of technology

The following observations can be made from Figure 5.31 Teachers found that technical issues and a positive attitude will impact the use of technology. Interestingly teachers' knowledge of technology and their willingness to experiment are also ranked very high. This suggests that teachers need to have sufficient technology knowledge to want to experiment and that a positive attitude may bring about more technology use. This is supported by Cinque (2013).

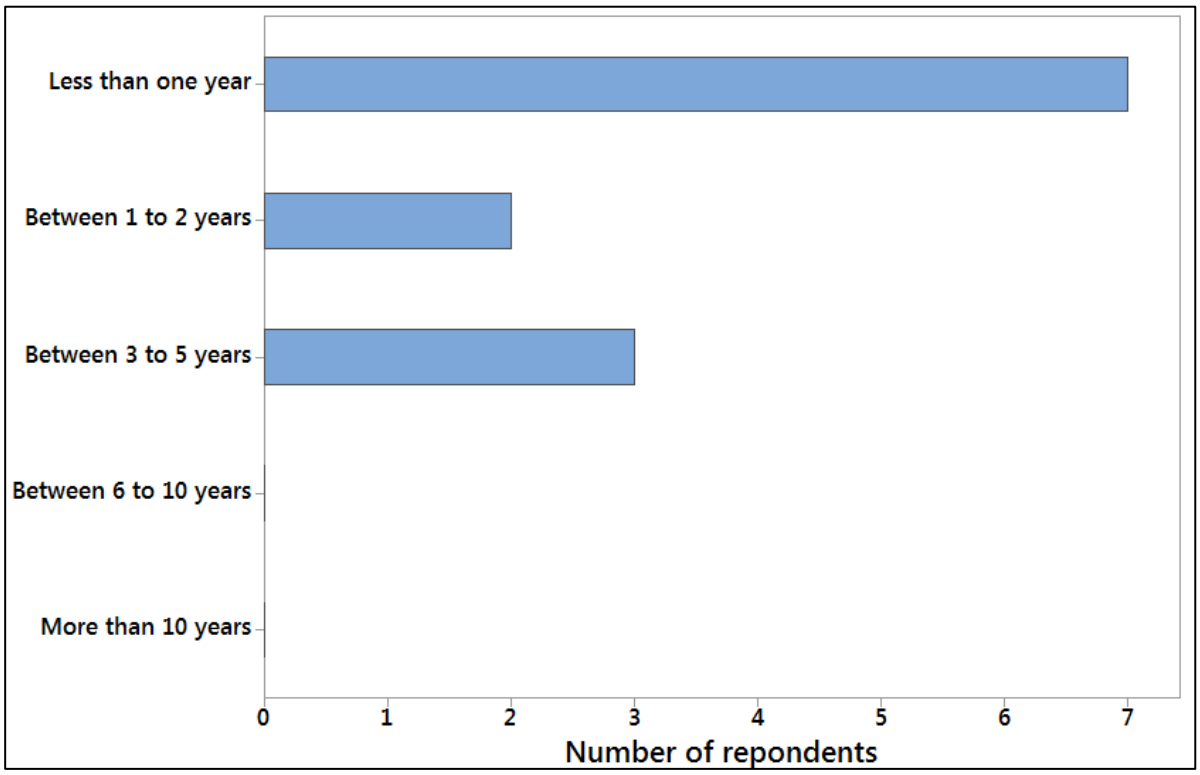


Figure 5.32: Years of incorporating M-Learning in your classes

This graph illustrates that most teachers have only started using mobile technology once they were introduced to it in the mobile learning workshop. Prior to this teachers have stuck to traditional teaching methods. Even though many teachers have technology knowledge and technology ICT ability, are positive and understand the benefits of technology use and they find it easy to use, they still do not use it for educational purposes. This is supported by Gray et al. (2010).

5.9.4 Section 4

Section 4 of the questionnaire dealt specifically with Teacher Identity and was structured to show any change in teaching as a result of mobile technology use, as well as confirm other data. Table 5.25 indicates the questions and how they were grouped to shape the

identity development. The questions tested the planning, implementing, reflection and development that took place as the participants used mobile technology.

Table 5.25: Questions posed to determine the impact of Mobile Learning on Teaching Practice.

Impact of Mobile learning on Teaching Practice	
Plan	How does the implementation of technology in your class change the way in which you prepare?
	How does the implementation of ML in your classes change your approach to teaching?
	How does the implementation of ML in your classes change the type of interventions you plan for the class?
Implement	How does the implementation of ML in your classes change student/learner participation?
	How does the implementation of ML in your classes change communication between you, students/learners, others?
	How does the implementation of technology in your classes change the attitude of the learners/students?
	How does the implementation of technology in your classes change your own attitude towards technology?
Reflect	How does the implementation of technology in your classes change the way in which you reflect on your own teaching practice?
	How does the implementation of technology in your classes impact on your work load?
Develop	Which aspects in your teaching are you doing the same as before, but on mobile devices?
	Which aspects in your teaching is enhanced due to the incorporation of mobile learning? Explain how.
	What did mobile learning bring to your teaching practice that was not possible to do before?

The data received from these questions were analysed and presented in Table 5.25 and illustrate the experiences and perceptions of Mobile Learning that the participants had during the implementation process. Participants found the planning process to be creative, innovative and learner centred. It allowed them to use peer assessment, various different apps, interactive lessons and was learner centred. This created room for flexibility in their teaching methods and aimed to grab the learner's attention by using audio or visual stimuli.

The implementation process created different experiences for the learners and the teachers. The learners seemed to be more motivated, excited, involved in the lessons and eager to learn. There was a change in the tone and atmosphere in the classroom. It created an opportunity for group work and cooperative learning as the learners were willing to share. Even though some learners still wanted paper based lessons, homework was done more regularly and learners were enthusiastic and positive about school. The technology

use also seemed to bridge the gap between the teacher and learner in terms of age and generation.

Since this study focuses solely on the teacher, the response of the learners will not be elaborated on as this is an additional finding to the study. The teachers found that using technology allowed them to use more creative and innovative methods of teaching. They felt accomplished, more passionate about teaching and positive and enthusiastic to teach because of the positive response and reaction of the learners. Although some teachers mentioned the frustration of technical issues, they felt that technology enhanced the enjoyment of learning. They commented on the great benefits of technology but also on making sure that technology does not replace the teacher.

Many teachers found that the biggest development that took place was realising that they had become complacent in their teaching methods and were not using innovative, different teaching methods to create fun interactive lessons for their learners. They received better feedback from their learners and were able to give better feedback to their learners. This opened room for better communication and they could identify problems and apply interventions more easily and earlier on in their teaching. The teachers found it to be stimulating for them to try new alternative methods and described it as improving skills in an unknown territory. Teaching with technology afforded them the chance to plan more research based activities and assessments and gave their learners more information to take home.

As they reflected on their teaching with technology they found that the initial planning was time consuming but the workload would decrease after they had created their resources. They found themselves wanting to try new apps and being involved in discussions with colleagues to share ideas and compare teaching styles. Some teachers saw teaching with technology as a fun and permanent way of teaching as the learners had a visual of or audio experience to help remember the work. They found themselves doing more reflection on their teaching and becoming more passionate teachers. A summary of these findings is illustrated in Figure 5.33.

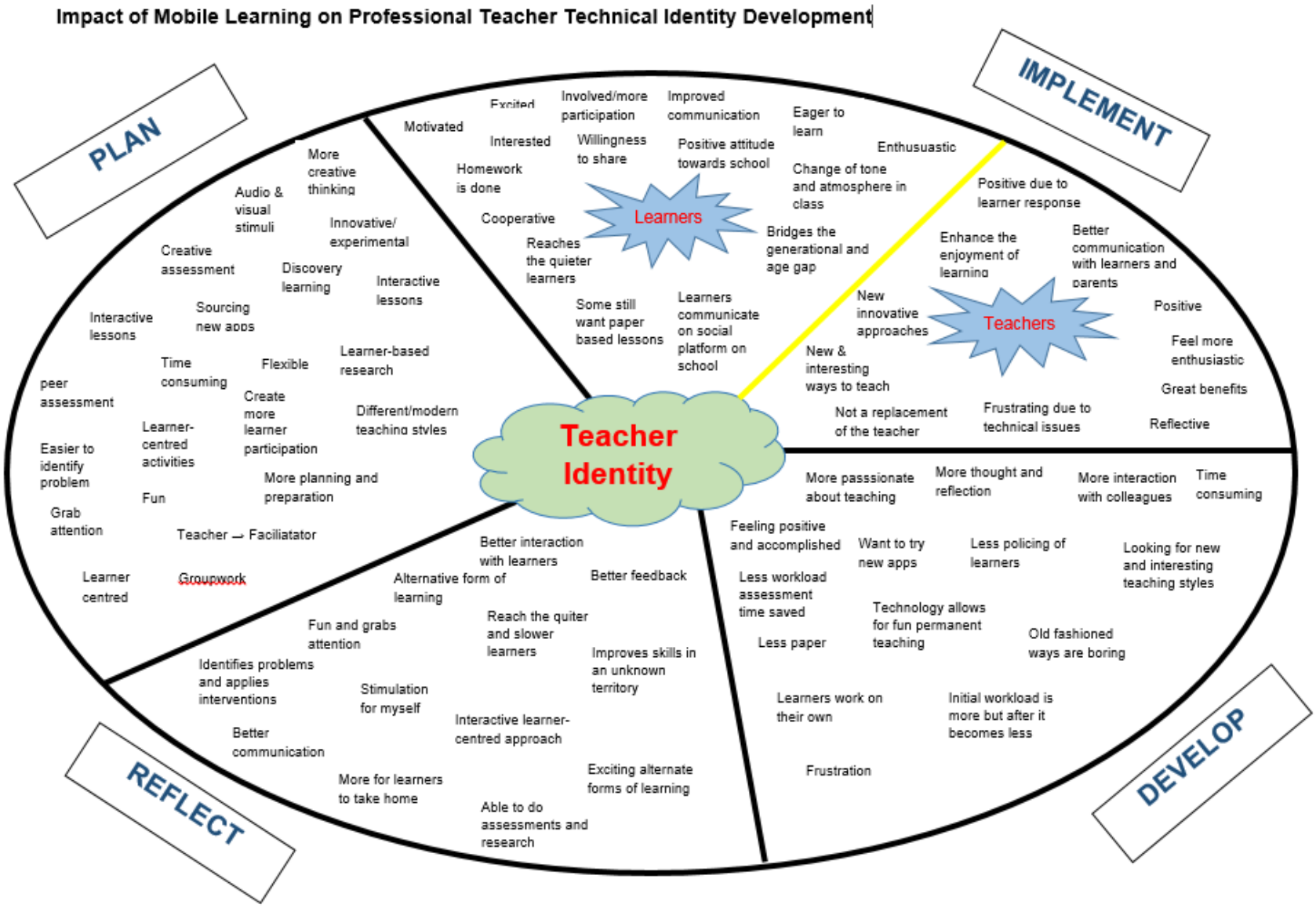


Figure 5.33: Impact of Mobile Learning on Teacher Professional Identity Development

5.10 Analysis of Lesson Reflections

During the staff development the participants were expected to plan, implement and reflect on lessons that they had done using mobile technology. Instrument 4 was used as a guide to assist participants to plan and reflect on their teaching experience. The lesson reflections aimed to identify individual challenges that the teachers experiences and how they overcame these challenges. This would directly influence their identity development and provide insight into the development of Framework 2 and the practical contribution **(P3)**. The table below summarised the number of lessons reflections received and the level of technology implementation they achieved according to the teachers. For purposes of the table only the first letter of each teachers pseudonym is given.

Table 5.26: Teacher's perception of their own technology use in terms of the SAMR model.

	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Total
Week 1	Did not attend the staff development				1	1	1		1				1		1	5
Week 2		1		1		1	1	1	1	1				1		8
Week 3			Discontinued	1		1			1		Discontinued					3
Week 4						1			1							2
Week 5						1			1							2
Level of SAMR		M		A	S	R	S	S	M	M			A	M	S	

The information from Table 5.26 shows a clear indication that once the teachers had to start planning and implementing the technology use, they struggled. The number of lesson reflections decreased as the weeks progressed. The main reason for this was that the teachers found planning for technology based lessons to be time consuming and tedious because they sometimes struggled to use the technology and often their lessons failed if the school Wi-Fi didn't work. Anne decided not to attend the workshop as she felt that using technology was frustrating and that she needed more individual attention. Carol discontinued the study as she found that using technology was useful but she preferred to just teach the way she always has because it works. Liam just stopped attending and showed no interest in technology use as he also found that he preferred to just teach the way he always has. Fred and

Jill were the only teachers that did all five lessons and their reflections show evidence of apps, group discussions, games, quizzes, homework activities etc. that all include mobile technology use. Fred was very passionate and positive about technology use and he tried to include it in all his lessons. It was easier for him because his knowledge of basic technology was very good and he enjoyed the interaction with the learners as can be seen in the focus group discussion transcripts. Most of the teachers only did one lesson with technology over the five week period and their reasons for doing so were time to prepare which is elaborated on in the online questionnaire. It is interesting to see the change in attitude, ability, anxiety, and new emerging factors that influenced teacher identity development.

The teachers whose lessons were successful with little to no technical issues seemed to be very positive about technology use. None of teachers reported classroom discipline as an issue but Kevin, Nina and Fred mentioned that it needs to be guided and managed very well. All the teachers described the learners' response as fun, exciting, attentive, focussed, interested, motivated, captivating and independent learning. This shows a positive feedback from the learners and also boosts the confidence of the teacher to use technology again because they see the benefits of it for their learners. Heidi says, "You're never too old to learn new things." She is excited to have learnt how to integrate technology into her teaching. Owen, however says he became frustrated when he found that some learners had not downloaded the app he wanted to use. This again shows the carefully guided approach required that is mention above by Kevin, Fred and Nina. Gail explains, "I am more confident using technology and amazed at how much is available. Technology plays an important part in the teaching process and its effectiveness cannot be underestimated. It is a very effective and powerful tool to use in class and the pupils respond very well to it. The [learners] were immediately captivated and interested." Gail was initially nervous to try to use technology to teach as she was worried that she would not be able to keep up due to her age. This is also mentioned by Czerniewicz and Brown (2005) in a similar study. Her positive remark shows that after seeing the effects of technology in her teaching she is more confident and willing to use technology. The positive feedback from the learners made the teachers realise that teaching with technology is what they want and that they needed to keep up with their teaching methods. Peter, Kevin, Jill

and Gail mention how their learners ask for more lessons with mobile devices. Pam's responses show growth in teacher identity:

> I was initially quite nervous but I am now much more confident to use mobile technology in the class. I have realised that even if it doesn't work the first time, as a group, you will figure it out and then become confident. Using technology takes time and practise. It also takes a trial and error approach with the learners but they are generally very patient and helpful. (Pam)

Pam, Nina and Heidi experienced technical issues during their lesson but Pam and Heidi maintained a positive attitude whilst Nina immediately felt she could not use technology to teach. This is supported by Figure 5.20 showing a change in anxiety during implementation. Dora on the other hand sees time as an obstacle:

> I am learning a lot about how to implement technology in a useful way in my class, however this is very time consuming and I do feel that this is an obstacle as I need to finish the syllabus in a limited amount of time and do not always have the time to adjust teaching. (Dora)

These are only a few of the many responses that lean toward teachers understanding the usefulness of the technology but their difficulty in using technology tends to dampen their spirits and restrict their use of it. Even though Figure 5.21 shows no statistical difference in ability to use technology (before implementation and after implementation), the reflective journal and the lesson reflections show otherwise. Their attitude to technology and to change their teaching methods plays a key role in the adoption process. This required a paradigm shift as mentioned by Rajasingham (2011) in the literature or identity development (Alsup, 2006; Flores & Day, 2006; Mitchell & Weber, 1999; Rodgers & Scott, 2008; Sfard & Prusak, 2005) is necessary for the smooth implementation of mobile technology.

