UNISA | college of science, engineering and technology

A framework for mobile digital literacy skills of educators using mobile technology in rural formal education

by

Farshida Jahoor

Submitted in accordance with the requirements

for the degree of

MASTER OF SCIENCE

In the subject

COMPUTING

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: DR A BOTHA

JANUARY 2019

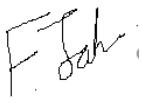
Student number: 4175 454 9

DECLARATION

I hereby declare that this document entitled: *A framework for mobile digital literacy skills of educators using mobile technology in rural formal education*, submitted for evaluation towards the requirements of the subject Information and Communication Technology, as part of the MSc qualification at the University of South Africa, is my own original work and has not previously been submitted to any other institution of higher learning, or subject, for evaluation. All sources used, or quoted, in this document are indicated and acknowledged by means of a comprehensive list of references.

Surname, Initials: Jahoor, F

Student Number: 4175 454 9

Signature:  Date: 14/11/2018

ABSTRACT

Information and communication technology (ICT) is considered a vital enabler in the quest to reduce the disparities between the developed and developing world. Developments in mobile technology have dramatically changed the ICT landscape. Mobile cellular technologies have flourished and proliferated more rapidly than any previous technology hitherto and is thus considered, at this time, the most pervasive technology in the world. However, the introduction of mobile ICT in rural formal education is faced with many challenges and ways in which to maximise its usage is still being explored.

This research explores mobile digital literacy skills required by a rural educator to successfully integrate mobile technology into the classroom. This exploration used the ICT for rural education development (ICT4RED) project as its case study and added dimensions to the project through the development of a framework for mobile digital literacy skills.

ICT4RED was an appropriate case for the exploration as it met the following criteria: educators were using mobile technologies in the classroom, educators had been part of the Teacher Professional Development (TPD) course offered by the ICT4RED project and educators were based in a rural resource-constrained area in South Africa. Questionnaires were used to gain insight into which skills educators rated as most important, and least important, as based on their teaching experience using mobile technologies in the classroom.

The work is grounded on an interpretivist research philosophy and followed an inductive reasoning approach. Additionally, the research employed a qualitative method of analysis with a single case study, comprising of two units, facilitating a perspective of the phenomenon. Framework development was enabled through a literature review which assisted in theorising the mobile digital literacy skills. An expert review, followed by a questionnaire driven survey for educators, was conducted. The qualitative analysis revealed that most of the mobile digital literacy skills from literature were important and should be employed. The majority of educators and experts felt that the skills could not be categorised as, due to the lack of resources, most are

considered very important. The lack of stable internet connection/s were also considered a major (if not *the* major) hindrance to successful mobile integration in rural areas.

The main research question answered by this study is:

How can a framework for educators' mobile digital literacy skills support educators using mobile technology in formal rural education?

The findings of this research should be significant to developers of mobile technology training programmes, as well as educators trying to successfully integrate mobile technology into their classrooms. The framework will enable both trainers and educators to prioritise skills and channel resources into the acquisition of those skills which have been identified as important by this research work.

Keywords: Mobile digital literacy skills, digital literacy, mobile technology, rural formal educator, m-learning, 21st century, information and communication technology, rural formal education, digital literacy, education.

ACKNOWELDGEMENTS

I would like to express my sincere gratitude to my supervisor, Prof. Adéle Botha, without whom this study would not have been possible. Thank you for motivating me and making me believe in myself. Thank you for the knowledge you generously shared with me. You have taught me so many skills that I will treasure. You were a God sent angel who guided me. I treasure our relationship and, from the bottom of my heart, a very big and sincere thank you.

To my husband, Ziyaad, thank you for your unwavering support. I could complete this study - because of you. You had my back through it all. I am blessed to have a supportive partner who reassures me of my abilities and supports my achievements. I truly appreciate you.

To my dear children, Hamza and Abdur Rahman, thank you for putting up with me. Thank you for your little prayers, I love you two so much. This one is for you! I hope it serves as a reminder that you can achieve anything you want in life.

To my parents, Farouk and Havabibi, I am what I am because of you. You always motivated me and reminded me that the sky is *not* the limit. The drive I have to be successful and achieve is due to your constant support and encouragement. Thank you for being by my side.

To my awesome siblings Farzeen, Sahil and Shabaaz. Thank you for always lifting my spirit and making me believe in myself. I love you guys and I hope to serve as inspiration to you all. Everything is possible with the right mind-set and determination. Put your heart and mind into that which you wish to achieve.

I would like to express my gratitude to Ms. Esteé Wiese for being so willing to proof read my work. Your time and effort is highly valued.

Thank you to a very special lady, Mrs Nhanha Tyembile, who was of great assistance to me during the data collection phase. She outdid herself and helped me beyond what was expected. Thank you very much. God bless you.

And lastly, thank you God. Which of your favours can I deny? You have been so merciful to me. My success is by your will.

TABLE OF CONTENTS

List of Figures

LIST OF TABLES

A FRAMEWORK FOR MOBILE DIGITAL LITERACY SKILLS OF EDUCATORS USING MOBILE TECHNOLOGY IN RURAL FORMAL EDUCATION

CHAPTER 1: INTRODUCTION

Mobile Information and Communication Technology (ICT) continues to infiltrate the market (Chang & Hwang, 2018) and, consequently, the digital divide is becoming more significant (Bartikowski, Laroche, Jamal, & Yang, 2018). This situation is prevalent within the education domain in South Africa (Mabila, Biljon, & Herselman, 2017). However, it is believed that mobile technologies can revolutionise and support 21st century teaching and learning in South Africa (Finn-Stevenson, 2018).

The number of technology users have increased considerably, not only South Africa, but across the world (ITU, 2018). Thus, it is safe to say that mobile ICT is the world's fastest growing technology and presents several developmental opportunities (Van Biljon & Renaud, 2017).

A strong connection exists between the use of ICTs and the improvement of the development status of rural areas (Masonta, Kliks, & Mzyece, 2017). Based on this relationship, initiatives such as ICT4RED were pioneered (Mabila et al., 2017) to uplift education in rural areas. Mobile ICT can be beneficial to rural education (Floricel, Piperca, & Tee, 2018), thus facilitating the improvement of literacy rates amongst learners (McShane & Wilson, 2017). However, mobile ICT cannot function on its own. ICT initiatives have previously failed due to lack of a focus on, amongst other factors, the digital literacy skills (Mabila et al., 2017). The lack of skills pose a challenge for educators to successfully integrate mobile technologies into the rural classroom (Yu, Lin, & Liao, 2017).

This research explores mobile digital literacy skills needed by educators using mobile technologies in rural formal education. It builds on the mobile digital literacy model (Ng & Nicholas, 2013), in which skills are divided into: technical, cognitive and social-emotional dimensions. The study then proceeds to develop *a framework for mobile digital literacy skills of educators using mobile technology in rural formal education*.

The rest of the chapter is structured as follow. Section 1.1 briefly outlines the background of the study. Section 1.2 presents the research question along with the

research objectives and purpose. Section 1.3 gives an overview of the research methodology used for this study and section 1.4 discusses the scope of the study. Sections 1.5 discuss ethical considerations which govern the study. Section 1.6 provides a chapter outline detailing the lay-out of the rest of the thesis. Section 1.7 summarises Chapter 1.

The next section presents the background to the study.

1.1 BACKGROUND

Technology has manifested in several aspects of life, gradually evolving from main frame computers to present day mobile devices, such as tablets (Ventimiglia & Pullman, 2014). This change has been readily accepted by people as the inventors of technology were able to synthesise human interaction with technology (Ventimiglia et al., 2014).

Evolving technologies enabled access to a wide range of tools which necessitated a change in skills to be acquired (Harper, 2003). Progressive honing and acquiring of skills enables one to deal with the change and thus successfully transfer from an era where information was scarce to an era of information abundance (Boileau, 2014).

Mobile digital literacy skills have been incorporated into many careers (Ventimiglia et al., 2014) and will be applied to educators in this study. The days of educators using the traditional *chalk and board* method of teaching are considered antiquated (Bingimlas, 2009). Learners need to be equipped to successfully navigate this changing landscape and educators need to harness all available technologies to enhance teaching and learning engagement (Cheung & Slavin, 2011). Having applicable mobile digital literacy skills, beyond the basic digital ability that every educator should possess, provides a teacher with significant growth opportunities (Ventimiglia & Pullman, 2014). An educator needs to be digitally literate in addition to possessing knowledge regarding his/her field of specialisation (Jones & Flannigan, 2006). The incorporation of mobile digital literacy into fundamental subjects within schools prepares learners to adapt to the convergence of humanity and technology (Ventimiglia & Pullman, 2014).

Mobile digital literacy skills enable educators to derive digital solutions, acclimatise to new tools and discover ways of enhancing their careers (Ventimiglia & Pullman, 2014).

Educators need to be able to use technology, not only from a consumer's point of view for communication and socialisation, but as a driving force to create digital leaders (Ventimiglia & Pullman, 2014). An educator needs to understand the shift in his/her role, from being a *user* of technology to being a *creator* of information through technology (Spangler, 2015). One of the many benefits which an educator will experience from the use of mobile devices in schools, is a sense of intellectual liberation (Ventimiglia & Pullman, 2014).

As explained before, mobile digital literacy skills are a vital and empowering skill. These skills will help educators deal with evolving technologies and make sense of the plethora of information. An extensive discussion on mobile digital literacy has been provided in the literature review in Chapter 3, 4 and 5. This research aims to explore and identify the mobile digital literacy skills which an educator would require to enable him/her to use mobile technologies for teaching, operationalised through a framework for mobile digital literacy skills.

1.2 PROBLEM STATEMENT AND PURPOSE

The lack of sufficient skills, amongst other issues, was identified as a pertinent reason why educators are unable to successfully implement mobile technology into the rural formal classroom (Takavarasha & Adams, 2018). Equipping educators with the necessary skills can thus prove beneficial as it can be argued that it will enable them to embrace the opportunities facilitated by mobile ICTs and thus gain 21st century acuity (Finn-Stevenson, 2018). In this regard, Nieveen and Plomp (2018) state that mobile digital skills are, in essence, 21st century skills.

This research utilises the ICT4RED project as its case. The ICT4RED project was aimed at introducing mobile technologies to rural schools in the Eastern Cape, South Africa. The project is, by far, one of the largest and most ambitious projects of its kind in South Africa, reaching out to the resource-constrained areas and trying to address the issue of quality education (Mabila et al., 2017). More information regarding the project is provided in Section 6.5.1. This initiative, which was successfully implemented, engaged more than 300 educators who were trained in mobile technology integration in the classroom. Although the implementation of the ICT4RED project was successful, its sustainability remains a worry (Meyer & Neethling, 2017).

Technology roll-out is just one aspect through which the success attained by ICT4RED can be measured. Other aspects, like skills development and technology support, also played a vital role (Dlamini, Meyer, Marais, & Ford, 2017).

Educators lack of relevant digital skills and the lack of sufficient literature regarding mobile digital literacy skills for educators in rural formal schooling environments are all factors which could be addressed by a well conceptualised framework. This study identified frameworks which focus on different digital skills, but no framework which specifically addresses mobile digital literacy skills in the context of rural formal education.