5.11 Analysis of Part 2- Reflective Journal

The data obtained from the reflective journal was used to confirm the findings of the online questionnaire, focus group discussions and lesson reflections. This was to ensure that valuable data was not lost because it was not mentioned or emphasised in the lesson reflections. It also served to help triangulate the data needed for the designing of Framework 2.

Anne

Anne became so frustrated with using technology after the workshop that she decided not to attend the focus group discussions. She did however do basic substitution of technology in her lessons where she could play a video or elaborate on something she was able to show her learners on the data projector. Anne's inability to use technology and anxiety to use technology have contributed to her negative attitude and therefore she feels less confident to use it.

Brenda

Brenda used technology to make the library more accessible to the teachers. She created email groups and newsletters with the hope of creating a library app. It is not evident whether she will be successful in doing this. She maintains a positive attitude, has no technology anxiety and sufficient technology knowledge. She finds mobile technology useful but it is not evident that she will use it. Brenda ranks herself at modification but since there is no evidence to show how she transformed teaching itself she is regarded as reaching substitution.

Carol

Carol withdrew from the study and said she would write a report to explain why but she didn't. During the workshop she said that it is her attitude and that she just does not want to use technology when what she does works, is simpler and easier. Carol does however use technology already but at a substitution level.

Dora

Dora battled with planning of her lesson and time constraints. She did however use apps, create online groups and do group work in class using blended learning. Dora has a positive attitude, sufficient technology knowledge, and no anxiety to use technology. She finds the technology easy to use and useful but facilitating conditions such as time and technical issues restrict her from using it more often. Dora ranks herself at augmentation and she has used technology to enhance her lessons.

Elize

Elize attempts only to use technology for homework as her subject does not lend itself to mobile technology. She is positive about the use of technology, proficient in

the use of technology and holds no anxiety towards using it. Her concern is purely on how to incorporate it into her subject. Elize ranks herself at substitution, which is the level at which she has been able to incorporate it.

Fred

Fred goes all out to make his lessons interactive and fun. He tries a range of different things trying to include technology in every lesson. Fred is very confident and positive and speaks with great passion to make his lessons interactive and enjoyable for his learners. Fred is proficient in technology use and has no anxiety towards it. He finds technology useful and easy to use and constantly emphasises the benefits. Fred ranks himself at the redefinition level and he is definitely there because he redesigns his lessons to transform learning. He uses a range of apps and flipped classroom approaches, blended learning and is excited to use mobile technology as a learning tool.

Gail

Gail, who was very nervous to use technology, actually did very well with the technology use and both her and her learners enjoyed it. She videoed her learners giving speeches and then formulated a class discussion around these videos, where they could see how they presented and suggest ways to improve. Even though Gail ranks herself at the lowest level, substitution, her lesson was transformed and therefore should actually be at modification. Gail shows a positive attitude and accommodating response to teaching with technology.

Heidi

Heidi is keen and excited to try out the technology but she is anxious and worried about whether or not she will remember how to use the app. She battles to find apps and to facilitate the lesson. She has limited technology ability and finds the technology to be useful but not very easy to use. Heidi ranks herself at substitution and that is the level she has reached, using technology to enhance lessons.

Jill

Jill used the technology in a few lessons but mainly for substitution and augmentation, merely to enhance the lesson, however she ranks herself as having reached

modification in her lesson reflections. Although she maintains a positive attitude to using technology and she finds it easy to use her efforts to explore further are not evident.

Kevin

Kevin is eager and ready to change to teaching with technology. He has used a range of different apps and has shared his knowledge of mobile technology with his colleagues. Kevin mentions technical issues to be a restriction but seems to always have a “plan B” to assist him with getting on with his lesson. Kevin ranks himself at the modification level, which he is at because he is transforming his lessons to include technology use. Kevin is proficient in technology use and has no anxiety to use technology. This makes it easy for him to use.

Liam

Liam tends to be less positive than at the workshop. He does not do any lessons using the technology. He speaks of apps that he has found but seems to prefer to use traditional teaching methods. He has sufficient technology knowledge, no anxiety, but had a negative attitude towards the end as he stopped attending the focus group discussions. Even though he finds the technology easy to use and useful, he does not use it. Liam would not be ranked on the SAMR model.

Mary

Mary seemed to have lost interest as the focus group discussions continued. She didn’t do any lesson reflections but spoke of a single instance of using technology in class and for homework purposes, which her learners enjoyed. It will appear that Mary is unsure how to incorporate technology into her teaching and she prefers traditional methods because it is less time consuming. She ranks herself at augmentation and she has just enhanced her lessons slightly.

Nina

Nina wants to try to use technology and teach but her technology ability is slightly limited. She also battles to plan and facilitate the lesson. Nina finds apps that she can use but then becomes very negative due to technical issues. She does have some technology anxiety. Although she finds the technology useful, she does not find it

easy to use. Nina ranks herself at augmentation but she is merely substituting technology in her lessons.

Owen

Owen is keen and has tried several uses of technology, apps, quizzes, group discussions and augmented reality. He has even done formative assessment using technology to see how his learners respond. He has a positive attitude, good technology knowledge and no anxiety to use technology. He finds it useful and easy to use. Owen ranks himself at modification which is the level he has reached in his lessons.

Pam

Pam was anxious and reluctant to teach with technology and her reasons were fear of less control. She did however teach lessons that included augmented reality apps and various quizzes. Pam became more confident as she saw the response of her learners to be positive. Pam has sufficient technology ability, however her use of technology is purely to enhance teaching. Pam ranks herself at the level of substitution but she has in fact reached augmentation.

It seems that even though the teachers found technology useful not all teachers were keen to use technology. Anne, Carol, and Liam chose not to teach with technology and this is seen as a negative attitude towards teaching with technology. Nina and Heidi want to use technology but their technology ability restricts them from more technology use leaving them less confident even though only Heidi perceives her ICT ability to be low (see Table 5.5). Brenda, Mary and Elize are keen but their subject does not allow for it. Dora and Pam are keen but they find time and technical issues to be an obstacle in their technology use. Jill, Gail, Kevin, Owen and Fred have excellent technology use and they find it easy to use and try out various different methods to incorporate it, with structured and guided facilitation leaving them with successful lessons.

5.12 Analysis of focus group discussions

During the focus group discussions the teachers discussed their experiences with the implementation of technology in their teaching. Their experiences are described

below with special mention of information that contributes greatly to identity change. It is important to note that only fourteen participants started attending the focus group discussions and twelve attended all the focus group discussions. Anne left as she felt very demotivated and frustrated with using technology. She felt that she could not use it.

Brenda

Brenda contributed very little to the discussion but did mention the importance of planning for technology use. She focused on the facilitating conditions and how it was vitally important to make sure everything was prepared and tried before the lesson.

Carol

Carol showed a change in her willingness to use technology from the workshop to the focus group discussions. She mentioned time as being a major factor and the fact that the old methods do work and she is assured of learning in that sense. She questioned the usefulness of technology use as she found that learners find it fun and an innovative way of teaching and learning but she was not convinced that actual learning was taking place. She speaks about being “comfortable” with her old ways of teaching and more in “control”. She stopped attending the focus group discussions after the first week.

Dora

Dora tried a few different approaches to teaching making her lessons more learner-centred and found it to be more exciting. The response from her learners motivated her to try different things and she describes it as “throwing them in the deep end” and letting them find out for themselves. She mentions the skills that they learn when sifting information and researching for themselves.

Elize

Elize did not contribute much in the focus group discussions. She did not do any lessons using mobile devices ad she found that this type of technology does not lend itself to Information Technology as a school subject. She mentions constraints from the CAPS syllabus and Departmental Regulations that do not make room for such technology integration.

Fred

Fred contributed the most to the focus group discussions. He had been using technology prior to the workshop so his attitude towards technology use is very positive. He went into great detail of what he did in his classes, how he planned, how the learners responded, what he changed and what he learnt in the process. He spoke of “changing his lesson” to include technology, “changing his approach” illustrating a change in pedagogy. He spoke of the learner response and how that positive response has inspired and motivated him to use more technology and different forms of technology. He explains with great enthusiasm some of his learners’ comments, “Sir we need to do this every day”. He explains his emotions as comfortable, excited, positive and enjoyable. He also mentions how he has changed from being a teacher that was a “control freak” to letting go and letting the learners construct knowledge on their own. He elaborated in great detail of how his lessons have changed from the usual “death by PowerPoint” to interactive lessons. He describes his lessons as quiet, ordered and structured lessons that need planning and guidance. The only limitation that he mentions is Wi-Fi that was occasionally a problem.

Gail

Gail often mentions her age as being a factor when starting the workshop. She was afraid that she would not be able to keep up and often searched and tried things on her own to prepare herself so that she could keep up. To her surprise she coped very well. She planned lessons that were very interactive using technology in innovative ways. She described her experiences as positive and very beneficial to her learners. The motivation from her learner responses made Gail plan effectively and kept her positive throughout the study.

Heidi

Heidi was very enthusiastic but her contribution to the focus group discussion was minimal. This was simply because she did not plan effectively and became frustrated with the technology at first. She did mention though that the learners often helped her if she could not use it and so the lesson commenced. Heidi in the focus group discussion isn’t sure of the usefulness of technology yet and finds that time and her

ability to remember what to do when using the technology plays an integral role in her adoption to using it.

Jill

Jill did not contribute much in the focus group discussion but used technology to teach. She finds it exciting and very important for her to keep up with using innovative ways of teaching. She describes it as fun and enjoying teaching. She says that her learners are very responsive and cooperative in class when they use technology.

Kevin

Kevin contributed a significant amount to the focus group discussions. He is in favour of technology use but finds that it does not necessarily lend itself to Engineering Graphics and Design. He found ways to ensure all learners had devices and confirms that devices and Wi-Fi are some of the facilitating conditions that withhold technology integration. His learners responses are “Please sir, can we do it again?” and his affirmation from his learners creates a positive attitude for him as a teacher. He explains the importance of teachers having extensive technology knowledge and how this could “take teaching to a whole new level”. He is confident about teaching with technology and believes that it should be used for reinforcement to enhance learning. He elaborates on how teachers want to have “control” over their work and the importance of changing your teaching approach.

Liam

Liam showed a very negative response to technology use once he had to start implementing it, so much so that he stopped attending the focus group discussions. He agreed that all the resources were available but the time to prepare was a major factor for him. He spoke about not having control over what the learners were doing and the expense of certain apps and software. He felt that he would rather use the technology but not while teaching and not with the learners.

Mary

Mary started the workshop being very enthusiastic about technology use but once she had to implement it she only used it for assessment and once to introduce a lesson. She found that the technology didn’t lend itself to the level of maths she was

teaching. Even though she felt her learners enjoyed it, facilitating conditions such as Wi-Fi, data and the technology kept letting her down. She also didn't attend all the focus group discussions. She seemed very disinterested as she didn't have the time to plan for the lessons.

Nina

Nina didn't contribute much in the focus group discussions. She became frustrated with the technology and Wi-Fi and time to plan made her very negative about using technology. She understood the usefulness and how much learners enjoyed it but she was not convinced about using it.

Owen

Owen was in favour of technology use and tried several things. He found that it saved time as they didn't need to spend time copying things down and this meant they could use "class time more effectively". He used it for online grading, and also tried a flipped classroom where he could monitor their work even though he was not in class. His concerns were having all the learners on at the same time and available Wi-Fi as aspects that needed to be planned carefully.

Pam

Pam used several different integrated approaches in class and found that her learners loved using it. Technology lends itself well to life sciences. Her concern was also Wi-Fi and she felt that this was such a huge factor that it would determine how despondent a teacher becomes about the use of technology. She was enthusiastic and saw technology as a great way to enhance her teaching.

At the end of the focus group discussions Anne, Carol, and Liam had decided they were not going to use technology because even though it was useful the traditional methods worked and they were comfortable with using it. Elize and Kevin felt that the technology didn't lend itself to their subjects. Brenda, Heidi, Mary and Nina, were negative as they didn't use it, couldn't use it effectively or the facilitating conditions frustrated them so they didn't use it. Dora, Fred, Gail, Owen, Jill and Pam managed to successfully integrate technology into their teaching and had positive results.

5.13 Professional Teacher Technical Identity Development Framework 2

After Phase 3 of the study other factors started to emerge that influenced the acceptance of mobile technology and the identity development of teachers. It was now becoming evident that there was a change in some of the teachers' preconceived ideas and perceptions of mobile technology use. Section 2 of the questionnaire which is explained in Section 5.8.1 illustrates the teachers' responses to questions that relate to the perceived ease of use and perceived usefulness of technology, now that they have started implementing it. There is an evident change in how some of the teachers feel about technology use now as compared to the onset of the study. This is evident in Section 5.8.2 where the teachers' anxiety towards technology use increased and their attitude towards technology was more positive. The researcher aimed to provide favourable conditions for the study and this was confirmed in the Figure 5.15. The teachers believed that support was available and they wanted to use technology to teach. Table 5.27 summarises the influence of the factors during Phase 3 of the study.