1.2.1 **Research purpose**

The purpose of this study is to explore and identify relevant mobile digital literacy skills, and to develop *a framework to address mobile digital literacy skills for educators using mobile technology in rural formal education*. This study endeavours to extend current digital literacy skills frameworks by an adaptation to mobile technologies in rural formal education. The development of this framework will be informed by the Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler 2006), and is conceptualised within their *technological pedagogical* sub-category.

The main research question and sub-research questions which direct this study will be discussed in the next section.

1.2.2 **Main research question (MRQ)**

The study was directed by a main research question which established the principle idea of the inquiry in the study, namely:

How can a framework for educators' mobile digital literacy skills support educators' use of mobile technology in formal rural education?

The following sub-research questions will help address the main research question.

1.2.3 **Sub-research questions (SRQ)**

SRQ1: How can mobile digital literacy skills, from literature, support educators when using mobile technology in rural formal education?

- Understanding digital literacy skills and then focusing on mobile digital literacy skills.
- Identifying existing frameworks.
- Understanding the role of technology in the TPACK model.

This research question will enable the researcher to understand the different mobile digital literacy skills from literature that will enable the building of a framework.

SRQ2: How do the identified mobile digital literacy skills influence educators' practice in rural formal education?

This research question enables the researcher to apply the mobile digital literacy skills to the context of study which is rural formal education.

1.2.4 **Research objectives**

The following objectives are set to address the purpose of this study. These are to:

- Explore and identify, through a literature study, relevant mobile digital literacy skills.
- Examine the TPACK model, and other relevant frameworks that can inform this study.
- Develop and describe a Theoretical framework
- Develop research instruments.
- Articulate criteria for sampling.
- Evaluate existing skills from literature that can inform the research instruments.
- Evaluate the validity of existing skills in the literature review.
- Articulate a framework to assist educators in conforming to those mobile digital literacy skills required for employing mobile technologies in rural education.

1.3 RESEARCH METHODOLOGY AND PROCESS

The research is grounded in an interpretivist research philosophy through the use of an inductive reasoning approach, implemented through a single case study design (Levitt et al., 2018; Yin, 2017). An interpretive paradigm regards people's (in this case educators in rural formal education) personal experiences and views as imperative. This paradigm attempts to make sense of people's experiences by understanding them and considering what they know and believe (the epistemology). This approach

is aligned with the hermeneutic circle (Figure 6-12), which will facilitate the data analysis process (Kafle, 2011).

The case study is operationalised through three phases, as illustrated in Figure 1-1.

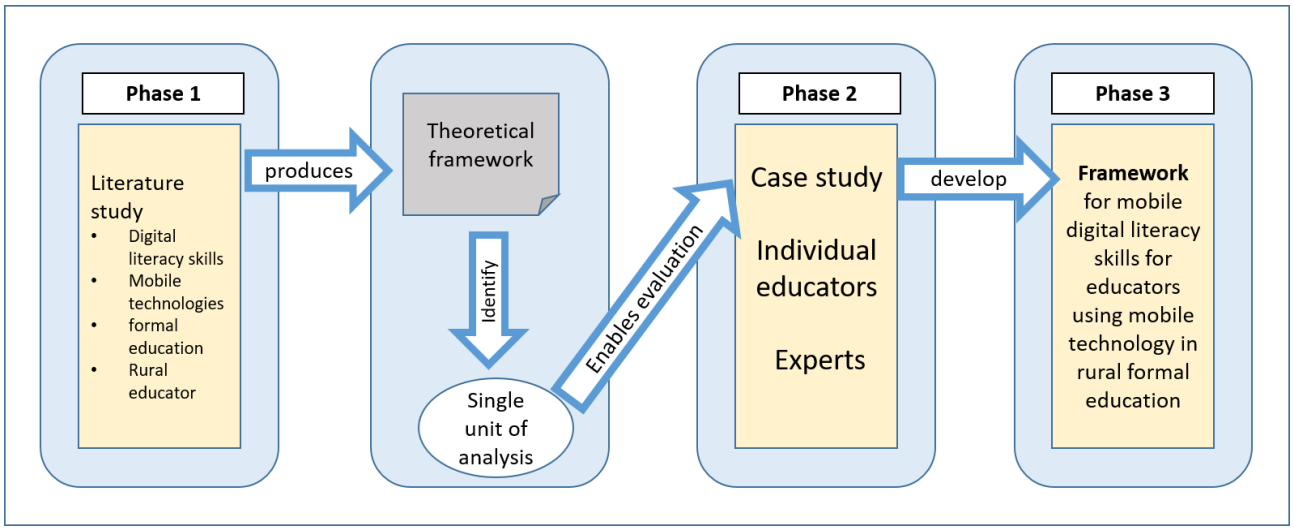


Figure 1-1: Three phases of the research design applied in this study.

Each phase is briefly explained.

Phase 1: The literature study aims to answer the first sub-research question by investigating available and relevant literature to identify mobile digital literacy skills (Chapter 3, 4 & 5). Identification of relevant mobile digital literacy skills will help in the development of a Theoretical framework (Section 5.6), thus achieving the outcome of the first phase. The components of the framework will serve to identify the units of analysis for the single case study (Creswell & Creswell, 2017; Levitt et al., 2018; Yin, 2017).

Phase 2: The case study (Section 6.5.1) involves the development of a theory before evaluating the phenomenon in the real world (Levitt et al., 2018; Yin, 2017). The literature study, conducted in Phase 1, enabled the discovery and understanding of concepts towards developing a Theoretical framework that would guide the exploration of the phenomenon in rural formal schools in South Africa. The Theoretical framework was validated and revised by two domain experts then four experts (Section 6.8.3) in the field of education and the use of mobile technologies in education. This was done to ensure the relevance, applicability, conciseness and comprehensiveness of the identified skills. A questionnaire, derived from the Theoretical framework, was

distributed to 20 respondents, in this case rural school educators (Section 6.8.2.1). The questionnaire allowed for qualitative data collection (Strauss & Corbin, 1998).

Phase 3: The Theoretical framework, developed in Phase 1, was improved by taking into consideration the results from the exploration in the case study (Phase 2). The case study, therefore, helped conceptualise the *framework for mobile digital literacy skills for an educator using mobile technology in rural education* (Chapter 7).

1.4 SCOPE OF THIS STUDY

The scope of this study is:

- Rural schools which were part of the ICT4RED project.
- The mobile digital literacy skills of educators currently using mobile technologies in rural formal education.
- The mobile digital literacy skill subset of 21st century skills.
- Reviews of the Theoretical framework done by experts in the field of education and mobile information technology in education.
- Limited to classroom practice.

Although this study acknowledges the various views of technology in education, within this context, the study positions mobile technology in education as having to facilitate *active learning* as a classroom practice (Jahnke, Norqvist, & Olsson, 2014).

The strength of the results is subjective to the assumption that 20 educators (or approximately 13% of the population) who completed the Information and Communication Technology for Rural Education Development (ICT4RED) training, and are currently using mobile technology in the classroom, represent the population of the educators using mobile technology in rural formal education.

1.5 ETHICAL CONSIDERATIONS

A researcher should assume responsibility for his/her chosen research approach. Research outcomes should be open to debate and criticism and, as such, be transparent as well. Creswell (2007) suggests that ethical considerations assist a researcher to assess his/her standards of conduct. Participants' rights in this study were respected by observing the listed principles:

- Informed consent.
- Participation on a voluntary and willing basis.
- Confidentiality.
- Anonymity.

Ethical clearance for this study was obtained from UNISA's College of Science, Engineering and Technology's Ethics Committee (as per Appendix A). Since the educators and experts hailed from the ICT4RED project, a permission letter to engage these participants was obtained from the CSIR (as per Appendix B).

1.6 DISSERTATION OUTLINE

This study contains nine chapters, structured accordingly:

- Chapter 1 provides background information to the research and an overview of the study. This chapter also presents the purpose, problem statement, research questions and research objectives.
- Chapter 2 considers the literature that deals with *mobile digital literacy skills* and develops constituents which influence it.
- Chapter 3 contains a scoping review of educators' technological pedagogical skills. In-depth definitions of mobile digital literacy are presented.
- Chapter 4 provides a scoping literature review on information and communication technology (ICT) specifically mobile technology.
- Chapter 5 deals with ICT in rural education, more specifically from a rural South African perspective. It discusses the challenges associated with mobile technologies in rural education. It also presents the Theoretical framework derived from literature.
- Chapter 6 provides an in-depth explanation regarding *how* the research will be conducted, thus elucidating the research methodology and design.
- Chapter 7 presents the raw data collected through the data collection process. The results are summarised in accordance with the research questions formulated for the study and discussed at length. Conclusions are drawn from the results and a final framework is presented. The framework consolidates and

validates the Theoretical framework, derived from literature, with the results and findings.

- Chapter 8 concludes the study and presents recommendations for future research.

1.7 SUMMARY

Chapter 1 introduced the concept of *mobile digital literacy skills* in the context of educators' use of mobile technologies in rural setting classrooms. The aims of the research study, as well as the research questions which guided exploration in this study, were defined. A general outline as to the research methodology and design were presented and the scope and context of the study were defined. The significance of the study was outlined and ethical considerations were stated.

Chapter 2 will elaborate on how the literature review will be conducted and which sections it will encompass to better understand and explore mobile digital literacy skills from an educator's point of view.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Chapter 1 provided the background to the research and described the research problem in terms of the research questions and objectives.

This chapter (Chapter 2) aims to frame the literature review articulated in the following three chapters (Chapter 3 to 5) as illustrated in in Figure 2-1.

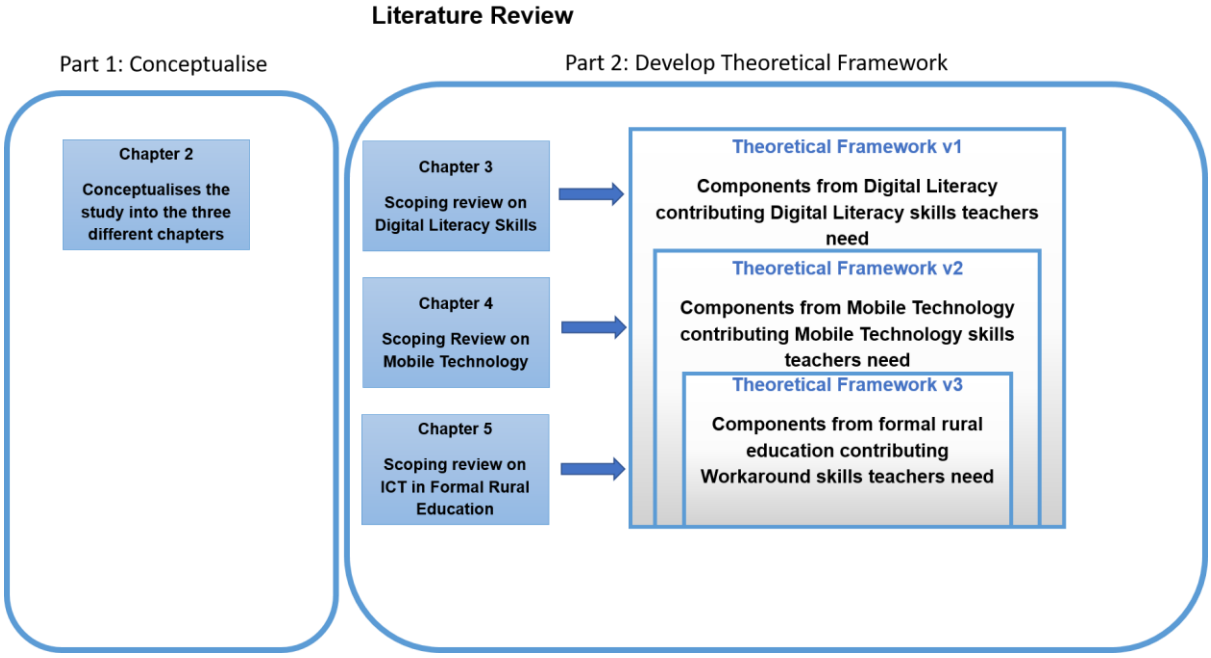


Figure 2-1: Literature review.