Table 5.27: Influence of factors contributing to teacher technical identity development

Figure	Factors	Framework Code
5.12	Positive attitude maintained	**T11**
5.13	Low ICT anxiety	**T12**
5.14	High ICT ability	**T13**
5.15	Facilitating conditions favourable	**T14**
5.16	Support available	**T15**
5.17	High voluntariness	**T16**

Section 3 looked further into the factors of subjective norm, facilitating conditions and voluntariness. The results suggest a relationship between FC - perceived usefulness **(T14)**, SN - perceived usefulness **(T15)** and voluntariness - perceived usefulness **(T16)**. Facilitating conditions such as access to Wi-Fi and subjective norms, such as what their colleagues think of technology use and having the option to voluntarily use technology, started to play a role in their perceived usefulness of technology. The teachers did not only need to find the technology easy to use but they needed to find it useful and in order to render it useful these three new factors of facilitating conditions, subjective norm and voluntariness needed to be addressed. Facilitating conditions was prevalent to play a crucial role in technology integration as mentioned by Brenda, Heidi, Liam, Mary, Nina and Owen during the focus group discussion. In

this case the main limiting factor being the Wi-Fi connection. The voluntariness of wanting to integrate technology can be seen by the contrasting perceptions of Carol and Fred in the focus group discussions. The subjective norm evidently played a role as mentioned by Carol, Dora, Elize and Pam in how the learner response and the syllabus impacted on their willingness to use technology. Section 4 of the online questionnaire shows the experiences that the teachers had as they started implementing technology. Figure 5.33 emphasises these experiences and they are confirmed by the lesson reflections and reflective journal. The change in their way of planning and delivering lessons, resulted in an identity change. The dropping of the components "*substitution*" and "*augmentation"* to "*enhancement*", and "*modification*" and "*redefinition*" to *"transformation*" was confirmed as the teachers perceived level of integration and actual level of integration was not always the same. Table 5.26 reflects only the actual level of integration as the focus group discussions confirm more elaborately that this distinction could not be made (E.g Fred). The focus group discussions confirmed most of the findings in the online questionnaire and also gave the teachers the opportunity to express their challenges and concerns about technology use. The descriptive responses provided insight to the data and emphasises the practical contribution **(P2)** of the study. The codes used in the previous Framework are not explained again as the findings remained consistent. . Framework 1 was re-designed to include the 3 new factors as shown in Figure 5.34.

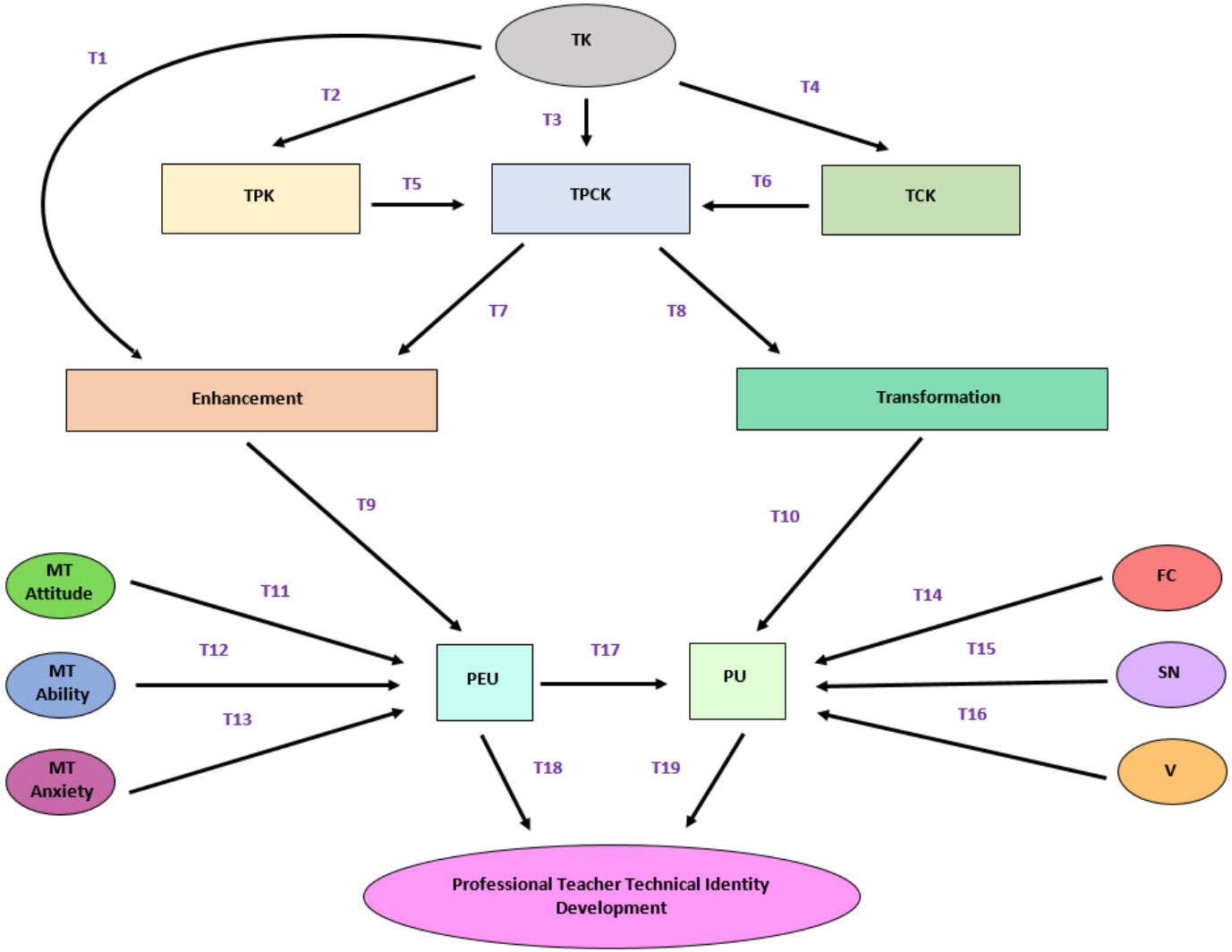


Figure 5.34: Professional Teacher Technical Identity Development Framework 2

The purpose of the interviews was to clarify and confirm the data already collected and establish an understanding of how identity development occurs. The interviews provided a holistic perspective of the entire implementation process and also identified shortcomings in the methodology of the study. The interviews created a platform for teachers to show their awareness of their professional teacher technical identity and how technology use has impacted on their teaching.

The interviews which are also part of Phase 3, occurred two years afterwards to confirm the data obtained and to identify any information that may have been left out. The interviews were conducted with Anne, Jill, Fred and Heidi. These participants were purposefully chosen and were still willing to contribute to the study. Anne was chosen because she held a very positive attitude initially which then changed when she realised that her technology ability limited her. The researcher suspected that identity development would be more clearly recognised in the case of Anne as she already showed a change in her perception of technology use. Jill was chosen because she was young, keen and eager and the researcher wanted to find out if she had progressed beyond the study requirements with her technology use. Jill would possibly show levels of progress in technology use. Fred was chosen because he had excelled and reached the highest level of the SAMR model, so he could explain some of his challenges and methods to overcome them. Fred's contribution to the study provided a holistic outlook on technology implementation and identified many of the challenges that are commonly faced. Heidi was chosen because she understood the usefulness but did not manage to implement mobile technology. Heidi was interviewed to investigate if she would make the attempt to use technology on her own if she found it useful but difficult to use. All four of these teachers would be able to explain if the study impacted on their teaching methods and if their teacher identity had changed. Jill was the only novice teacher, whereas Anne, Heidi and Fred had several years of teaching experience.

5.14 Analysis of Semi-structured interviews

Four participants were selected for semi-structured interviews. Two (Anne and Heidi) that showed very little progress at the onset of the study were selected and two (Jill and Fred) that showed great progress at the onset of the study were selected. This was done because it was assumed that changes in professional teacher technical

identity development would be more clear and visible. The interview questions were structured in six categories that were purposefully used to gather as much information as possible to either confirm or revoke previous findings. The interviews are analysed using the identity model by Izadinia (2014).

Anne and Heidi showed little to no change at the start of the study. Jill and Fred took to the technology use instantly and showed great progress in implementation and professional teacher technical identity development. An account of each interview is given below highlighting the aspects that add value to the study and emphasise identity development.

Anne

Anne perceives mobile technology as useful as it allows for audio-visual stimulation which is necessary for her subject. She does basic technology integration such as YouTube videos which enhance her lessons. Factors that limit her mobile technology usage are Wi-Fi access or power failure. Anne describes her emotions as frustrated, impatient, angry and nervous at the onset of the study which was due to her not receiving one on one support, which she regards as necessary for older teachers, and not knowing what to do if something goes wrong. This illustrates a change in ICT anxiety as she says she is more confident, less nervous, not scared, and more comfortable with technology use now. Much of Anne's anxiety is as a result of ICT ability as she explains how she is unsure how to access certain things and how she needs support in order to create her own PowerPoint presentations. Anne explains how she has changed since the workshop by being more willing to try new things and that since she is more confident she finds technology to be more useful and beneficial. This suggests that a teacher's willingness and positive attitude are directly linked to technology use. She also explains how she sees it more as progression and not just the workshop, suggesting the voluntary, life-long learning as a teacher. She emphasises this by saying, "I suppose I view myself now as more modern, keeping up with the changes let's say, keeping with modern times."

Looking at all the data collected for Anne, it is evident that Anne has high ICT anxiety at the start of the study but gradually becomes more comfortable with technology use. This anxiety is largely dependent on Anne's poor ICT ability which is evident in her score of 7/24 for technologies used in the written questionnaire. Anne has

maintained a high perceived usefulness throughout the study but has changed in terms of perceived ease of use. This can be seen from the reflective journal, her unwillingness to be part of the focus group discussions and her more positive attitude towards technology use now in the interview. Figure 3.35 provides a summary of Anne's Technology use. The change during implementation is highlighted.

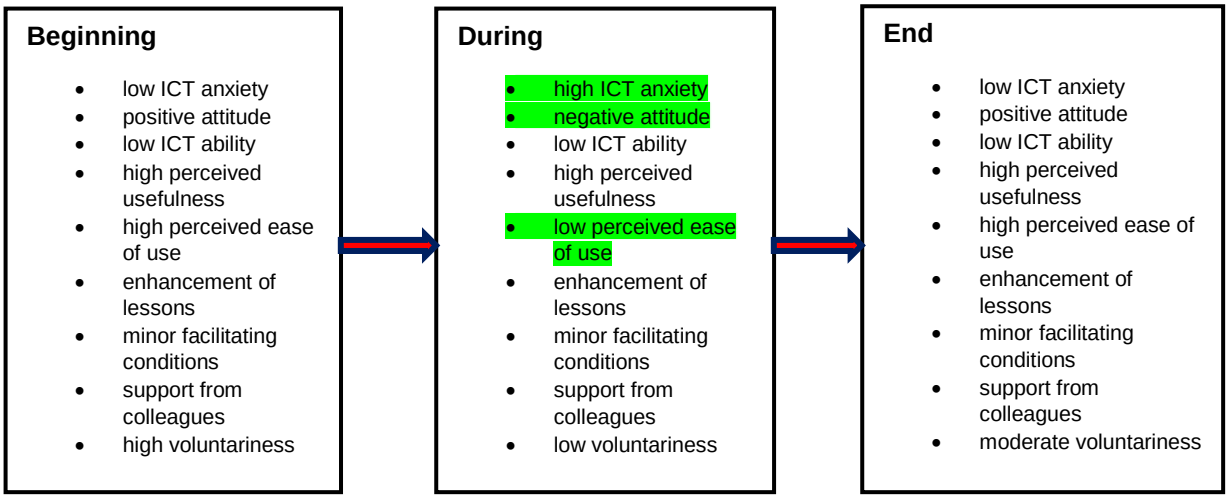


Figure 5.35: Summary of Anne's Technology Use

A further analysis of the data can be done using the identity development model by Izadinia (2014). Anne's teacher identity reflects an openness to mobile technology use. In terms of self-categorisation, Anne tends to feel that her age and lack of ability to use ICT makes her seem less confident. Even though Anne's is accepted by her colleagues she chooses not to be a part of the focus group discussions as it made her uncomfortable. Once Anne tried to use technology at her own pace and gradually implemented it, she found that it became easier, implying self-verification. Her teacher identity then changed and developed to accommodate mobile technology in her teaching and she uses it with more ease to enhance her lessons. Figure 5.36 illustrates the identity development process of Anne.

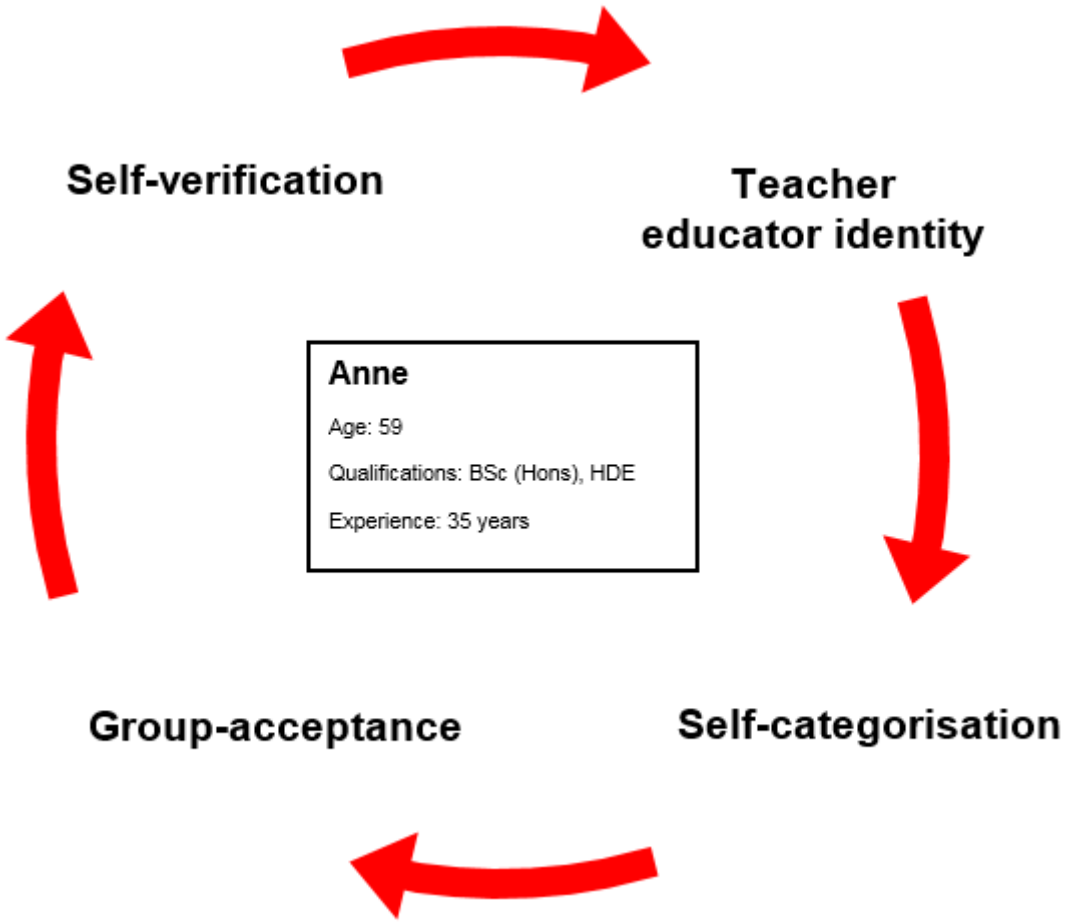


Figure 5.36: Summary of Anne's Identity Development

Initially Anne can be regarded as a non-adopter as she only explored the use of the tablet but did not reflect on what it may have to offer over a long period of time. This is in line with the works of Hu, Poston, and Kettinger (2011). Further on in the study Anne became a slow adopter as she spent time initially reflecting on the capabilities of the tablet and later realised the full potential benefits within a classroom setting. She only needed to be shown how to engage with the technology and then took the initiative to slowly explore and experiment its various uses. This is in agreement with Venkatesh et al. (2003a) where on-going support is needed for professional development.

Heidi

Heidi finds mobile technology to be useful but did not manage to implement much of it in her teaching. She emphasises time and a demanding syllabus to be her main limitations for this. Heidi uses mostly YouTube videos and PowerPoint to teach, suggesting an enhancement of learning. She maintains a positive attitude throughout

the study but mentions her age and technology ability as a downfall in actively using technology. Her greatest challenge is to set up whatever is required for the lesson with technology and she believes that continuous support is necessary for teachers that are already in the system for several years. Heidi highlights the importance of such courses for future teachers as being beneficial, again showing that she finds technology useful. She wants to learn and change her teaching style, illustrating voluntariness and a willingness for personal growth. She describes her initial feelings of technology use to be weary, nervous, fearsome, anxious and apprehensive but later found herself to be less fearful, experimental, willing to ask for help and not afraid of failure. She is open to technology use but is afraid of losing control of the class because of her ICT ability. She describes changes in her approach to planning and speaks of a mind shift towards being more open to technology. Figure 5.37 provides a summary of Heidi's technology use. The change during implementation is highlighted.

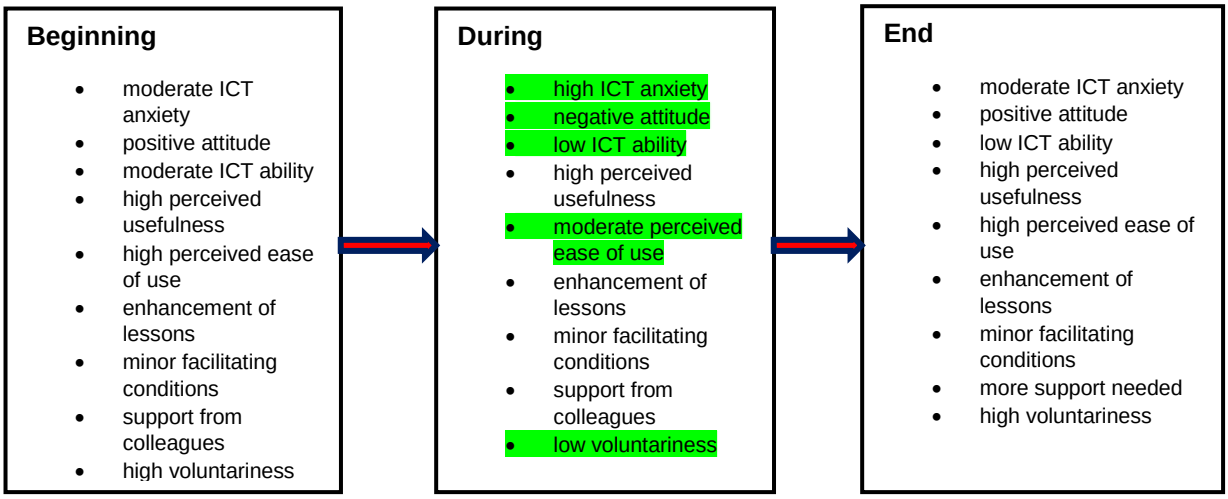


Figure 5.37: Summary of Heidi's Technology Use

Heidi's data displays a low use of technology as she only scores 6/24 in the written questionnaire for technology used. She is anxious from the start but very positive about using technology and willing to learn. She mentions age as being a factor that limits her many times, however concludes by saying that colleagues that are older have mastered the technology use in their classrooms and perhaps it's the subject and initiative taken by the person. Heidi shows change in her perceived ease of use as she explains how she would need time to plan and practise before using

technology more frequently. She also shows change in ICT anxiety as she becomes more confident but still uncertain. Figure 5.38 illustrates the identity development of Heidi.

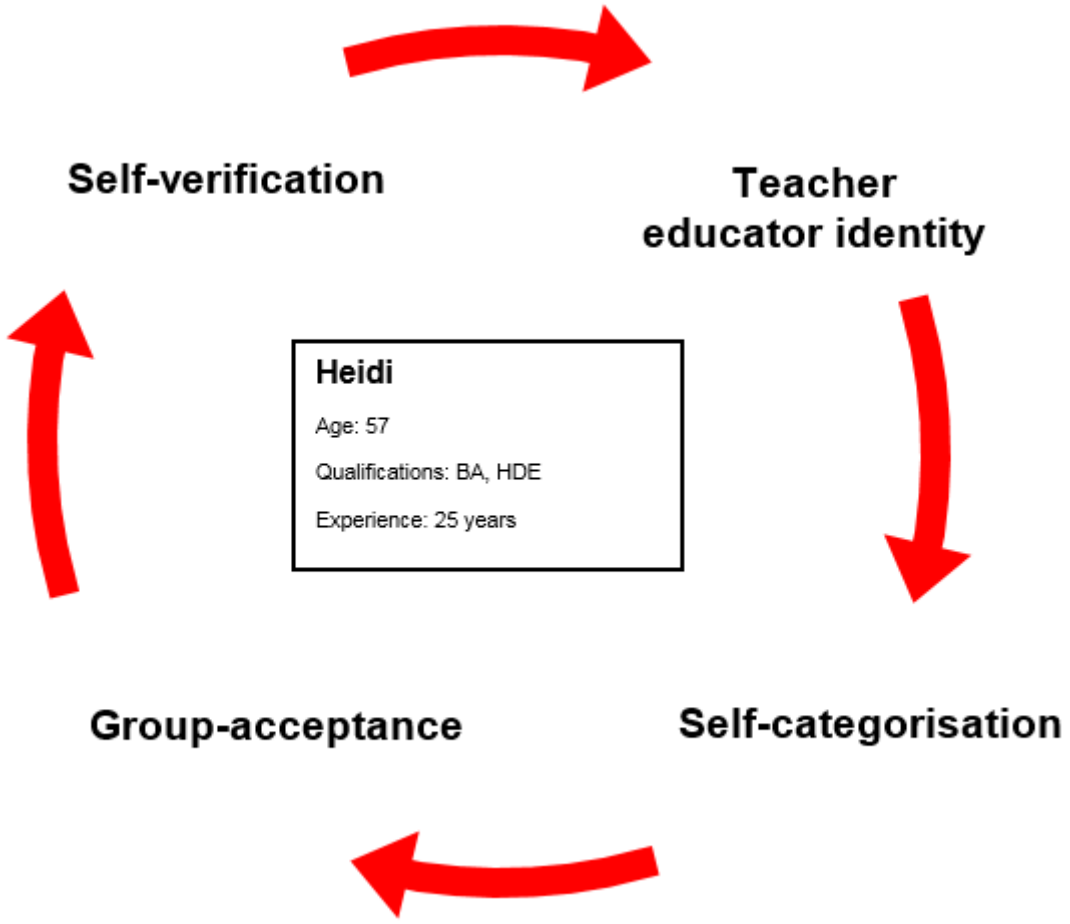


Figure 5.38: Summary of Heidi's Identity Development

In terms of Izadinia (2014) identity development model Heidi has a very traditional teach identity. She is not aware of the availability of technology resources and has not explored further to find out how she can enhance or transform her lessons. She categorises herself as being someone that is not in the "millennial age" and therefore uses her age as a limitation when it is actually her technology ability and ICT literacy that restricts her. In terms of group acceptance, Heidi mentions negative people that tend to demotivate her and youngsters that somewhat intimidate her. Heidi does enjoy using technology if she gets it to work properly as illustrated in, "The games, we set up I made one or two of them on my own Kahoots which I enjoyed making, I was quite proud of myself…"

Heidi speaks of a mind shift which is similar to the paradigm shift mentioned by Rajasingham (2011) in the literature. Her openness to use technology has created this mind shift. Heidi can be seen as a contained limited adopter as she did limited reflection on the use of tablets. There was no degree or depth to her use of the tablet and its long term potential benefits. There was an inherent refusal to explore beyond the immediate functionality and to find suitable methods of using it. She therefore only used it within existing limits and did not seek out any further capability or use. This was also found by Venkatesh et al. (2003a).

Jill

Jill maintains a positive attitude toward technology use and technology integration throughout the workshop. She is very eager and willing suggesting voluntariness. She finds technology to be useful and easy to use and sources information easily for her lessons. She enjoys the variety it brings to her lessons and makes learning creative and fun. Jill mentions having a back-up plan to accommodate for facilitating conditions such as power outages or Wi-Fi access. She understands assistance to be more along the lines of hardware and software and not in terms of support by someone else. This is interesting as she does mention that the older teachers often struggle to plan with technology because of their lack of ICT literacy. Jill has no anxiety towards technology and is confident because she is proficient in technology use. Figure 5.39 provides a summary of Jill's technology use. The change during implementation is highlighted.

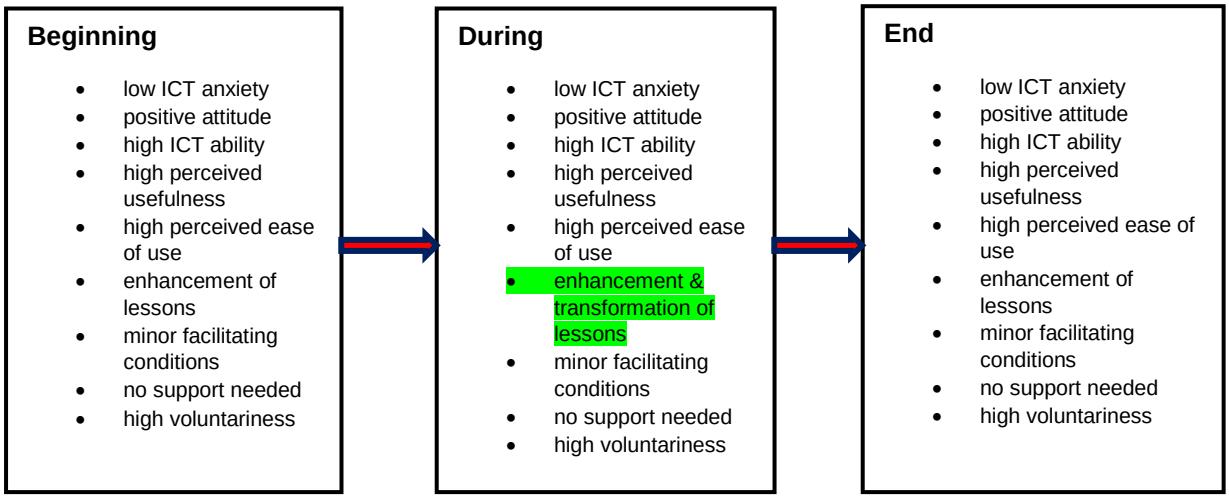


Figure 5.39: Summary of Jill's Technology Use

Jill scored the highest in the written questionnaire for the number of uses of technology, 18/24. She maintains a low ICT anxiety and high ICT ability throughout the study. She is positive and willing to try new things. She takes the initiative on her own and always plans if there are facilitating conditions that may disrupt her lesson. She does not require additional support and finds technology useful and easy to use. Figure 5.40 illustrates Jill's identity development.

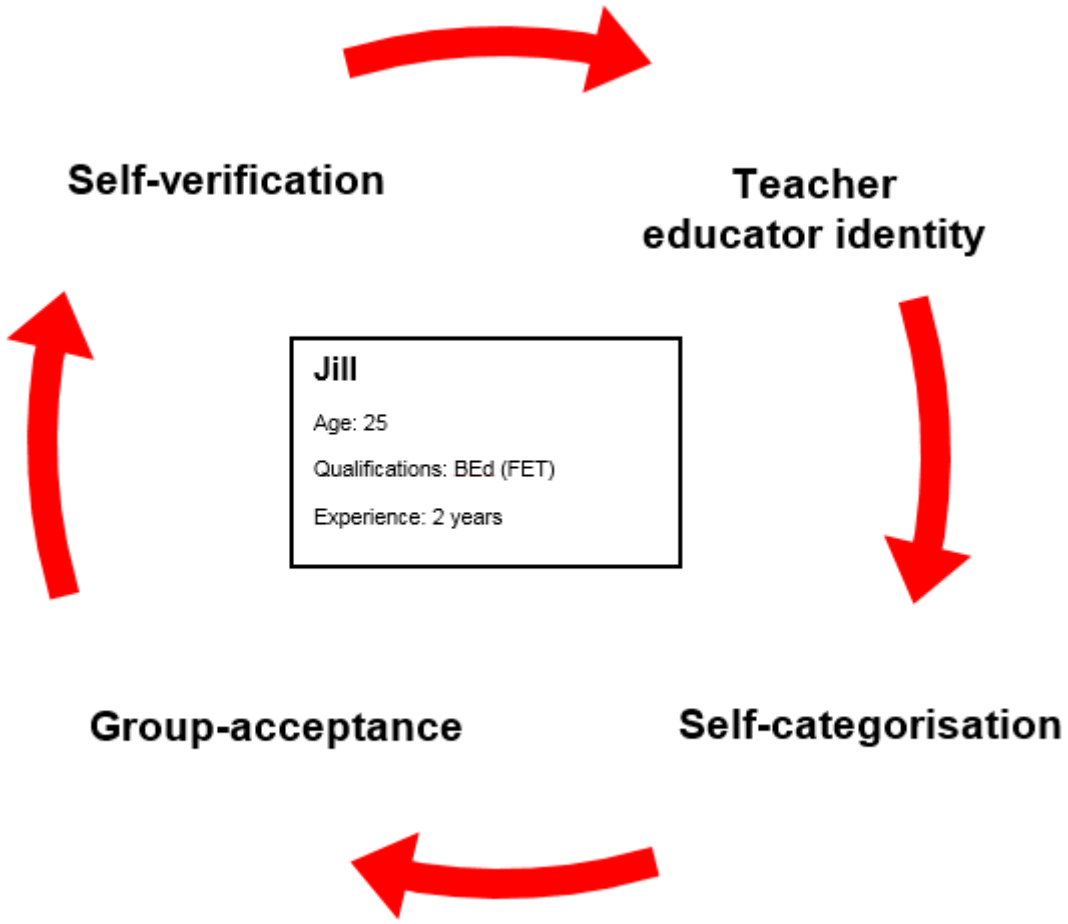


Figure 5.40: Summary of Jill's Identity Development

Jill's teacher identity is perceived to be open and willing to learn and grow. She fits into the study well as she finds it easy to use technology and she enjoys using it because it results in creative, innovative lessons for her students and this makes her lessons fun. The response from her learners plays a big role in her wanting to plan with technology. Jill feels accepted because she is using modern and current teaching methods that are applicable to the learners of today and they can relate to it. She sees this positive result and feedback from her learners as self-verification and uses it to develop further.