Figure 2-1 illustrates how this chapter introduces and frames the literature review. The literature study, in its entirety, spans three chapters and aims to:

- Identify what has already been established in existing literature regarding mobile digital literacy skills for educators using mobile technology in rural formal education.
- Answer the first sub-research question (SRQ1): How can mobile digital literacy skills, from literature, inform educators when using mobile technology in rural formal education?

The following narrative refines the scope of the literature study further.

2.1.1 **Classroom Practice**

As the uptake and use of mobile technology becomes more pervasive in education, it is argued that it is imperative that educators acquire sufficient skills to utilise technology and so enhance the teaching and learning engagement. The focus of this study is the rural educator and his/her classroom practice. It should, however, be acknowledged that this practice takes place within a complex ecosystem (Gracia-Penalvo et al., 2015).

Despite the long-term existence of mobile technologies, they have not been effectually integrated into the classroom (Mamba & Isabirye, 2015).

Classroom practice presupposes different interacting components within the classroom which are known as a *system*. Therefore, classroom practice can be understood as the techniques and skills used by an educator to ensure that learners remain: organised, systematic, focused, alert and academically productive within a classroom (Li & Oliveira, 2015).

Classroom practice is evolving away from traditional teaching practices towards adopting more innovative ways of doing. The shift in focus may place even more strain on educators to accommodate transformation (Li et al., 2015). These changes could be due to (Siemens, 2017):

- Rapid change in knowledge: educational goals are more focused on collaborative and life-long learning.
- People's perceptions and thoughts concerning learning needs have changed.
- Educational technology has developed: these tools provide new improved instructional methods and, therefore, new ways should be found to adapt these technologies to instructional settings.

2.1.2 **Active learning**

The role of technology in classroom practice has been the focus of many studies (Jahnke et al., 2014). Although the complexity of these studies are acknowledged, the study aligns with the fast body of knowledge that supports the use of technology to facilitate active learning as a classroom practice (Jahnke et al., 2014).

An educator's decisions regarding approach to classroom practice can either enable active learning, or serve as a hindrance to a learner's success (Wenglinsky, 2001). All in all, if classroom practice is grounded in an awareness of the appropriate use of mobile technologies, it can benefit all parties (Meyer, Ford, Marais, & Dlamini, 2017).

Active learning can be described as any instructional technique that facilitates students' active involvement in the learning process (Thompson, 2015). Consequently, the main fundamentals of active learning are *student activity* and *engagement* in the learning practice (Prince, 2004). This process, therefore, differs from the traditional classroom practice whereby students are passive receivers of information. Learners are subjected to a role shift: from being consumers of information to becoming active co-creators in the construction of new information (Jahnke et al., 2014). Active learning also requires a learner to *deep* learn. To *deep learn* means to evaluate and assess information constructively and to create new information collaboratively (Jahnke et al., 2014). Active learning will equip a learner to take his/her place in the new developing workforce (Langenhoven, 2015) by helping them become problem solvers, liberated intellectuals and autonomous decision makers (Russell, Rawson, Freestone, Currie, & Kelly, 2018).

Some scholars refer to active learning as *creative learning* (Cachia, Ferrari, Ala-Mutka, & Punie, 2010). Cachia, Ferrari, Ala-Mutka and Punie (2010, p. 19) define creative learning as "any learning which involves understanding and new awareness, which allows the learner to go beyond notional acquisition, and focuses on thinking skills. It is based on learner empowerment and centeredness."

Active learning, it is said, encourages educators to think of teaching and learning in non-traditional ways, therefore fostering innovative teaching (Cachia et al., 2010; Prince, 2004). As an enhanced teaching methodology it provides educators with several opportunities to attain and sustain an innovative and competitive edge (Floricel et al., 2018).

2.1.3 **Technology pedagogical skills**

Technology can facilitate changes in educators' practice in the classroom, therefore improving learner achievement. Educators need to keep their mobile digital literacy skills up-to-date and so ensure mobile technology's effective use for teaching and

learning. Mobile technology's effective implementation can help educators adapt to the shifting needs of schooling practice (Van Biljon et al., 2017).

Educational technologies have the ability to transform pedagogy in classroom practice (Choudrie, Islam, Wahid, Bass, & Priyatma, 2017). The teacher's *technology pedagogical skills,* which are essential in facilitating classroom change to adapt to mobile technology learning, can be derived from the Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler 2006). The TPACK model (Koehler & Mishra, 2009), is an extension of Shulman's ideas regarding pedagogical content knowledge (Shulman, 1986).

The TPACK model, illustrated in Figure 2-2, combines technological, pedagogical and content knowledge to attain subsets of: pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge (Koehler & Mishra, 2009).

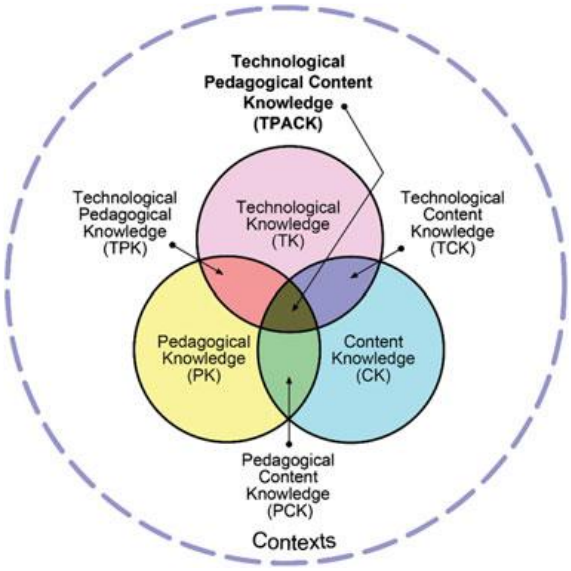


Figure 2-2: The TPACK model (Koehler & Mishra, 2009).

When content knowledge, pedagogy knowledge and technology knowledge overlap, they define the knowledge needed to facilitate the effective use of technology in learning (Mishra & Koehler, 2006).

- Technology Knowledge (TK) comprises the knowledge and skills needed for the appropriate use of technology (Mishra & Koehler, 2006). In this study,

technology knowledge would be the suitable knowledge of technology relevant to the use of mobile technologies in the classroom.

- Content knowledge (CK) comprises knowledge specific to the subject being taught (Mishra & Koehler, 2006).
- Pedagogical knowledge (PK) consists of effective teaching and learning methods that help to achieve academic purposes, aims and goals (Mishra & Koehler, 2006).
- Technological content knowledge (TCK) includes information which nurtures a reciprocal relationship between technology and content (Mishra & Koehler, 2006).
- Pedagogical content knowledge (PCK) involves knowing which teaching practices are appropriate to a particular content set (Mishra & Koehler, 2006).
- Technological pedagogical knowledge (TPK) refers to the familiarity with technology, for example, its existence and functionalities to support different teaching and learning practices (Mishra & Koehler, 2006).
- Technological pedagogical content knowledge (TPACK) is the foundation of effective education with technology and requires a sound understanding of the associated concepts of technology use (Mishra & Koehler, 2006).

Of importance to this study is *technological knowledge (TK)* and *technological pedagogical knowledge (TPK)*. The technological knowledge dimension investigates which mobile digital literacy skills are needed to use specific technologies. Technological pedagogical knowledge includes knowledge regarding the various technologies and their possible uses in the classroom. Some knowledge, as regards technology include: the existence of technology, constituents, functionalities and abilities and *how* teaching will be affected if these technologies were to be used (Mabila et al., 2017).

The term *knowledge* in this study refers to a theoretical and overall understanding of mobile technologies in pedagogy whereas *skills* refer to the competences established through training and experience. Skills need to be learnt and can be transferred through knowledge sharing, from one person to another (Neumann, 2018). Therefore, a skill set is a category of competences required to perform a task to a certain acceptable level (Doyle, 2017), thus creating a *literacy* (Schreuers, Quan-Haase, &

Martin, 2017). A collection of *literacies* creates a dimension in a framework, or model (Ng, 2012). These terms have been used throughout this study and are summarised in Figure 2-3.

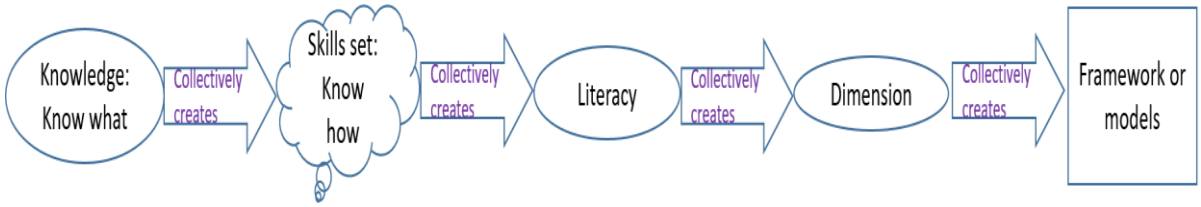


Figure 2-3: Terms used in this study (Source: The Researcher).

The literature study outlined in Chapter 3 to 5 will be framed by an exploration of *teachers' technological pedagogical skills to facilitate active learning through mobile technology use in classroom practice in rural formal education* and will be constructed using a scoping literature review approach.

2.2 SCOPING LITERATURE REVIEW ON MOBILE DIGITAL LITERACY SKILLS FOR A RURAL EDUCATOR USING MOBILE TECHNOLOGY

This section elaborates on adopting a systematic literature review protocol to conduct a scoping review on mobile digital literacy skills for an educator using mobile technologies in rural education and how it was applied in this study.

Fink (2005 p. 3) defines a *research literature review* as "a systematic, explicit, and reproducible method for identifying, evaluating and synthesizing the existing body of completed and recorded work produced by researchers, scholars and practitioners." The careful gathering of data by identifying, evaluating and synthesising (Fink, 2005), influences the credibility of one's work (Hart, 1998). The definition indicates that a systematic approach should be followed (Fink, 2005) to conduct a scoping review (Colquhoun et al., 2014). Colquhoun et al. (2014, p.1292) define a scoping review as "a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesising existing knowledge." Material which is non-research based can contribute to a scoping review (Davis, Drey, & Gould, 2009). Some of the reasons for conducting a scoping literature review include (Tricco et al., 2016):

- Examining the extent and nature of a research activity.

- Determining the worth of conducting a systematic review.
- Reviewing and disseminating findings.
- Identifying research gaps in existing literature.

The differences between a *systematic* and *scoping* review (Armstrong, Hall, Doyle, & Waters, 2011) are presented in Table 2-1.

Table 2-1: systematic review vs. scoping review (Armstrong et al., 2011).

Systematic review	Scoping review
Dedicated research question with narrow constraints.	Research question/s are broad.
Inclusion/exclusion defined at the beginning.	Inclusion/exclusion can be developed, as required.
Quality filters often applied.	Quality not a priority from the onset.
Detailed data extraction.	Data extraction could, and could not, happen.
Quantitative synthesis often performed.	Synthesis more qualitative and not necessarily quantitative.
Formally assesses quality of studies and generates a conclusion specific to the research question.	Used to identify parameters and gaps in literature.

As depicted in Table 2-1, a scoping review is appropriate for this study as it meets the requirements of searching the necessary literature relevant to the research topic.

2.2.1 **Conducting a systematic review protocol to conduct a scoping review**

There are eight important steps to conducting a systematic literature review (Okoli & Schabram, 2010):

Step 1 – Purpose of the literature review: a researcher needs to have a clear purpose and aim which governs the review and this should be communicated to the readers as well (Okoli et al., 2010).

Step 2 – Protocol and training: if a review is being conducted by more than one reviewer, then a protocol and procedure document, as well as training, should be provided to ensure that all reviewers share a similar understanding (Okoli et al., 2010).

Step 3 – Searching for the literature: a detailed outline of the literature search process needs to be presented (Okoli et al., 2010).

Step 4 – Practical screening: a reviewer should have criteria as to which literature to include and exclude, as well as a justification as to how the excluded literature would not undermine the quality of the review (Okoli et al., 2010).

Step 5 – Quality appraisal: articles included, as well as excluded, should adhere to certain quality criteria (Okoli et al., 2010) which, in turn, will affect the credibility of the review (Hart, 1998).

Step 6 – Data extraction: after literature has been selected for inclusion, the researcher should extract relevant data from these sources (Okoli et al., 2010).

Step 7 – Synthesis of studies: the use of quantitative, or qualitative, or both methods, to analyse information extracted from the literature (Okoli et al., 2010).

Step 8 – Writing the review: the final review should be written up with ample focus on detail, such that the outcomes could be replicated independently (Okoli et al., 2010).

This literature review (Chapter 3 to 5) aims to provide a narrative towards the creation of a Theoretical framework to guide subsequent research (Okoli et al., 2010). Relevant papers in the field were collected and analysed by means of a systematic literature review. The systematic approach enabled the purpose of this research process (Seuring & Müller, 2008) which is to contribute to existing literature (Okoli et al., 2010).

The systematic literature review protocol, adopted to conduct a scoping review, helped in identifying the constituents of the following concepts:

- Different types of mobile technologies.
- Rural education and its unique challenges.
- Implementation of technology in rural education.
- Implementation of technology in the classroom.
- The outcome of mobile technology for rural formal education.
- Educators' technological pedagogical skills.
- Working solutions that reflect use (best practice).

2.2.2 **Literature sources and study exclusion criteria**

The literature review was facilitated by access to the UNISA academic library that subscribes to a number of online journals. Some of the academic databases include: Scopus, IEEE Xplore, Wiley Online Library and Web of Science, Information systems research, INFORMS journal of Computing and MIS (Management Information systems) Quarterly.

Keywords and phrases for each chapter were used to retrieve relevant information. The keywords and phrases are stated in each chapter and summarised in Table 2-2.

Table 2-2: Summary of search criteria for each chapter in the literature review.

TOPIC	Chapters		
	Chapter 3:	Chapter 4:	Chapter 5:
	Educators' technological pedagogical skills	Mobile Information and communication Technology (ICT)	ICT in education: A rural South African perspective
Keywords	Digital, Literacy, Digital skills, Framework	Mobile ICT, Connectivity, Networks, Adoption model, Mobile digital literacy skills	Rural education, 21st century skills, Tablets, M-learning, Educator role, Active learning, Challenges, E-readiness
Keyword searches	"ICT skills", "Digital literacy", "Digital literacy skills", "Components of digital literacy skills", "Mobile digital literacy skills", "Mobile digital literacy skills + rural educators", "Framework for digital literacy skills and "Framework for mobile digital literacy skills"	"mobile technology", "connectivity", "categories of mobile devices", "wireless connectivity for mobile devices", "mobile technology penetration in South Africa", "Mobile digital literacy skills + mobile technology", "safe use of mobile technology" and "mobile digital literacy skills"	"ICT in education", "elements of m-learning", "roles of ICT in education", "department of education" + "ICT integration", "rural education" +" mobile technology", "Mobile digital literacy skills + rural educators", "Framework for digital literacy skills" and "Framework for mobile digital literacy skills"
Literature review method	Scoping	Scoping	Scoping
Databases used	Scopus, IEEE Xplore, Wiley Online Library, Web of Science, Science Direct	Information systems research, INFORMS journal of Computing and MIS Quarterly: Management Information systems, Web of Science, Science Direct	Information systems research, INFORMS journal of Computing and MIS Quarterly: Management Information systems, Web of Science, Science Direct
Inclusion and exclusion principles	Only publications written in English were used Studies referring to the components of digital skills were used Studies including frameworks and models of digital skills were used Studies involving PC-centric skills were excluded	Only publications written in English were used Studies referring to the components of Mobile Digital Literacy skills were included Studies looking at mobile technology in Africa were considered Uptake of technology in non-African rural areas were excluded	Only publications written in English were used Studies referring to mobile technologies in education were included Studies outside the education setting were excluded Studies concerning only formal education were included Studies specifically focusing on tablets in education were included Informal and distance education were excluded
Number of papers used	30	70	162

2.2.3 **Searching the literature**

Relevant and well cited articles regarding *frameworks for mobile digital literacy skills* and *educators in rural formal education* were identified in academic journals, as indicated in Table 2-2. As per year of publication, articles from 2000 to 2018 were included. Some older articles were incorporated as they were highly cited by other publishing researchers or were often viewed.

2.2.4 **Data analysis and selection**

A systematic review is iterative in nature and presents a consistent flow of information, as depicted in Figure 2-4.

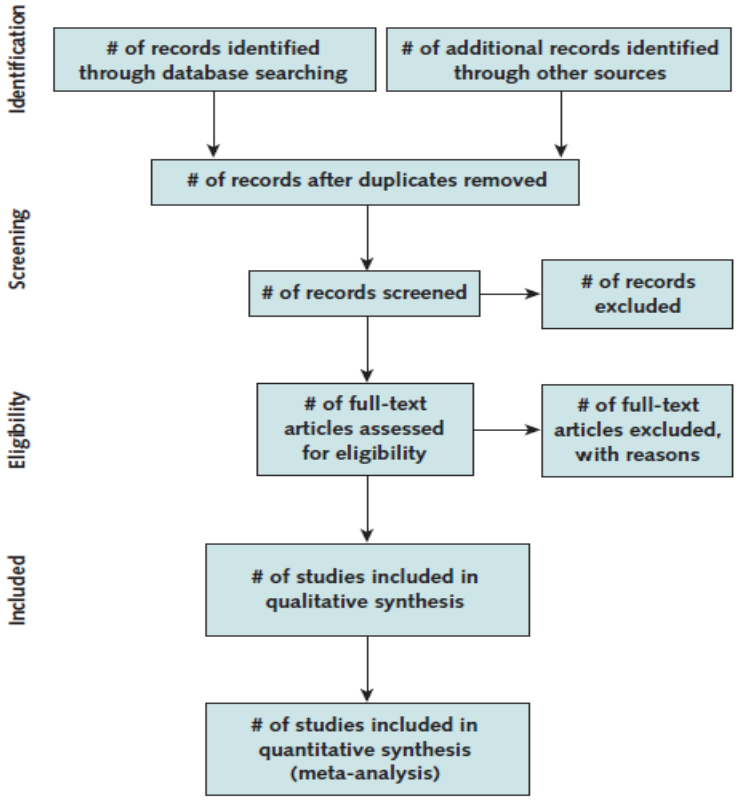


Figure 2-4: Information flow through different phases of a systematic review (David et al., 2009).

The general process illustrated in Figure 2-4 was applied to each of the literature chapters (Chapter 3 to 5) in this study to describe the process flow specific to the context of that particular chapter.

2.3 SUMMARY

The literature study outlined in Chapter 3 to 5 will be framed by an exploration of teachers' technological pedagogical skills to facilitate active learning through mobile technology use in classroom practice in rural formal education and will be constructed using a scoping literature review approach.

The literature study is operationalised as follows:

Chapter	Chapter 3:	Chapter 4:	Chapter 5:
Topic	Educators' technological pedagogical skills	Mobile Information and communication Technology (ICT)	ICT in education: A rural South African perspective

Each of these chapters contribute towards a Theoretical framework, used to conceptualise the *Framework for mobile digital literacy skills of educators using mobile technology in rural formal education.*

Abend (2013) suggests that a Theoretical framework is a structured approach to supporting the research study. The development is further outlined in the research methodology chapter, Chapter 6.

CHAPTER 3: EDUCATORS' TECHNOLOGICAL PEDAGOGICAL SKILLS

This chapter provides a scoping review of *educators' technological pedagogical skills*. The relevant data sources and keyword searches used in this chapter are presented in Table 2-2. A flow chart, presented in Figure 2-4, is applied to this chapter and presented in Figure 3-1.

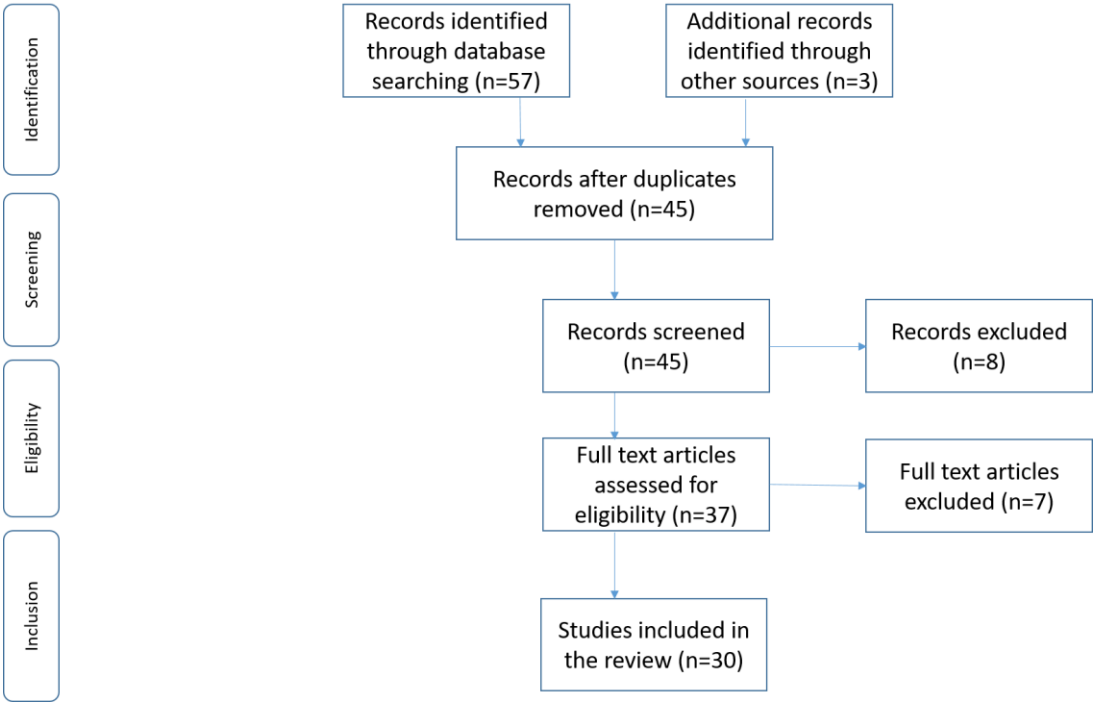


Figure 3-1: Flow chart of search phrases used in Chapter 3.