Jill can be considered to be an early adopter as she looked for different ways to enhance her teaching using the technology and the knowledge she gained to find different and innovative, applicable apps for her subject. There was great versatility and social interactions in her lessons thereafter and she continued to improve her teaching with the use of technology. This concurs with the works of Wenger, White, and Smith (2009).

Fred

Fred's contribution to the study was very beneficial and he gives very elaborative responses throughout the interview. Fred has always been positive about technology use and has been using it before the workshop. He finds it to be useful and has even created his own class reflections of the use of technology to help develop and advance his lesson planning. Fred is very confident with technology and mentions that teachers are often resistant and fearful towards technology use. He finds teaching with technology to be a "collective journey" with his students and that this is a higher order process. Fred mentions the scepticism and criticism and negativity of other staff that tend to hinder one's progress with using technology. He feels that learners are also often overwhelmed by teaching with technology and that it should be a gradual process of implementation because they need to understand how the technology works in order to interact with it. He has found the learners response to be positive but teachers don't realise, "that by making mistakes and by the failures you were learning new things…". Fred has the support of four other colleagues and they share ideas and assist each other. He also mentions that teachers use their subject as an excuse to not show initiative to integrate technology. Figure 5.41 is an illustration of Fred's technology use.

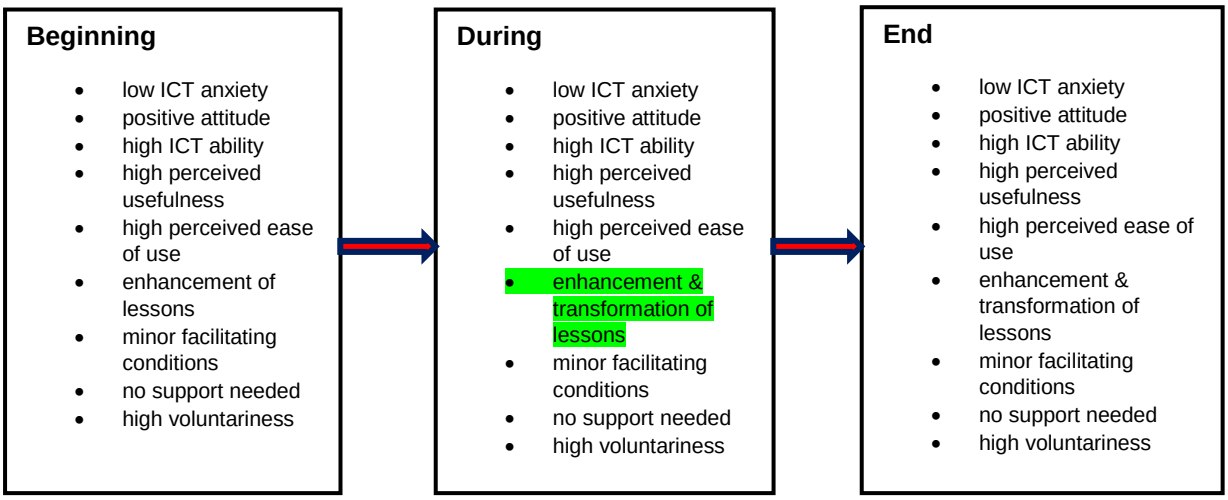


Figure 5.41: Summary of Fred's Technology Use

Throughout the study Fred has been the most positive and eager participant. He has managed to teach lessons on the redefinition level but found that learners still want to be guided and that the use of technology in lesson is still relatively new to them. He has excellent ICT ability, and ICT attitude. He has no ICT anxiety and finds technology to be useful and easy to use. He is not discouraged by facilitating conditions and works around them. He voluntarily uses technology and tries to develop further. He receives support from his colleagues and offers support to his colleagues. Figure 5.42 illustrates Fred's identity development.

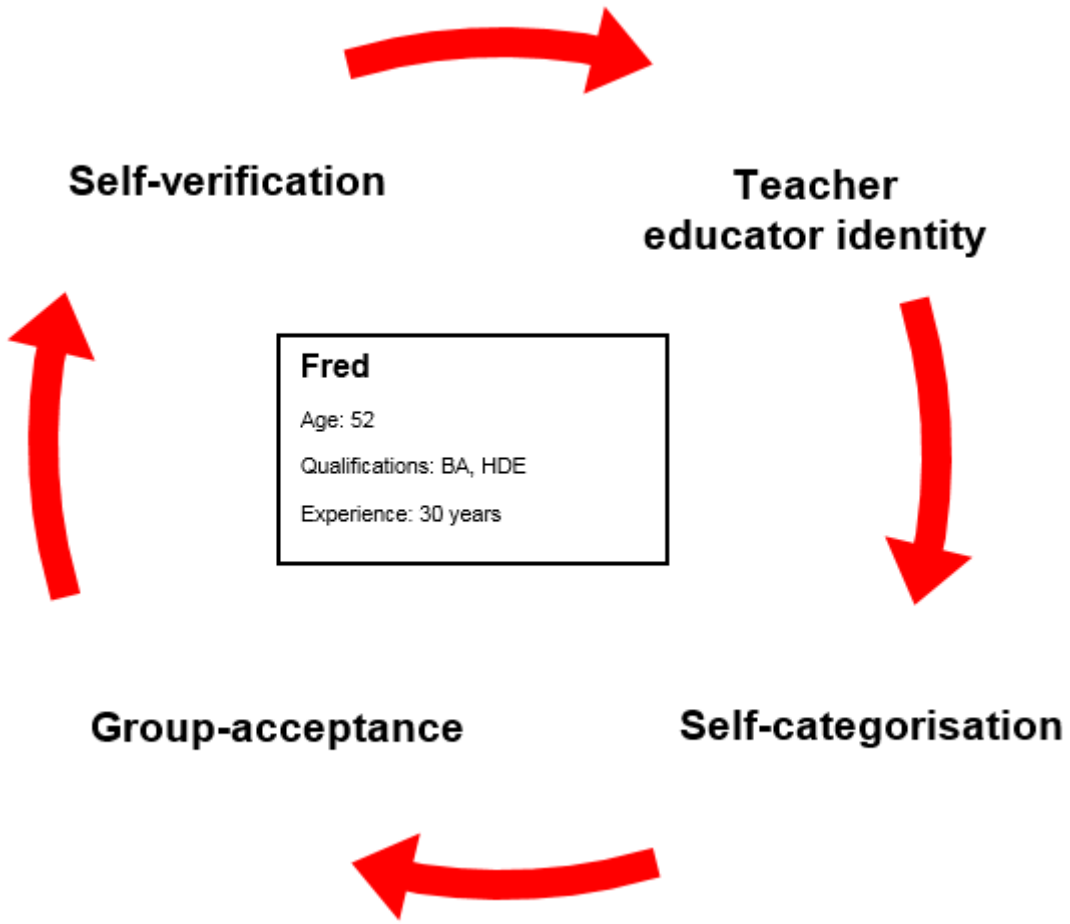


Figure 5.42: Summary of Fred's Identity Development

Fred's teacher identity is ever changing in that he is consistently developing and open to growing and learning more with and about technology use. He has a very positive attitude towards teaching in general and this encourages him to try different things. Fred believes that he offers his students a different approach to learning by using technology. However, this approach is often criticized by his colleagues as it is different and they are resistant to the use of technology. He gets his self-verification from the response from his learners and also having now done this workshop. It has in many ways confirmed his belief of teaching with technology to be beneficial and useful. Fred's teacher identity has changed in that he has developed new skills and is not complacent in his teaching methods. This is evident in his descriptive responses during the focus group discussions and interviews of lessons he has conducted. It has allowed him to actively source new methods and resources to transform his teaching.

5.15 Findings – Phase 3

Figure 5.43 illustrates the coding of the data that was collected throughout the study. It emphasises the factors that contribute to the perceived usefulness and the perceived ease of use. These factors are further broken down by words that the participants used to describe their emotions, perceptions, experiences, challenges, and successes. By evaluating the change of these emotions, perceptions, experiences, challenges and successes, the development of professional teacher technical identity becomes more visible as clearly discussed and illustrated in the lesson reflections, reflective journal, focus group discussions and interviews. All the teachers have shown some change in teacher identity. It is important to note that this change was brought about by the implementation of mobile technology.

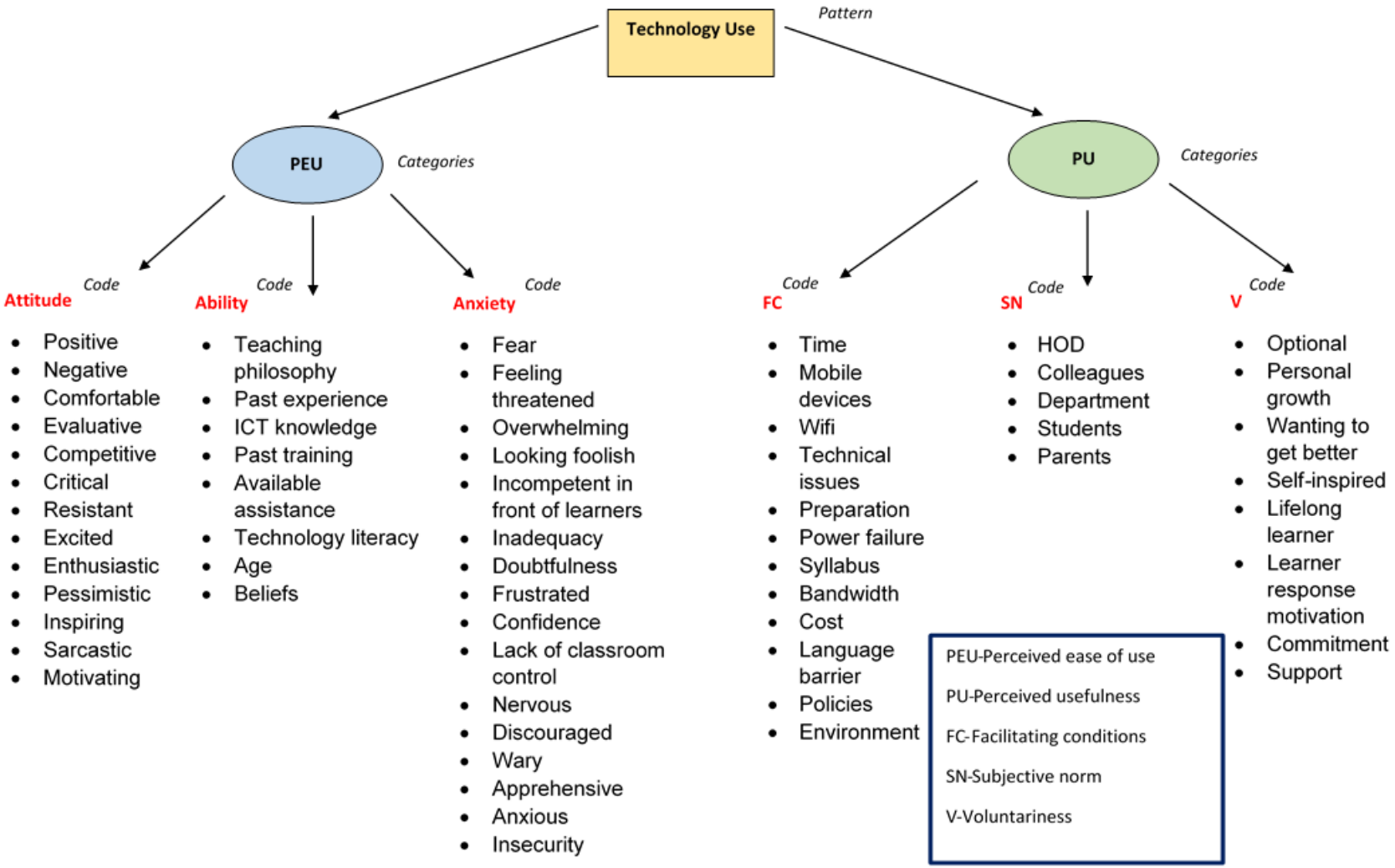


Figure 5.43: Common codes applied and extracted during data analysis

The next Chapter will give an elaborate account of the development of the conceptual Framework to assist teachers in implementing mobile technology, and how this Framework was developed using the data obtained in this Chapter. A final evaluation of Framework 2 is done after the interviews to incorporate any new findings and understand the relationship between all the aspects represented in the Framework. The final Framework will be given in Chapter 6 where an attempt to answer the research questions will be provided with further recommended research.

Chapter 6

Summary of the Findings, Conclusion, Recommendations and Implications

"Technology is a useful servant but a dangerous master"

Christian Lous Lange

6.1 Introduction

The final chapter of this thesis provides a consolidated account of the findings and proposes the conceptual Framework for Professional Teacher Technical Identity Development.

This Chapter will summarise the relevance of the TPCK, TAM and SAMR model, address the research questions and provide recommendations for further research. The limitations and implications of this study will also be deliberated.

6.2 Research Overview

Figure 6.1 illustrates the thesis overview as presented in Chapter 1. This diagram summarises the events of the study according to each chapter and provides a brief outline of how the research was conducted. A detailed account of each aspect is presented in the thesis. A descriptive account of the development of the new framework is given in this chapter, together with a summarised explanation of how each framework was designed throughout the study.