The flow chart process in Figure 3-1 indicates that 30 articles were included in the literature review for this chapter.

This chapter looks at ICT as a tool in education, rather than a subject being taught. It thus focuses on the skills an educator requires to use ICT effectively in the classroom. Consequently, the literature is explored for references to ICT skills and the categorisation of said skills. In particular, the focus is on mobile digital literacy skills for an educator using mobile technologies in a rural resource constrained area. To identify these skills, the general, and rather broad term, *digital literacy* will be considered. This will be followed by mobile digital literacy skills and lastly the mobile technological pedagogical skills specific for educators.

Mobile technologies can help attain the outcome of this study: active learning and innovative teaching (Thompson, 2013). However, Mabila et al. (2017) mention that mobile technologies, in isolation, cannot change education, but an educator with sufficient skills to incorporate mobile technologies and the right attitude might affect this change. Mobile technologies bring about new prospects as well as new responsibility for educators as they can use technology to support learning approaches (Thompson, 2015). Nieveen et al. (2018) support the aforementioned by stating that the way in which educators learnt their subject material is vastly different from the way 21st century learners want to learn. Therefore, in this day and age, being *digitally literate* enables one to be *digitally competent* in whatever one does (Sherwood, 2017).

The term *knowledge* in this study refers to a theoretical and overall understanding of mobile technologies in pedagogy whereas *skills* refer to the competences established through training and experience. Skills need to be learnt and can be transferred through knowledge sharing, from one person to another (Neumann, 2018). Therefore, a skill set is a category of competences required to perform a task to a certain acceptable level (Doyle, 2017). Having clarified the terms, the next section discusses digital literacy.

3.1 DIGITAL LITERACY

Literature suggests that reading and writing were adequate literacy proficiencies a decade ago and certainly sufficient to distinguish the educated in society (Zheng, Yim, & Warschauer, 2018). Lankshear and Knobel (2008) argue that this, however, is no longer the case. Technology has given rise to new literacies, involving different sets of skills and abilities to perceive and manage information**.** Markauskaite (2007) further notes that practical skills are a very important aspect of digital literacy. The exploration of literature, however, highlights that *digital literacy* refers to more than the mere operation of a technological device (Parry, Eikhof, Barnes, & Kispeter, 2018; Sadaf & Johnson, 2017; Zapata, 2018; Zheng et al., 2018).

Mohammadyari and Singh (2015) state that *digital literacy* is a relatively old concept which has been modified over time and in response to changing technologies. Gilster (1997) was one of the first scholars to use the term *digital literacy* with his main focus being on education. After Gilster, various authors through the years have defined

digital literacy from different viewpoints and in accordance to different perceptions (Bair & Stafford, 2012; Eshet-Alkalai, 2004; Eshet-alkalai & Chajut, 2009; Lankshear et al., 2008). Thus, Ferrari (2008) noted that it is not easy to assign one clear definition to digital literacy skills as each author's definition holds worth. Despite the many definitions, most scholars define digital literacy as a collection of literacies (Parry et al., 2018; Sadaf et al., 2017; Zapata, 2018; Zheng et al., 2018).

Regardless of the aforementioned, the *European Information Society* do not define *digital literacy* as a collection of literacies, but rather as *"*the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process" (Martin, 2005, p. 135).

3.1.1 **Digital literacy: A pool of other literacies**

Various scholars believe that *digital literacy* does not constitute one literacy, but rather a pool of literacies, to thus better reflect the complexities of the digital age (Parry et al., 2018; Sadaf et al., 2017; Zapata, 2018; Zheng et al., 2018).

Russell et al. (2018) propose that digital literacy constitutes information literacy but they add the Information and Communication (ICT) tool as well, whereas Zheng et al. (2018) add a third element, multimedia literacy. Media literacy is a key to Zapata (2018) definition as it supports media literacy by stating that it creates a platform to interact with the world.

Gilster (1997) lists different literacies to constitute *digital literacy* namely: communication literacy, visual literacy and information seeking literacy. Eshet-Alkalai (2004) also mentions categories of literacy, similar to Gilster (1997), namely: photo-visual literacy, reproduction literacy, branching literacy, information literacy and socio-emotional literacy (Eshet-Alkalai, 2004). Eshet-alkalai et al. (2009) included a sixth category into the framework namely real-time thinking skills. Eshet-alkalai adds that operating a digital device does not sufficiently define digital skills, but merely suggests a framework of literacies. These literacies are briefly described below (Eshet-Alkalai, 2004; Eshet-alkalai et al., 2009):

- Photo-visual literacy – skills to comprehend graphical representations in a digital environment.
- Reproduction literacy – ability to manipulate existing data and audio to reproduce information.
- Branching literacy – knowledge construction by navigating different knowledge domains.
- Information literacy – ability to scrutinise information for validity, quality and reliability.
- Socio-emotional literacy – effective online communication.
- Real-time thinking skills – ability to process and evaluate large amounts of information instantly.

Sherwood (2017) suggests three literacies: information literacy, lateral literacy and reproduction literacy. These components are similar to the components listed by Eshet-Alkalai (2004). Sherwood (2017) elaborates on the three categories by Eshet-Alkalai (2004), as follows:

- Information literacy – involves analysis and inspection of digital information for quality and validity.
- Lateral literacy – involves creating knowledge across different domains.
- Reproduction literacy – involves using reproduction abilities, like *copy and paste*, to create information.

In addition to these different literacies, the Joint Information Systems Committee (2015) includes both *technology* and *skills* in its explanation of digital literacy by defining the term as *the assertive and acute use of ICT.* The definition further states that digital skills keep changing according to the situation, time and context as technologies are constantly evolving with updated features (Jisc, 2015).

3.1.2 **Components of Digital Literacy skills**

In addition to the definitions, a trend of three to four generally accepted *components* of digital literacy skills were observed. Ferrari (2008) mentions that these components outline a set of abilities that enhance educators' digital literacy skills.

Ferrari (2008, p. 29-30) lists these components as: “underpinnings, background knowledge, central competencies and attitudes and perspectives”. Ferrari elaborates on these concepts as follows (Ferrari, 2008):

- Underpinnings are traditional level skills.
- Background knowledge is basic knowledge in acquiring information.
- Central competencies delve into the usage of technological tools.
- Attitudes and perspectives of individuals are illustrated as they deploy literacy skills.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) mentioned four self-explanatory components of digital literacy in their policy report entitled “Digital literacy in Education”. These components are: accessing information, integration of information, creating new information and communicating *this* information to the target audience (Ferrari, 2008). Gilster (1997) agreed with the components identified by UNESCO and emphasised that one needs to acquire other competencies, such as a strategised approach to online searching, assessing information and manipulating information to become meaningful knowledge. Schreuers et al. (2017) do not clearly define different components, but view information and digital literacy in a similar manner to UNESCO. These scholars feel that the digital environment encompasses a plethora of information, hence it is imperative to know how to search, manipulate and use this information (Schreuers et al., 2017).

3.1.3 **Combining the literacies and components into one framework**

Several methods have been used to define the term *digital literacy*. Some authors regard digital literacy as a *group of literacies* whereas others prefer *components*. This research is supported by the digital literacy framework of Ng (2012). This framework, as highlighted in Figure 3-2, combines all the aforementioned literacies and components into a single digital literacy model.

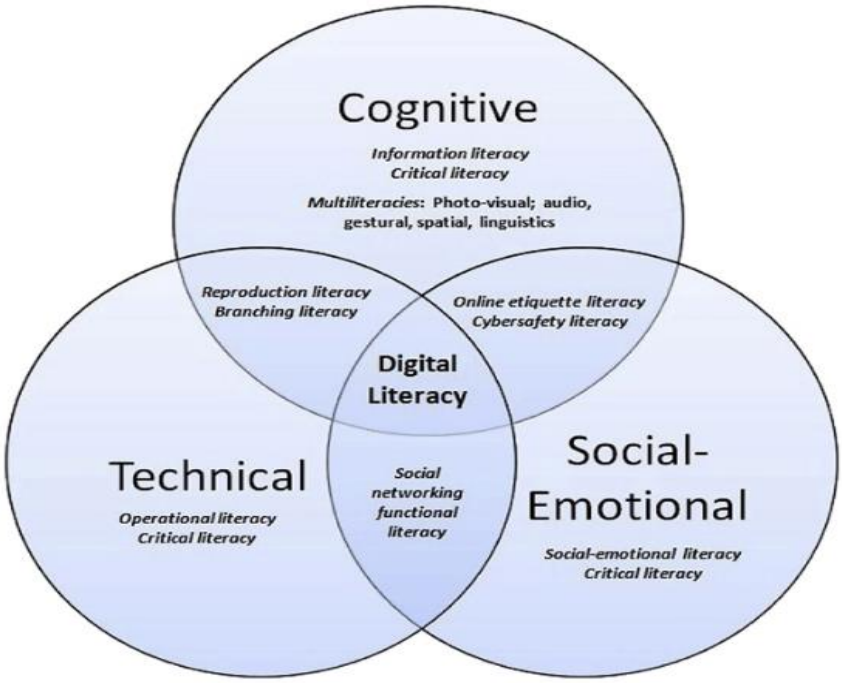


Figure 3-2: Digital Literacy model (Ng, 2012).

Figure 3-2 suggests that digital literacy is facilitated by the intersection of technical, cognitive and social-emotional perceptions. It involves the continuous development of an individual's skills (Ng, 2012). The three dimensions are described in Table 3-1.

Table 3-1: Dimensions of the Digital Literacy model (Ng, 2012).

Dimension	Literacy	Description	Examples
Technical dimension	Operational Literacy Reproduction Literacy Branching Literacy Social networking functional literacy	Technical and functional know-how of ICT in daily use.	Connect input and peripheral devices e.g. headset, speakers, external keyboards. Information of operational parts. File protection. Troubleshooting. Understanding storage, file sizes and file structures. Finding, installing and uninstalling applications. Using Bluetooth and infrared. Data costs associated with downloading data files. Setting up and using communication tools. Use of the internet, setting up an account, changing information on the internet. Sending and receiving information through e-mail or Dropbox and opening them appropriately, for example, unzipping a folder. Understanding software. Understanding user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.