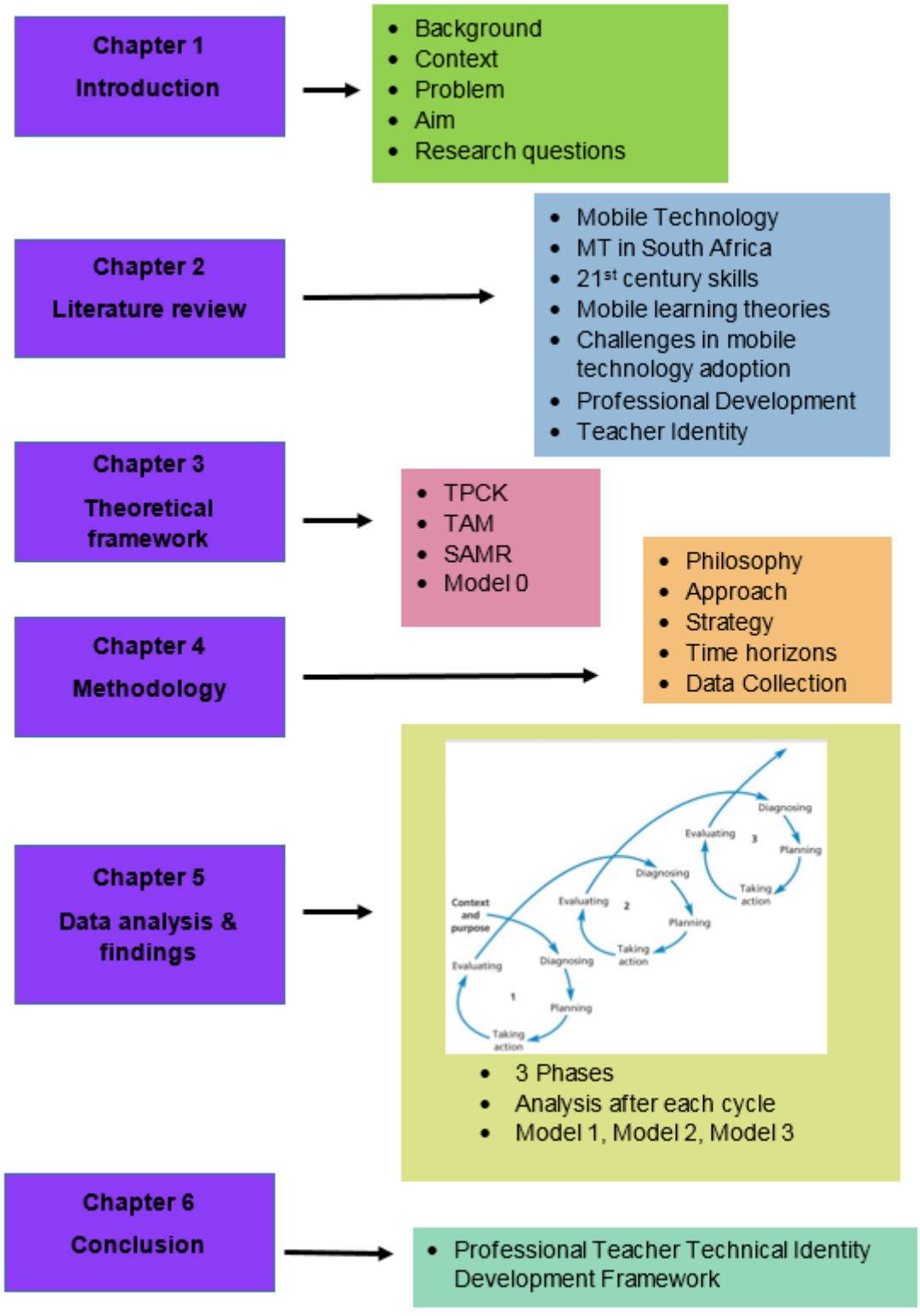


Figure 6.1: Structure of Thesis

6.3 Research Findings

6.3.1 Findings on the relevance of the three models

Each model was specifically chosen by the researcher because it added value and relevance to the study as mentioned on page 82. Since the study needed to show the inclusion of mobile technology, an aspect of teacher acceptance to mobile technology and an element of how the technology would be implemented in teaching, these three models were chosen.

6.3.1.1 Relevance of the TAM Model

The findings confirm the teacher acceptance part of the study and the relevant use of the TAM model as a theoretical Framework (see Section 3.3). Essentially the teacher's acceptance of technology is the most crucial part of the implementation process and will govern any further growth or identity development. If a teacher is unable to overcome all of these factors that contribute to perceived usefulness and perceived ease of use, the actual use of technology is limited and he/she is less likely to implement technology use (see online questionnaire and focus group discussions). The TAM model emphasises the importance of the role of the teacher in the implementation process. This can be seen in the literature (Mac Callum et al., 2014).

6.3.1.2 Relevance of SAMR model

The level of complexity in terms of technology use (Puentedura, 2012) is the next factor that was examined. The lesson reflections, focus group discussions and the interviews confirmed that the teacher's level of technology usage was highly dependent on their perceived ease of use and their perceived usefulness of technology. Yet, it is not possible to confidently say that only one of the two factors determines whether the lessons are enhanced or transformed. This is due to teachers' beliefs of the usefulness of technology but constantly mentioning that it should be used collectively with traditional methods and should not replace current methods (see Section 4 online questionnaire). The uncertainty created by technology ability places a restriction on the usefulness and actual use of technology. This in turn determines the level of technology usage and explains the relevance of the SAMR model as a conceptual framework for the study (see Section 3.4).

6.3.1.3 Relevance of the TPCK Model

The TPCK model is the essence of the study (see Section 3.2). In order for teachers to implement mobile technology they need to have knowledge of the content, pedagogy and relevant technology. All the teachers showed relevant TPK and TCK from the lesson reflections and through the focus group discussions when they explained how they would incorporate the technology into their subject. The ability to decide when and how it should be incorporated shows sufficient TPK and TCK. The TK was provided by the mobile learning workshop to assist the teachers with technology literacy and guide them on how and where to source subject specific and generic apps that they could use for teaching. It is expected that if a teacher is able to use technology together with content and pedagogy then TPCK is achieved (Mishra & Koehler, 2006). If this is mastered then the teacher's Professional Teacher Technical Identity has been altered because the element of technology has been included successfully in his/her teaching.

6.3.2 Research findings based on the empirical data

The research findings are presented for each Phase with a summary of the changes in the development of the Frameworks from each Phase. Data collected from each Phase required a redesign of the Framework to incorporate the findings. This representation was chosen as it is best suited for an action research approach.

6.3.2.1 Findings from Phase 1

From the literature study it was evident that there was a link between mobile technology and professional teacher identity (Siddiq et al., 2017; van Laar et al., 2017). The barriers to m-learning as presented in Section 5.2 illustrate that there are many gaps that need to be filled before successful implementation can take place. A detailed description of the development of Framework 0 is given in Section 5.2. Figure 6.2 illustrated the relationship between the three models and outlines the role that they play in professional teacher technical identity development and in this study. This was further elaborated on in Section 6.3.2.

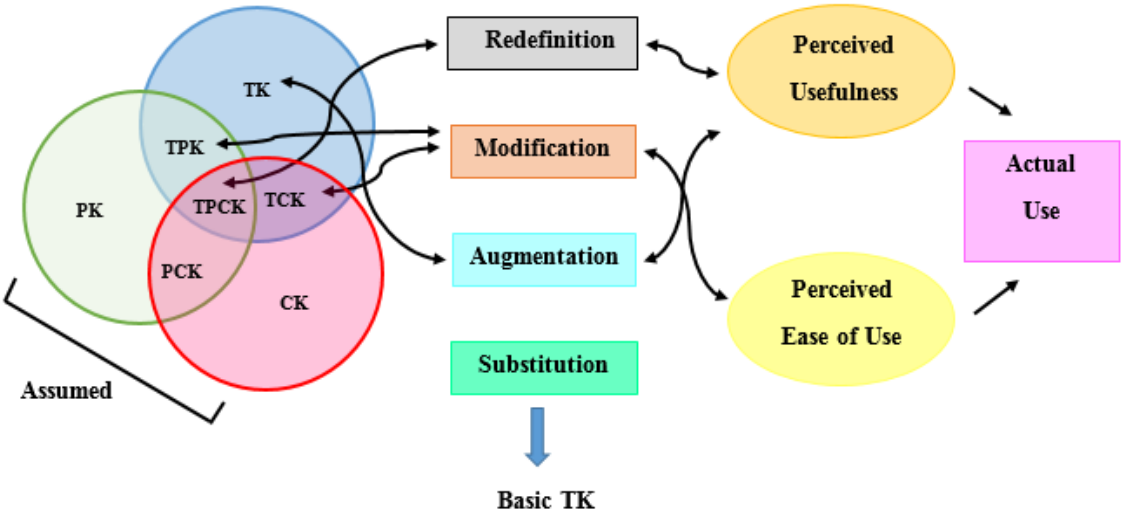


Figure 6.2: Framework 0

6.3.2.2 Findings from Phase 2

The findings from Phase 2 of the study confirmed much of what was found in the literature regarding mobile technology use and the factors that contribute to the effectiveness of mobile technology use. The findings are largely similar to Mac Callum et al. (2014) in terms of teacher acceptance towards technology. This was found using the written questionnaire (see section 5.4) and helped to provide some bases for the study on where to pitch the training done in the mobile learning workshop. The questionnaire provided insight on the level of technology literacy that the teachers had and how accepting and willing they were to learn how to implement it in their classrooms. The reflective journal (see section 5.5) displays various different responses as the teachers started to use the technology and provides awareness of their existing teacher technical identity, which was vital in the study in order to track their development. The TPCK model was reduced to only show the technology aspect as this was the influential factor. From the data obtained three factors were found to contribute to the perceived ease of use of technology. In addition it also included the relationship of perceived ease of use and perceived usefulness. This is illustrated in Figure 6.3.

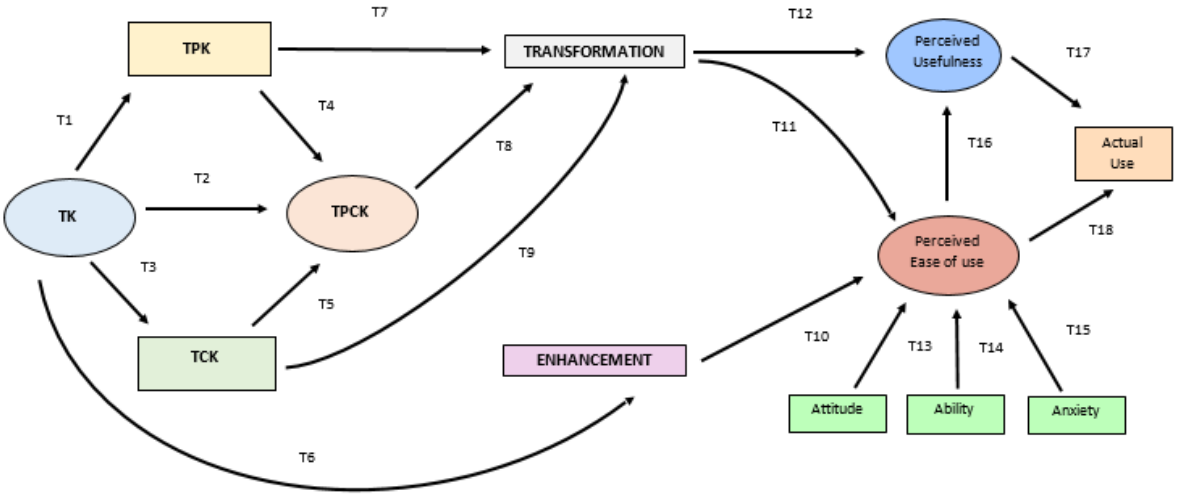


Figure 6.3: Framework 1

6.3.2.3 Findings from Phase 3

Other factors found in the models related to the TAM model include voluntariness and subjective norm, and facilitating conditions were also found. A large amount of the data confirming this came from the online questionnaire. The responses from the graphs (Section 3 online questionnaire) reflect that teachers accept technology more willingly if they believe it will offer them personal and professional growth and because they aspire to be better at their job. This should be optional and self-paced, putting no pressure on them to use technology. Support from their institution, colleagues, learners, parents and the Department of Education motivates and encourages their use of technology. However, facilitating conditions such as Wi-Fi connectivity, power failure, technical issues and time seem to largely limit their progress of implementation. Whilst time for preparation is also a major factor, the willingness of the teachers often overcomes this. These factors largely determine the teacher's perception of whether or not technology is useful and worthwhile for teaching.

The three factors mentioned by Mac Callum et al. (2014) were clearly identified and confirmed in the focus group discussions. Anxiety was the most prominent as the perceived ease of use of technology displayed considerable change in the lesson reflections. It was here that teachers identified most of the subjective norms and facilitating conditions that impacted on their perceived usefulness. They used descriptive words to explain how they felt and when the lessons went well and when the lessons did not go well. They also explained the impact that the technology had on their lesson and how their learners responded to it. Each lesson and discussion

provided insight into the action research that was taking place and allowed for several responses that changed during the course of the study for each teacher. The summary of these changes and the impact on the lesson is illustrated in Figure 5.33, showing the development and construction of a new teacher identity. This led to the design of Framework 2 which is illustrated in Figure 6.4; it includes the three factors that contribute to the perceived ease of use and the three factors that contribute to the perceived usefulness.

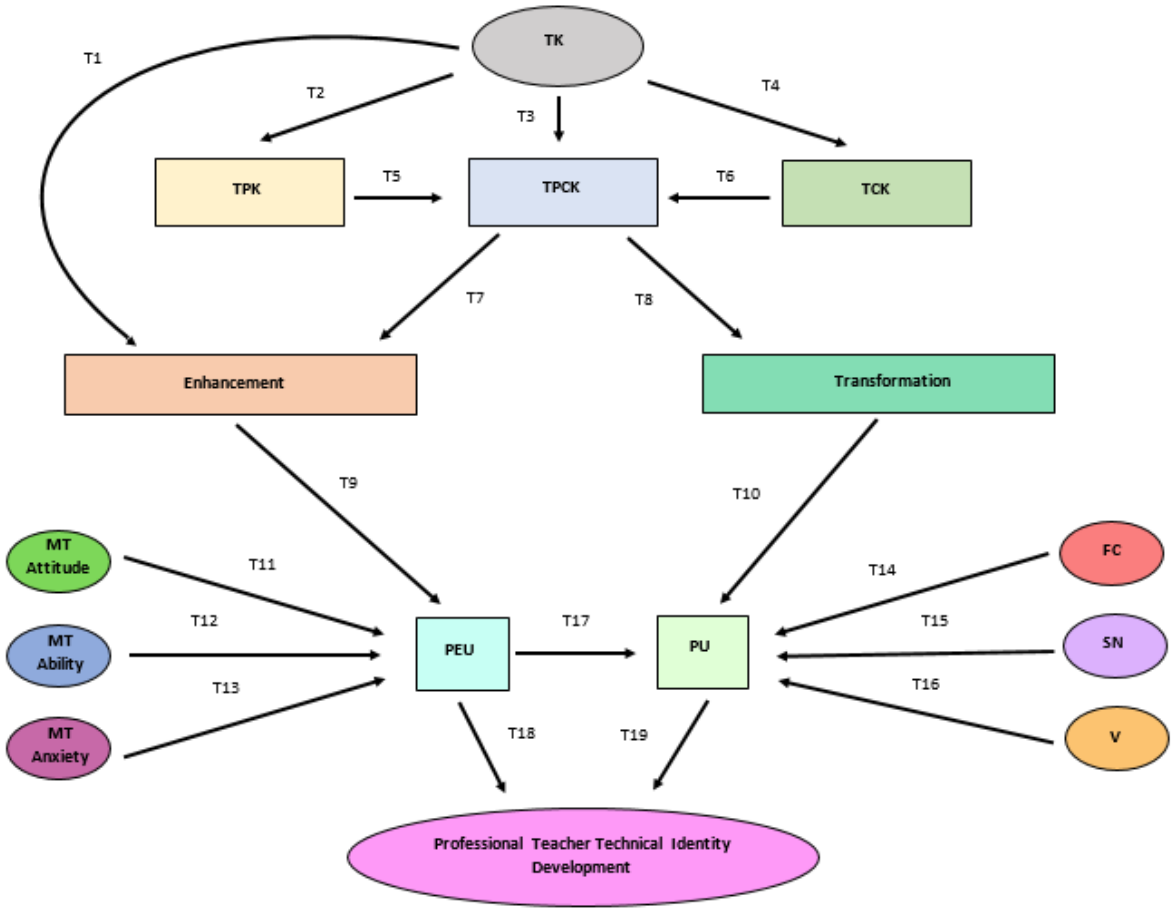


Figure 6.4: Framework 2

Phase three of the study confirmed the relevant data in the previous Phases, however another link between Ability and Attitude and Ability and Anxiety may be evident. Whilst a teacher's Attitude towards teaching with technology plays a major role in the ease of use of technology, it was found that there is a large overlap between these three factors. The data is insufficient to conclude as to whether the teacher's Attitude may cause technology Anxiety, as some teachers found it easy to use technology and still chose not to and the teacher's Ability to use technology played a role in creating technology Anxiety that determined the perceived ease of use. The interviews

confirmed that factors such as technology literacy, past training, past experience with technology and age play a vital role in the teacher's comfort with using technology. This comfort or discomfort creates anxiety that discourages the use of technology and creates a barrier to their perceived ease of use. Since the interviews were done two years later the Framework was re-evaluated to create the final framework for Professional Teacher Technical Identity Development.