Dimension	Literacy	Description	Examples
Cognitive dimension	Information Literacy Reproduction Literacy Branching Literacy Online etiquette literacy Cyber safety Literacy	Critical thinking for digital information.	Carry out a search. Evaluate information for authenticity and quality. Recreate information. Software selection for specific tasks. Knowledge regarding the ethical use of information, thus not committing plagiarism and respecting copyright resources.
Social-emotional dimension	Social-emotional literacy Social networking functional literacy Online etiquette literacy Cyber safety Literacy	Use internet appropriately.	Know about the safe use of the internet. Know about legal rights with online banking and online purchases. Behaving in a decent manner over the internet. Avoiding the use of vulgar language. Not disclosing private information. Identifying threats and knowing how to deal with such situations.
All dimensions	Critical Literacy	Applicable to all dimensions and involves understanding that information is written by people and they have their own agendas as well.	Critical assessment of digital information.

Table 3-1, therefore suggests that for a person to be digitally literate, he/she requires a combination of technical, cognitive and social-emotional skills (Ng, 2012). Ng (2012) states that a *digitally literate individual* should be able to:

- Conduct simple computer-based operations and retrieve resources for daily use.
- Critically search and evaluate information.
- Chose appropriate technological tools and functionalities for tasks completion and problem solving.
- Display appropriate conduct in the online environment and protect his/herself in a digital setting.

In support of the literature by Ng (2012), digital literacy promotes intellectual freedom when compared to conventional literacy, as illustrated in Table 3-2 (Ventimiglia & Pullman, 2016).

Table 3-2: Traditional literacy vs. digital literacy (Ventimiglia & Pullman, 2016).

Traditional Literacy	Digital Literacy
Finding information	Scrutinising information – finding information is not the only important skill in digital literacy but carefully analysing said information and assessing its validity and quality is important (Bansal & Joshi, 2014; Granger, Morbey, Lotherington, Owston, & Wideman, 2002).
Reading (solution emersion)	Actively searching for solutions: Learners should be able to assess a problem, develop a method to derive the solution and then present the solution (Bansal et al., 2014; Gopalan, Karavanis, Payne, & Sloman, 2011).
Note-taking	Curating: developing connections between information (Patten, Arnedillo Sánchez, & Tangney, 2006).
Output and writing style are set methods	Output style constitutes: videos, coding, audio, data graphics (Aventurier, 2014; Voogt, Erstad, Dede, & Mishra, 2013).
Learns from educators	Learner is able to self-teach.
Permanent	Non-permanent.

Table 3-2 suggests that once an individual is sufficiently digitally literate, he/she is free and empowered to discover and create meaning (Frank & Castek, 2017). Most definitions of digital literacy skills pay attention to sets of skills needed by an individual to survive in a progressively digital environment (Martin, 2018) with less focus on specific tools, or technologies (Floricel et al., 2018). For this study, the focus is on *mobile technologies* specifically. The skills needed to operate mobile technologies will thus be considered in the next section.

3.2 SUMMARY

This chapter explained *how* literacy has evolved over the years: from basic reading and writing to skills needed to operate technological devices. Through the years, authors have attempted to define the term *digital literacy*. Some have defined *digital literacy* as *a collection of literacies* whilst others have described it as a *pool of competences*. Ng (2012) summarised different literacies and competencies into one visual representation known as the digital literacy model. This literacy model by Ng (2012) highlights competences in three dimensions namely: technical, socio-emotional and cognitive. Each of these dimensions can be sub-divided into further categories of digital literacy skills. Ng's digital literacy model serves as a foundation for the

development of the Theoretical framework developed in this study. Table 3-3 presents the Theoretical framework version 1. It highlights the different categories of digital skills, as based on the digital literacy model of Ng (Ng, 2012).

Table 3-3: Theoretical Framework v1: Literacies used for the framework, as extracted from digital literacy model (Ng, 2012).

Dimensions: Digital Literacy Model	Category of Digital literacy skills
Technical dimension	Operational literacy
Socio-emotional dimension	Social-emotional literacy Social networking functional literacy Online etiquette literacy Cyber safety Literacy
Cognitive dimension	Reproduction Literacy Branching Literacy Information Literacy
Literacy for all dimensions	Critical Literacy

CHAPTER 4: MOBILE INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

This chapter provides a scoping literature review of *mobile ICT*. The relevant data sources and keyword searches used in this chapter are presented in Table 2-2.

The flow chart, presented in Figure 2-4, is applied to this chapter, as per Figure 4-1.

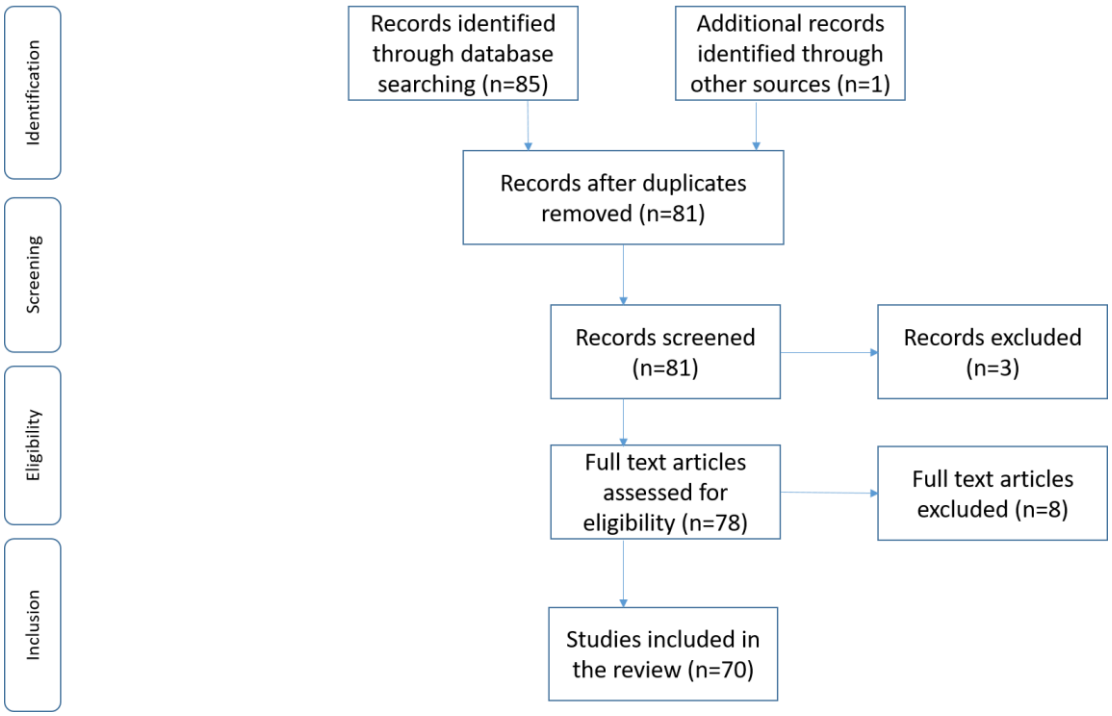


Figure 4-1: Flow chart of search phrases used in this chapter.

Figure 4-1 illustrates that a total of 70 articles met the criteria for inclusion in this chapter.

Mobile technologies have evolved over the years, from specific devices created for either communication or information access, to a powerful mixed device supporting both *information access* and *communication* (Chipangura, 2016; Walls, 2017). Harper (2003) believes that mobile devices should primarily be used for communication and not to access information. Jarvenpaa and Lang (2005) commend this powerful mobile device stating that it is the first real individual and personal computer which forms part your personal belongings, like car keys and a wallet, which you would grab as you exit your home in the morning (Caudill, 2007). Therefore, mobile technologies are described as computing devices that are portable due to their smaller size (like a cell

phone or smartphone) and can include tablets, laptops and netbooks (Valk, Rashid, & Elder, 2010). Keegan (2005) did not completely agree with laptops and netbooks being part of the definition as he felt that the main criteria is based on *mobility* and not only *portability* (Rashevska & Tkachuk, 2018). In agreement with Keegan's explanation, Traxler (2007) defined a mobile device as a device that can be carried anywhere, without difficulty and inconvenience, of a personal nature.

4.1 MOBILE TECHNOLOGY

Mobile devices are *easy to carry around communicating devices* which can perform a number of functions (Walls, 2017). Pulli, Aarnio, Miettinen, Roimela, and Vaarala (2008) mention that mobile devices are easily and widely available and have evolved into a multidimensional devices (Qureshi & Xiong, 2017). Kelly and Minges (2012) comment on the multidimensional aspect of the device, asserting that in today's world, a device needs to be an excellent communicating tool, video recorder, camera, calendar and clock, amongst many other features.

4.1.1 Grouping of devices

One of the first mobile technologies were Personal Digital Assistants (PDAs). PDAs possessed most of the features of a laptop, but were smaller, pocket sized devices (Caudill, 2007). The drawback of PDAs was their lack of processing capacity, unlike a laptop (Caudill, 2007). PDAs were followed by mobile phones which, at their inception as per Mellow (2005), were mainly used for messaging. Different types of mobile devices evolved over time and other features, in addition to messaging, were added (Hausknecht & Kaufman, 2018). Kelly et al. (2012) elaborated on the *aesthetic* aspect of mobile devices, commenting that these devices did not alter in terms of their functionalities, but aesthetically as well. Sharon (2003) touches on aesthetics, mentioning that the first mobile devices had external key pads and the latest version have built-in keyboards, accessible by touchscreen.

Pulli et al. (2008) suggest three groupings for mobile devices whilst Kelly et al. (2012) propose a fourth additional category. These categories are illustrated in Figure 4-2.

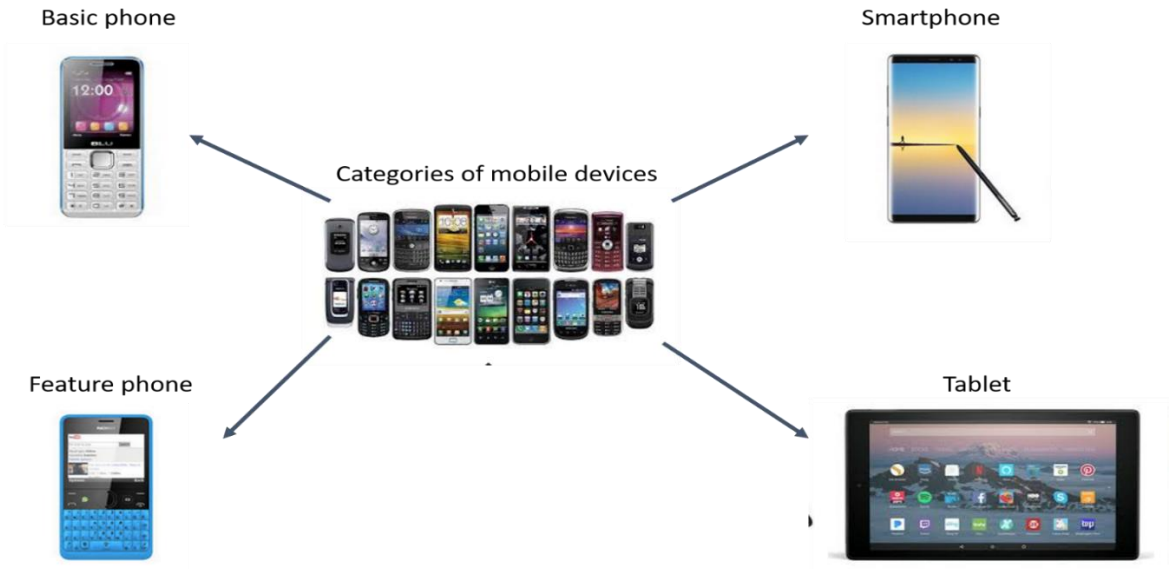


Figure 4-2: Four phone categories (Adapted from: Kelly & Minges, 2012).