6.4 Addressing the research questions

Each sub-question will be addressed first before addressing the main research question of this study is attempted. This is to provide a holistic understanding of how the final conclusion of this study was reached. The research questions will be cross referenced with the instruments and the theoretical Framework as discussed in Chapter 4.

Table 6.1: Data Collection instruments

Main Research Question: How does mobile technology acceptance advancements shape professional teacher technical identity development?					
Data Collection Instrument	**Research Question**	**Theoretical Framework**			**Appendix**
		TPCK	**TAM**	**SAMR**	
Written Questionnaire	RQ1, RQ4, RQ5	X			1
Online Questionnaire	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	2
Lesson Reflections	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	3
Reflective Journal	RQ1, RQ2, RQ4, RQ5		X		4
Focus Group Discussions	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	5
Semi-structured Interviews	RQ1, RQ2, RQ3, RQ4, RQ5	X	X	X	6

6.4.1 Research Question 1

What are the beliefs of teachers towards mobile learning?

Teacher's beliefs towards mobile learning vary considerably. This is due to the mobile device seen as a distraction at times rather than a teaching tool (Royle & Hadfield, 2012). Many teachers understand the usefulness of teaching with a mobile device and the efficiency that comes with it. This is evident in Table 5.10 and the data obtained from the focus group discussions. However, the lack of their own technology literacy, time and confidence to use the device and maintain classroom control seems to be one of the biggest challenges. Table 5.7 and the comments by Fred in the focus group discussions confirm this. Although teachers are aware of the importance of using modern teaching methods they succumb to traditional methods as a form of comfort and assurance that teaching and learning are in fact taking place. The difference in technology anxiety shown in Figure 5.20 confirms that teachers understand the usefulness but become anxious when they have to use the technology. This is due to several reasons as indicated in Figure 5.43.

6.4.2 Research Question 2

What are the identifiable mobile technology acceptance advancements during the mobile teacher training?

Some of the identifiable changes in their behaviour and attitude suggest that teachers become insecure in their teaching as a result of change and lack of knowledge of technology. This insecurity is identified by their ICT anxiety and ICT ability. A further change is seen in their anxiety which is sometimes dependent on their experiences of how easy technology is to use. This is clear and evident in their change of willingness to teach with technology if they have positive experiences and if they have negative experiences. For example, in the case of Anne, she was willing to use technology and really wanted to, but became frustrated and discouraged when she couldn't get the technology to work. She had the support of her colleagues and knew that it would be beneficial for her learners as her learners wanted to use technology. It was only when she tried on her own and didn't feel any pressure to use it that she slowly started trying simple things and now is comfortable to use technology. This gradual change of technology acceptance illustrates the change in attitude from willingness to total resistance and then willingness to try again.

6.4.3 Research Question 3

How do teachers implement mobile technology in teaching after formal training?

Teachers implement technology in their classrooms in various different methods. Some need a gradual introduction as in the case of Anne. Others prefer to go all in as in the case of Fred, Owen, and Jill. It is important for technology implementation to be self-paced in order for the teacher to feel assured, confident and comfortable and avoid anxiety. Since each teacher has their own teacher identity they will grow and develop differently so there is no single answer as to how they implement it and at what rate they implement it. Each teacher will also have to look at the best suitable method to integrate mobile technology for their specific learning area so as to ensure that it is most beneficial to their learners as some subjects tend to lend themselves to technology use more than others (See responses from Kevin, Elize and Liam in the reflective journal).

6.4.4 Research Question 4

What factors influence the level of implementation of mobile technology?

Each teacher will start at the bottom of the SAMR ladder and reach different levels depending on their attitude, ability, anxiety, facilitating conditions, subjective norm and voluntariness at different times. These factors are identified through different approaches and it is necessary that one considers all aspects that may lend themselves to these factors. Since implementation involves action through practical experience it is not possible to identify all factors at once as the teacher only becomes aware of these factors during the process. In some instance it is one factor that contributes to another factor. For example: ICT ability causing ICT anxiety and resulting in a negative ICT attitude. Teachers vary in terms of how they deal with facilitating conditions. Teachers either become completely despondent as in the case of Nina and Heidi or they find ways to work around it as in the case of Fred, Kevin and Pam. Teachers are influenced by others. Jill, Gail, Fred and Kevin get their motivation from the response of their learners. Heidi and Nina are influenced by colleagues that have negative attitudes of technology use and therefore do not take the initiative to explore further. Voluntariness plays an important role as it is a personal choice and this has an immediate impact on the level of technology use (E.g Mary, Carol and

Liam). Attitude is the main contributing factor to technology acceptance as seen in Figure 5.22. There is a link between ICT ability and ICT anxiety as teachers that have low ICT ability tend to have ICT anxiety as in the case of Heidi. High ICT Anxiety and low ICT Ability result in a low perceived ease of use of technology (see figure 6.4).

6.4.5 Research Question 5

How do these factors shape teacher identity development?

These factors collectively shape professional teacher technical identity development because if one of the factors are not addressed it will impact the technology implementation. The success of technology use changes their perception of technology use and makes them less resistant and more accepting of the use of technology. With continuous practise they are able to become more confident, overcoming the insecurities of teaching with technology and they become more proficient in their technology use. Support from colleagues, learners and institutions helps to keep teachers motivated to continue trying as they become easily discouraged (see Figure 5.27). Their own attitude and willingness to learn and develop shape their identity the most as this determines the rate at which they develop (see Figure 5.26). For in-service teachers who find technology use to be a completely new component to teaching, continuous support and professional development are crucial to give them the relevant TCK and TPK to teach with technology (see interview – Heidi).

6.4.6 The Research Question

How does mobile technology acceptance advancement shape professional teacher technical identity development?

As you recall this study was to investigate possible ways to help bridge the gap between teacher and technology and teacher and learner. To achieve this the study aimed at understanding the growth and development of professional teacher technical identity development through the use of mobile technology. The purpose of the study was to create a Framework that will support professional teacher technical identity development. It can be said that there are six underlying factors that shape professional teacher technical identity development. These factors are: Attitude, Ability, Anxiety, Facilitating conditions, Subjective norm, and Voluntariness. These

factors determine the perceived usefulness and perceived ease of use of technology. This in turn determines the level of technology integration, whether it is enhancing or transforming teaching. This integration demonstrates the three elements necessary for successful teaching: Technology, Pedagogy and Content knowledge. Through this process of integration Professional Teacher Technical Identity Development can be identified and tracked.

Mobile technology acceptance advancement is shaped by continuous professional development and support from colleagues and institutions (See Figure 5.27). When teachers use technology embedded in their subject, they embrace learning for themselves and often use tools to transform their knowledge of their subject. This allows them to adjust their teaching repertoire as they expand and develop their knowledge (Ally et al., 2014). Positive feedback from learners and parents (see lesson reflections and focus group discussions) provides motivation for teachers to continue with implementation and integration. Teachers need to have all facilitating conditions addressed to ensure that all resources are available (see focus group discussions). Teachers need to maintain a positive attitude and understand the benefits of teaching with technology (see Figure 5.22). Technology skills are a necessity but not merely technology skills (see lesson reflections). Subject specific technology skills are required to ensure TPK and TCK. This awareness allows teachers to reflect on their teaching practice and question their professional practice. Lastly technology acceptance is highly dependent on the willingness of the teacher as it is a personal choice to continue to adapt teaching and learning with times (see Figure 5.27 and 5.31). This adaptability changes teacher identity continuously and allows for the reconstruction of, in this case, a professional teacher technical identity. This ensures that teachers are kept abreast with current technological advancements and the benefits for educational purposes.

6.5 Contribution to knowledge

Having interrogated the data the Professional Teacher Technical Identity Development Framework was created. This Framework encompasses all the data collected and contributes to the body of research in three ways.

6.5.1 Practical Contribution

The teachers in this study on numerous occasions express the importance of continuous development for teachers to keep up with current education innovation (see focus group discussions, interviews and Figure 5.30). Subsequently, their plea for teacher development in technology is clear, justified and supported by Cinque (2013). Teachers have a great need for technology training to develop both TCK and TPK, essential elements for successful technology integration (Blignaut et al., 2010; Summey, 2013). This training should include formal and informal instruction, mentoring, opportunities for collaboration and teamwork, ongoing support, online courses, constructive feedback, flexibility of training sessions with regards to time and place and be frequent. This is supported by Ally et al. (2014). The factors identified illustrate the dire need for technology skills and for support for teachers during and after the transition towards technology integration. It is only through the enhancement of their own practical experience, that identity change can take place. A study such as this which provided training to a single member of staff from each learning area can create a group of people that start to encourage those around them and teach other staff within their departments. This will allow departments to form their own community of practice reflecting and sharing technological methods for their learning area. An exercise such as this if conducted appropriately can be very fruitful to any school as it creates a chain reaction and can spread technology implementation through integration. As teachers receive support from their institution, learners and colleagues they start to understand the usefulness of technology and are keen to use technology (see focus group discussions).

The practical contribution of this study is evident in the lesson reflections, focus group discussions and reflective journals. Table 6.2 provides and summarises an account of the benefits of such a study and recommendations for further researchers should this method be used.

Table 6.2: Practical contribution

Practical contribution	Intervention	Benefits and challenges	Recommendations
P1	Mobile Learning Workshop	**Benefits:** • Provided the teachers with professional development **Challenges:** • Some teachers required individual attention	An assessment of the level of ICT ability must be done. Teachers must be trained accordingly. Training should be self-paced and provide interactive and reflective opportunities. Training must be on-going.
P2	Community of Practice	**Benefits:** • Provided teachers with the opportunity to share and reflect on their experiences and challenges • Allowed teachers to advise and support one another • Provided support and motivation to teachers that experienced difficulties • Enhances critical thinking and reflective practice through collaboration (21st century skills) **Challenges:** • Teachers that did not teach lessons could not contribute to the discussions	Teachers need to teach with technology in order to ensure that they can contribute positively to the discussions. The community of practice needs to run over a long period of time in order to track the development of teacher identity and provide more relevant and effective support. Challenges must be addressed promptly.
P3	Lesson Reflections	**Benefits:** • Individual lesson reflections allow the participants the chance to acknowledge their own growth and development • Lesson reflections allow teachers to	This is a critical part to personal growth and development. If conducted correctly, clearly visible change in lesson delivery can be seen.

		focus on improving their lessons thus encouraging enhancement and transformation. **Challenges:** • Teachers that do not reflect, do not improve very easily because they do not see the room for improvement or do not understand where or how to improve	

Figure 6.5 suggests a practical approach to improving on Professional Teacher Technical Identity Development. The practical contribution has been added to the framework to illustrate the impact in such a study. **P1** is achieved by delivery of some form of formal training to enhance the TPK and TCK amongst teachers. The value of a community of practice (**P2**) is in the sharing and reflecting of experiences to assist one another in overcoming some of the negative impact factors. These sessions need to be structured and guided in such a way that the teachers need to teach lessons and engage with the technology frequently. Since teachers develop differently and the teacher identity varies, **P3** allows for the tracking of personal growth and development. This encourages the enhancement and transformation of lessons. As teachers engage with the technology they can explore and shape their new technical identity.

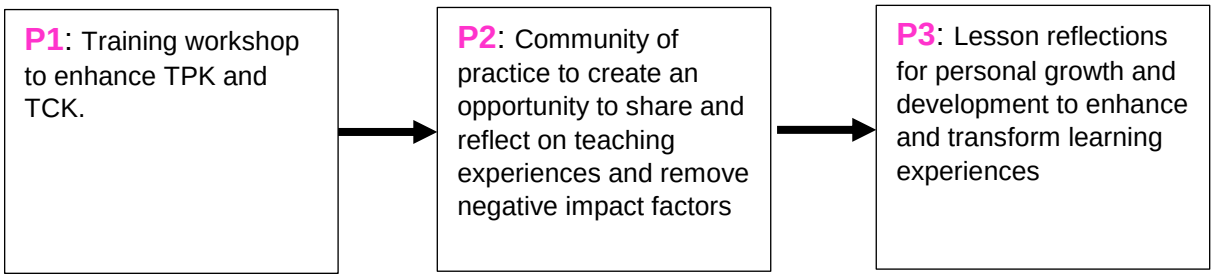


Figure 6.5: Practical approach to improving PTTID

6.5.2 Methodological Contribution

The nature of the action research methodology contributed to a community of practice within which teachers' Technical Identity could develop. Using the action-reflection

approach it is found that teachers are able to track their own growth which is similarly done by Beauchamp and Thomas (2009) and Royle et al. (2014). This way they become more aware of their teaching methods and the challenges that they face. Once they are aware of their challenges they are able to look for methods to overcome and address them. This awareness is not obvious as teachers are often consumed by the practice of teaching that they do not reflect on the "how" and "when" of teaching. The complacent nature of most teachers does not allow them to think beyond what they have always been doing and encourage them to develop (E.g. Heidi- not knowing different types of apps available or Carol-resistant to change). An intervention process such as that of the mobile learning workshop may enthuse teachers to become more open minded to various teaching methods that are more relevant to the schooling context at present. It creates a window of opportunity to explore and discover different teaching approaches and styles through experience. This method provides a guided structured approach to assist in-service teachers to implement technology through integration (Nkula & Krauss, 2014).

Even though this study does not change the action research methodology as such, it utilises action research to structure technical identity development within a community of practice. Methodologies of this magnitude has the capacity to engage teachers in communities of practices and creates opportunities to allow working collaboratively/cooperatively. In addition the analysis of the data in each section was coded in such a way that it emphasised the findings with codes used in the Framework itself. Even if the sampling data was not statistically significant, collected data could be helpful for individual feedback for the teacher's technical identity development.

6.5.3 Theoretical Contribution

The theoretical contribution of this study is a Professional Teacher Technical Identity Development (PTTID) Framework. This Framework is discussed in Section 6.6. It attests to the causal relationship between technology and teacher professional identity development. By creating an awareness of mobile technology and providing guidance and support to teachers through the implementation process, a change in professional teacher technical identity takes place. This is brought about by a change in technology acceptance and a questioning of professional practice that teachers carefully deliberate for themselves and then consider an alternative method. The proposed

Framework provides a theoretical and practical basis for further research. The Framework is coded and each theoretical relationship is emphasised in **red** and practical contribution in **blue**.

6.6 Professional Teacher Technical Identity Development Framework

After consolidating all the data from the three Phases including the interviews, the researcher was now able to identify the relationships between each factor and each Framework from the original theoretical Framework. It was evident that TPCK was the proposed outcome **(T1, T2, T3, T4, T5)**. In order to produce lessons that were technologically, pedagogically and content knowledge sound, teachers would need to receive training in all three aspects. Since technology knowledge is the newer element added to the original PCK Framework, training for in-service teachers would be a crucial aspect in order to provide the skills of teaching with technology and teaching about technology (see Section 2.2). This would enforce a more sound understanding of TCK **(T3, T4)** and TPK in a teacher as mere TK **(T5)** is insufficient for implementing mobile technology due to different learning areas.

Since mobile technology requires the redesign of lessons to suit the different levels of the SAMR model, teachers would need to decide if they wanted to use the technology to enhance the lesson or to transform the lesson (see Section 3.4) **(T6, T7)**. This is dependent on whether the teacher finds technology easy to use or useful. Generally if the teacher finds technology ease to use, the teacher is more inclined to use technology. However, since all teachers' understanding of technology is different they may be able to design their lessons to enhance or transform teaching as they wish **(T16, T17)**. Likewise if a teacher finds technology useful, he/she is inclined to use the technology more. Consequently this may be to enhance or transform their teaching as this is a personal choice **(T18, T19)**. This is evident from the lesson reflections and focus group discussions.

Since teaching with technology is a personal choice, several factors contribute to the likelihood of technology integration and implementation. Three factors that impact on the teacher's perceived usefulness of technology are: facilitating conditions, subject norm and voluntariness. The teachers need to want to use technology (voluntariness) **(T14)**, need to have support to assist with this transition in their teaching (subjective norm) **(T13)** and need to have all the available resources in order to stay motivated

(facilitating conditions) **(T12)**. Similarly, in order for teachers to find it easy to use technology they need to have a positive attitude towards using it (ICT attitude) **(T8)**, they need to have the necessary technological skills in terms of TPK and TCK to implement it (ICT ability) **(T9)** and they need to be comfortable, confident and proficient in technology use to avoid any form of anxiety (ICT anxiety) **(T10)**. Usually if a teacher finds technology easy to use and are made aware of the benefits of using technology to teach they often find technology useful as it adds new insight to their teaching. Often teachers that have low ICT ability tend to have high ICT anxiety, showing an interdependent relationship between these factors **(T11)**.

In order for teachers to develop their teacher identity, they first need some form of practical training **(P1)**. Next, the six factors that contribute to the usefulness and ease of use of technology need to be addressed. This, once identified and supported, is usually provided during community of practice sessions **(P2)**. Once this is done, teachers are now able to plan and deliver technology based lessons. As the teachers gain experience and become more proficient in teaching with technology, they are likely to try new and more complex methods of integration due to their constant reflection in teaching practice **(P3)**. During this process a mind shift of teaching occurs as their teaching methods change. This means a change in planning, assessment, and delivery (see Figure 5.33). During this change teachers develop a new identity of teaching. This change process is continuous and adapts as the teacher becomes more and more familiar with the technology use and starts to achieve lessons that encompass all three elements of the TPCK model. This continuous, adaptable and consequent process of change in a teacher is known as professional teacher identity development. The inclusion of technology in teaching creates room for professional teacher technical identity development. Figure 6.6 illustrates the proposed Framework for this study.

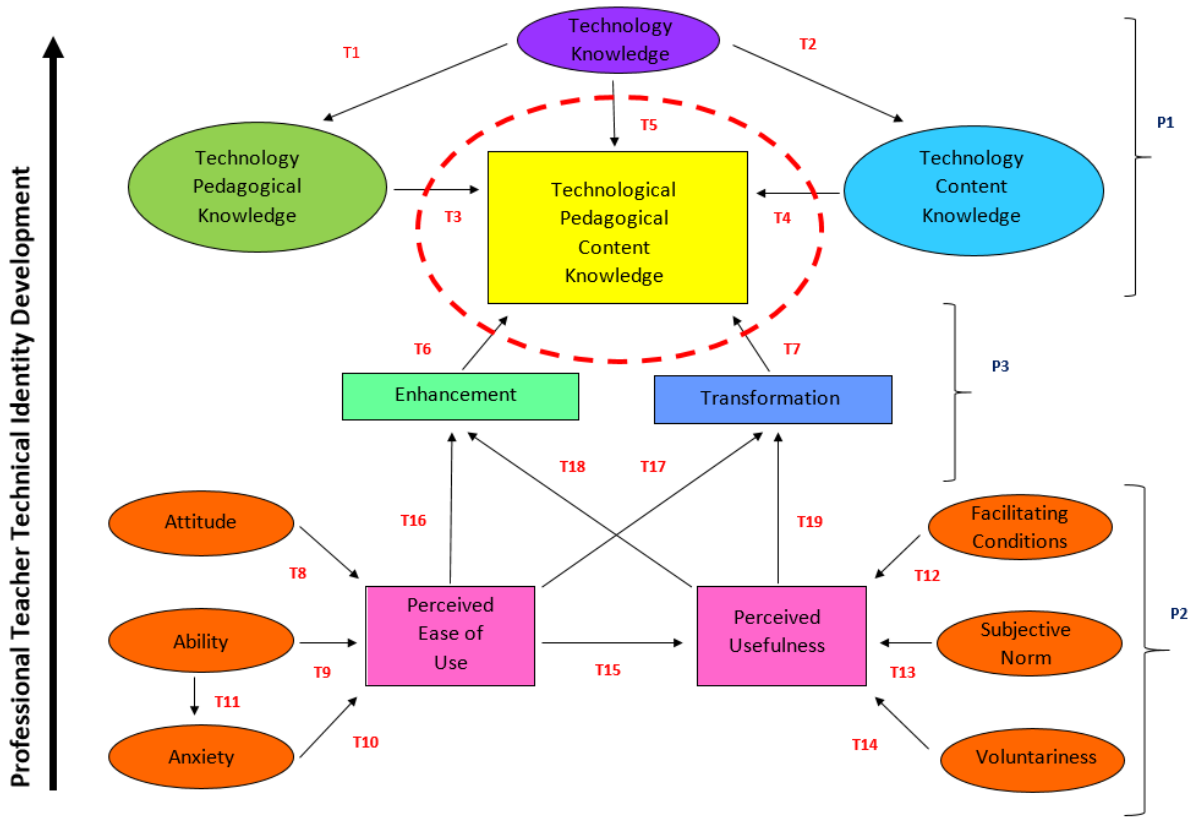


Figure 6.6: Professional Teacher Technical Identity Development Framework (PTTID)

6.7 Research reflection

A critical account of the scientific, methodological and personal reflections of the researcher is given below. These reflections collectively describe the research process and gives a holistic understanding of the researcher's thoughts on the study and research process.

6.7.1 Scientific reflection

The study explored the nature of research in technology acceptance in education. The approach of mixed method research is beneficial in such a field as it allows for inductive and deductive reasoning during the research process. This study highlighted the aspects in which development of ICT in teachers are required. It contributes largely to the manner in which professional development courses need to be designed and delivered for successful implementation of technology. The data reflects evidence of the need for support in various aspects for this implementation process. The structure of the study and research design proved to add value to the study by providing a saturation of data. The theoretical Framework developed can be used in other studies to test the effectiveness of such a Framework. It opens a door to research by exploring

the interdependence of these factors and how they work in isolation of one another. The researcher has gained insight on the statistical nature of interpreting behaviour related to identity development, both quantitatively and qualitatively through Histograms. This knowledge will contribute to further research in the field in the future.

6.7.2 Methodological reflection

The unique methodological nature of the study of action research can be seen as an example for future researchers within the field. The approach is unique as the focus is on a single element, being professional teacher technical identity development but it is conducted under the conditions of a practical action research. The cyclic nature of such a study allowed the researcher to work actively with the participants during the study to unpack as many contributing factors as possible that impact on professional teacher technical identity development. In doing so the researcher was able to consolidate these factors into a Framework that can be used as a basis for further research. Providing training at the onset of the study proved to be beneficial as there is a distinct difference in the response towards technology use before the training and during implementation. An added benefit would have been to structure the focus group discussions and lesson reflections in such a way that teachers are somehow only able to participate once they have delivered a certain number of lessons. This would have made the data more reliable as the teachers would have had more experience with teaching with technology. The collection of data in various forms allows for the trustworthiness and validity of data. Similarly structured questionnaires would have made the data analysis process less cumbersome. The three Phases within the action research process worked very well in that it allowed the researcher to critically evaluate and reflect before collecting more data. Such an approach is important in order to collect sufficient data.

6.7.3 Personal reflection

The study imparted skills and knowledge to the researcher in various ways. The experience of an action research provided the researcher with an understanding of the role of the researcher within action research. The ability to facilitate the focus group discussions without being biased or subjective to the responses of the teacher enabled the researcher to gain skills of objectivity. The statistical analysis of data both quantitatively and qualitatively improved the researcher's understanding of conducting

mixed method research. The research needed to critically evaluate the data and carefully synthesise it to create the Framework that was developed. These skills that were expected to be imparted to the participants were also gained by the researcher through the research process. The awareness and importance of 21st century skills is more prominent to the researcher and will be an added benefit to the researcher's future planning, and delivery of lessons. The study as a whole has impacted and shaped the identity development of the researcher as the experience, knowledge and skills of the researcher have changed.

6.8 Reflection of the key findings

- There are six key factors that contribute to technology acceptance amongst in-service teachers. Collectively these factors impact on professional teacher technical identity development. It is possible that the factors work interdependently or in isolation of one another.
- Professional development needs to be continuous and provide on-going support. Professional teacher technical identity development is a process and therefore once off training is insufficient for successful change to occur. Continuous training and support provide a larger time frame to monitor identity development and offer a more guided approach towards technology acceptance.
- TCK and TPK are an absolute necessity for successful technology integration. Knowledge of technology is insufficient to implement technology in classrooms as technology cannot be seen in isolation of content and pedagogy. The integration of technology in pedagogy and content promotes teaching and learning as it is seen as a resource to successful teaching.
- Teacher identity development occurs when a teacher questions, reflects and considers alternate teaching methods. The process of reflection is very important as it allows teachers to reconsider their approach and improve on it. It is only through reflection that teachers consider alternate methods and then reshape their teacher identity.
- The development of the Professional Teacher Technical Identity Development Framework embodies the prominent aspects of three models that contribute to

technology acceptance. This Framework can be used to conceptually analyse further research within the field.

6.9 Delineation and assumptions of the research study

This study portrays the demand for professional development for in-service teachers. The descriptions of the problems that teachers face when trying to implement technology into teaching are true to all teachers and is a true reflection of the challenges that teachers face. Figure 5.43 is a true depiction of the aspects that affect the implementation process on a day to day basis. These challenges coupled with several others in a holistic schooling system outlines the necessity for support and guidance for teachers during this integration process.

The study assumes the acceptance of learners, staff and parents of technology use and that all necessary resources are available. Socio-contextual factors are not considered as the focus was purely on teacher identity development. As a result the findings of this study cannot be generalised for all teachers within the South African context. The importance of “self” in identity development plays a crucial role in the study as all teachers have a unique teacher identity that is personal and only fully understood by themselves. For this reason the identity development process will not be the same nor will it take the same time for each teacher.

6.10 Limitations, Implications and Recommendations

6.10.1 Context

The study was limited to one school but did however look at the integration across different learning areas. This was to get an idea of whether teachers from different learning areas experience technology implementation differently. It was found that they do, as the availability of resources varies from learning area to learning area and some learning areas require a more hands on practical approach. Further research into the comparison of technology integration amongst different learning areas should be done.

6.10.2 Time

Another limitation was time. The actual use of technology and intended use of technology is not monitored in this study due to time constraints. Further research into observing lessons of implementation and monitoring teachers' behaviour during that actual lessons will definitely add rigour to further research within the field.

6.10.3 Professional development

Implications of such a study create room for more professional development workshops to be developed for teachers that will equip them with the skills necessary for technology use and help them to become more proficient in technology use. It is recommended that continuous teacher training programmes be developed to assist teachers at all levels of integration and that they ensure an element of subject specific training to ensure that technology, pedagogy and content knowledge are used collectively during teaching. Furthermore, tertiary institutions need to design courses that are more consistent in nature and include these aspects of teaching with technology into their programmes to create a holistic approach to implementation through integration.

Teacher awareness of their own professional identity needs to be created in order to allow teachers to reflect critically about their teaching practice, question their teaching methods and collaborate to design new strategies that are current. Within the South African context the South African Council for Educators (SACE) allocates Continuous Professional Development (CPD) points to teachers that attend professional development workshops that are accredited courses. This has become a new requirement for teachers to inspire and ensure that teachers keep abreast with latest teaching methods. Similar professional development courses exist in the Middle East, Africa, The United States, and Great Britain (Royle et al., 2014). Instructional designers need to remove technical obstacles, making technology more user friendly in order to ensure that mobile learning initiatives are possible with little initial learning required. Institutions need to promote the benefits of mobile learning and provide effective support and access to training opportunities.

6.10.4 Learner response

An interesting outcome of the study found that learner response plays an integral role in technology use. However the emphasis was not sufficient or relevant to this study. Research on learner acceptance of technology use and parental acceptance of technology will create a more holistic understanding as to how the subjective norm affects the development of professional teacher technical identity and therefore add to the body of research within the field. Fewer studies have been done on the factors that impact the adoption of mobile learning by learners (Aubusson, Schuck, & Burden, 2009; Lefoe, Olney, Wright, & Herrington, 2009; Seppala & Alamaki, 2003).

6.10.5 Factors identified

Finally, further research on any interdependence between the six factors identified; ICT attitude, ICT ability, ICT anxiety, subjective norm, facilitating conditions and voluntariness, should be explored. This will provide more insight on how to eliminate the factors influencing technology integration and hopefully decrease the time taken for integration. Furthermore the generalisation of the framework can form a basis for further research particularly in a rural setting to improve teaching and learning and provide insight to the complexities within such a context. An investigation of the improvement of the perceived ease of use for learning environments in schools with mobile devices would contribute to the effectiveness of the framework. The comparison of such a study would deem fruitful for the re-design or improvement on the framework.

6.11 Conclusion

A Professional Teacher Technical Identity Development Framework for mobile technology acceptance was created. This Framework encompasses the work of Mac Callum et al., (2014), Mishra & Koehler (2006) Puentedura, (2012) and the data collected from this study. Collectively the results illustrate the developmental process that teachers need to go through in order to implement mobile technology through integration. It highlights factors that impact on technology implementation and provides practical methods to assist in overcoming these challenges. This Framework can be used for further research to assist in technology acceptance for both per-service and in-service teachers. The practical and methodological contribution of the study

provides a structured and guided approach to assist in implementation through integration.

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