The categories in Figure 4-2 can be described in the following way:

- Basic phones – a device mainly used for making and receiving calls and text messages (Sharon, 2003).
- Feature phone – this phone is more capable than a basic phone and less able than a smartphone. In addition to the basic call and messaging features of a basic phone, a feature phone has basic multimedia and internet capabilities (Dhir, Kaur, Jere, & Albidewi, 2012).
- Smartphone – a smartphone can be compared to a mini-computer. They have a powerful operating system with numerous features (PC Magazine, 2011).
- Tablet – a tablet computer, normally shortened to just *tablet*, is a portable computer with a mobile operating system. It has a touchscreen interface and is smaller than a laptop or notebook, but larger than a smartphone (Walls, 2017).

The small memory and screen size used to be problematic with basic and feature phones (Brown & Mbati, 2015). Caudill (2007) noted that these limitations are of no consideration now as mobile phones have evolved, with modern features, to compensate for these drawbacks. Present devices, such as smartphones and tablets, have a large amount of built in storage space whilst also allowing for external memory (Qureshi et al., 2017). In addition, the screens are much wider (Brown et al., 2015).

Additionally, Valk et al. (2010) mention notebooks and laptops as mobile devices but other authors disagree based on size, configuration and boot up and shut down time (Qureshi et al., 2017; Walls, 2017).

Optimal use of a device is imperative. Table 4-1 highlights the characteristics of the basic mobile phone, feature phone, smartphone and tablet. The devices categorised display different features. Each category builds on the features of its predecessor device (Kelly et al., 2012).

Table 4-1: Mobile devices and their capabilities (Kelly & Minges, 2012).

Device	Capabilities	Device	Capabilities
Basic mobile phone	Network services, including: Voice telephone and voice mail SMS (short message service) USSD (unstructured supplementary service data) SMS-based services, such as mobile money USSD-services, such as instant messaging	*Smartphone*	As feature phone plus: Video camera Web browser GPS (global positioning system) 3G+ internet access Mobile operating “platform” (such as iOS, Android, Blackberry) Ability to download and manage applications VOiP (Voice over Internet Protocol) Mobile TV (if available) Removable memory card
Feature phone	As basic mobile phone plus: Multimedia Messaging Services (MMS) Still picture camera MP3 music player 2.5G data access	*Tablet*	As smartphone plus: Front and rear-facing video cameras (for video calls) Larger screen and memory capability Faster processor, enabling video playback Touchscreen with virtual keyboard USB (universal serial bus) port
Note: The list of capabalities is not exhaustive, and not all devices have all features.			

Table 4-1 lists the latest mobile technologies, such as smartphones and tablets, as well as their functions. These devices can be regarded as all-in-one tools. A mobile device can thus be used as a computer, an address book, a camera, a video recording device, a storage device, a navigational device and a calendar, to name but a few (Kelly & Minges, 2012). Qureshi et al. (2017), like Kelly et al. (2012), comment on the noticeable differences in features between feature phones and smartphones, as per Table 4-1.

Tilson, Sorensen, and Lyytinen (2012) believe that, in order to support the vast number of functionalities, mobile devices have special operating systems known as mobile

operating systems. Some of the most common operating systems are Google's Android, Microsoft's Windows and Apple's iOS. Each of these operating systems, respectively, supports software applications to enhance one's experience when interacting with the mobile device (Tilson et al., 2012). Thompson (2015) adds that each of these mobile operating systems supports vast numbers of free and commercial applications. (Hutchison, Beschorner, & Schmidt-Crawford, 2012) elaborate further stating that applications are created specifically for digital devices, normally used for a single, specific purpose and generally downloaded by connecting to the internet.

The next section considers the different forms of mobile connectivity available.

4.2 MOBILE CONNECTIVITY

To benefit from mobile technologies, a network connection is essential. Two main mobile connection networks exist namely: wireless connections (Caudill, 2007) and mobile cellular networks (Hansen, 2018; Qadir et al., 2018; Zhang, 2018).

4.2.1 Mobile cellular networks

The International Telecommunication Union (ITU) state that mobile devices are not only evolving in terms of aesthetics and features, but also in terms of network connectivity (ITU, 2009). Qadir et al. (2018) further highlights that network connectivity is a progressive vital change to the services offered by different industries. These network evolutions have been categorised into generations, as shown in Figure 4-3.

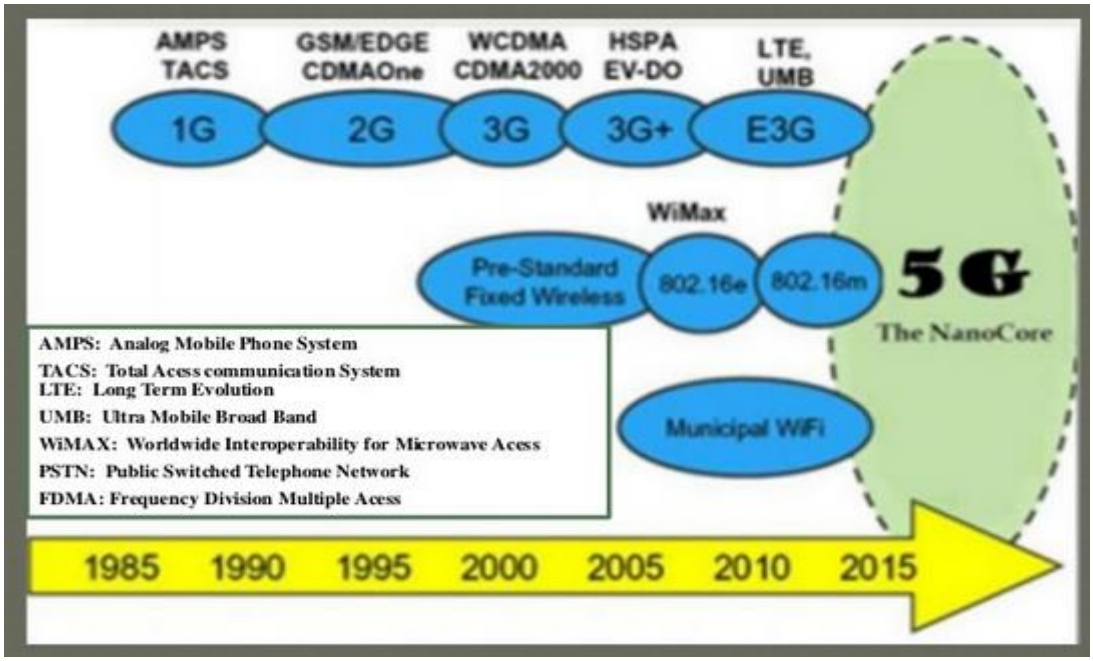


Figure 4-3: Evolution of mobile networks (Patel, Chauhan, & Kapadiya, 2012).

An overview of the evolution of mobile technologies is presented in Table 4-2.

Table 4-2: Evolution of wireless telephone technology (Zhang, 2018).

Generation	Description
0G	The beginning of wireless technology, just after World War II. This included the mobile radio telephone. Some of the technologies, as predecessor systems include, Push to Talk (PPT) and Improved Mobile Telephone Service (IMTS)
1G	First generation technology for cell phones. This technology allowed for voice-only cellular telephony. 1G signals were analog signals.
2G	Second generation technology included digital signals which could transfer digital voice data, time and date and SMS messaging. This was launched on the GSM standards. *2.5G – GPRS (General Packet Radio Service)* came in between 2G and 3G. This system was an upgraded packet switch domain, in addition to the normal circuit switched domain, that was used in 2G. Some GPRS enabled services included: Wireless Application Protocol (WAP) access, Multimedia Messaging Services (MMS) and basic internet connection for e-mail and web access. *2.75 – EDGE (Enhanced Data rates for GSM Evolution)* is an advancement to 2.5G and works in an extended GSM network. EDGE can function on any updated GPRS networks and allows for faster data transmission. EDGE enabled the use of many feature phones like Black Berry and Nokia phones.
3G	The third generation of mobile technology allowed for better services through an improved spectral of efficiency. This spectrum referred to the load of information transfer over a given bandwidth. Some services facilitated in a mobile environment were: voice calls, video calls, GPS (global positioning system) and broadband. Some of the advantages 3G had over its predecessor 2.75G were: Greater streaming speeds for both audio and video. Increased data speed. Support of TV through the Internet.
4G	This generation of technology is an extension of 3G. There is more bandwidth and a higher quality of both audio and video streaming over end to end Internet Protocol. The launch of 4G was in 2010.
5G	This is the future revolution of wireless technology. It will have astonishing capabilities.

Table 4-2 reveals the evolution of mobile cellular networks. In addition to cellular networks, people can use wireless connections on their mobile devices.

4.2.2 **Wireless Networks**

Wireless networks are characterised based on the number of geographical location covered (Ma et al., 2018). They are presented in Figure 4-4.

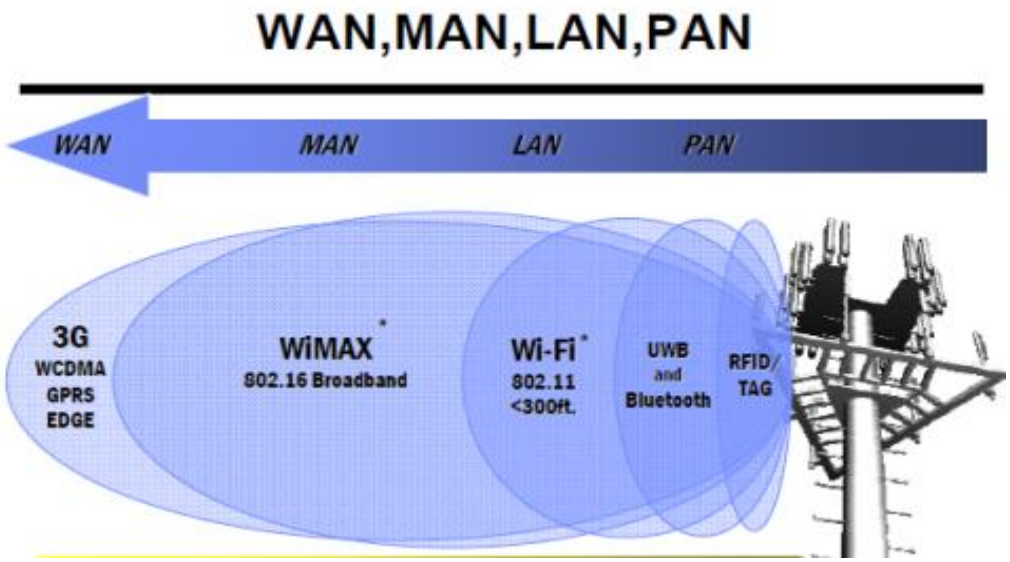


Figure 4-4: Wireless networks (Takei, 2008).

Figure 4-4 represents the different wireless networks which cover certain areas. The characteristics of these wireless networks are summarised in Table 4-3.

Table 4-3: Comparison between PAN, LAN, MAN, WAN (Delony, 2017; TechDifferences, 2016).

Basis of comparison	PAN	LAN	MAN	WAN
Expands to	Personal Area Network	Local Area Network	Metropolitan Area Network	Wide Area Network
Meaning	Network covering a significantly small area	Network connection of a small group of computers	A network covering a sufficiently larger area such as a town	This type of network spans large geographic areas, such as countries
Ownership of network	Private	Private	Private or public	Private or public
Design and maintenance	Easy	Easy	Difficult	Difficult
Propagation delay	None	Short	Medium	Long
Speed	High	High	Moderate	Low
Fault Tolerance	Very tolerant	More tolerant	Less tolerant	Less tolerant
Congestion	Less	Less	More	More

Used for	Room	College, hospitals, schools, coffee shops	Towns and cities	Country and continent
Examples	Bluetooth and Infrared	Wi-Fi	Worldwide Interoperability for Microwave Access (WiMAX)	3G WCDMA

Given the characteristics of mobile devices and different network connections, Figure 4-5 illustrates internet usage in South Africa in 2016.

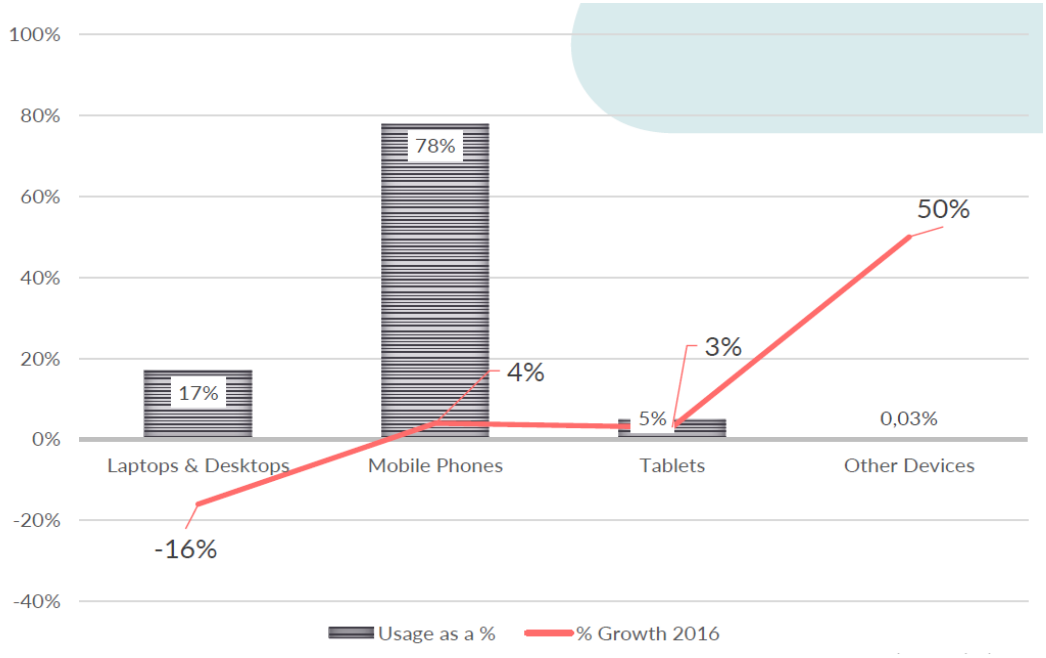


Figure 4-5: Share of internet usage by devices in South Africa (Qwerty, 2017).

A large amount of network traffic in South Africa stems from *mobile users*, as illustrated in Figure 4-5. Although the figure shows that mobile devices are the most convenient method for South Africans to connect to and experience the internet (Casey & Babu, 2016), it does not clearly indicate whether the internet is from cellular or wireless network origin. Van Biljon et al. (2017) comment on internet connection experiences via mobile devices and note that South African young people in rural areas are very appreciative of this new technology.

In spite of the many perks offered by the internet platform in Africa, issues remain. Firstly, the platform's reach, especially in rural areas, remains unstable. Secondly, data connectivity is still expensive in African countries (Astill, 2017). Some developments taking place in Africa have promised to place affordable internet

connections within the reach of even the remotest rural areas. These developments are facilitated by a significant increase in the capacity of undersea cables to Africa. Since 2015, bandwidth capacity has almost doubled and this has resulted in increased competition in the market place and a steady decrease in prices (Astill, 2017).

The next section will focus on mobile device accessibility, penetration, uptake, adaptation and safe use.

4.3 MOBILE TECHNOLOGY USE

Mobile technology, with its powerful features and the ability to connect to a network (Chang et al., 2018), has evolved into the most commonly used technology in modern life.

4.3.1 Accessibility and penetration

Mobile devices are the fastest growing technology (Unit, 2008) and, as such, it has taken the world by storm (Chang et al., 2018).

Cellular News (2009) reported that mobile device penetration, specifically in South Africa and inclusive of rural areas, stood at more than 100%. The Qwerty (2017) report affirms this mobile penetration figure by stating that South Africa has amongst the highest mobile penetration rates in the world. Figure 4-6 illustrates the number of mobile phone subscribers in 2008 across different countries, South Africa included. This figure serves to confirm the high mobile device infiltration, as suggested by various reports (Aker & Mbiti, 2010; Cellular News, 2009; Qwerty, 2017).

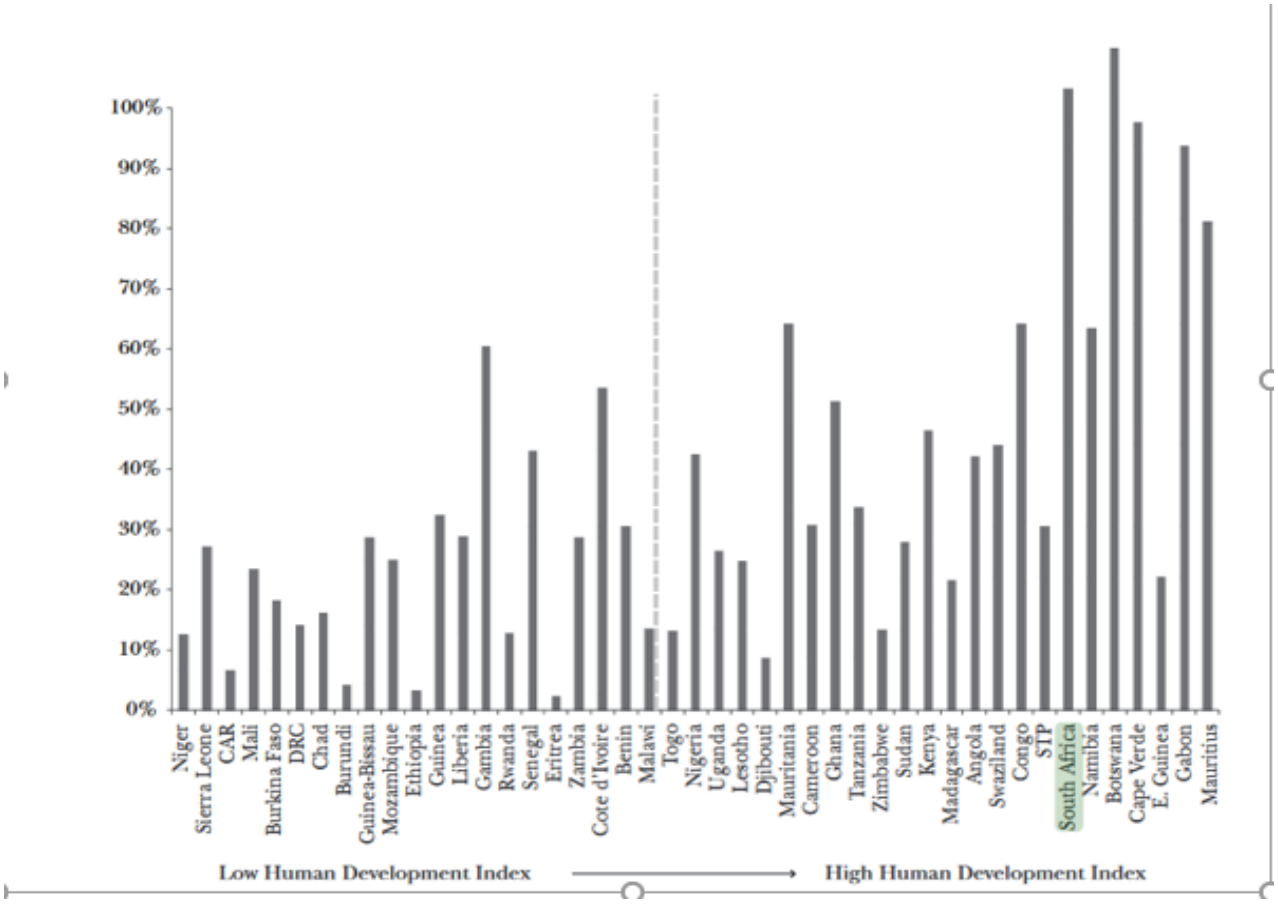


Figure 4-6: Mobile phone subscribers as a percentage of the population in 2008 (Aker et al., 2010).

Figure 4-6 shows that South Africa was almost at 100% in 2008 (Aker et al., 2010) and, as suggested by ITU (2018), that figure has increased over the past ten years. Aker et al. (2010) mention that the overall increase in use of mobile technologies has led to a decrease in cost of older mobile technologies and network usage costs. The decreased cost of older mobile technologies aids poorer communities in terms of affordability of a mobile device despite being slight outdated (Mitrovic, 2017). Floricel et al. (2018) note that the figures reflecting mobile device penetration are encouraging as mobile technologies, in most cases, remain the only access that some people in South Africa have to the information world. Floricel et al. (2018) further mention that this access is beneficial as it places the country in an advantaged position to benefit from the technology (Mitrovic, 2017). Mobile technologies can also overcome access barriers to ICTs, including a lack of physical infrastructure and financial resources, in rural constrained (Floricel et al., 2018).

Due to the developing functionalities of mobile devices, people have started using smartphones. Statistics show, that by the end of 2018, 66% of individuals globally will own smartphones. South Africa is one of the key countries in arriving at this figure (Casey et al., 2016). Jahnke et al. (2014) agree with the high forecasted smartphone access figure, commenting that almost every learner in the classroom has a smartphone.

Despite a high smartphone uptake, tablet penetration is still at an average of 20% (Caudill, 2007). Fu and Hwang (2018) ascertained that the reason for low tablet penetration is that individuals view tablets as *household devices* and not *personal devices* as they are too large to carry around.

In conclusion, with Africa having the highest growth in the number of mobile users, it would certainly be advantageous to make use of this powerful tool (Floricel et al., 2018) to develop a strong information society and a *digital Africa* (Mabila et al., 2017).

4.3.2 **Adoption of Mobile technology**

Van Biljon and Kotzé (2007) propose a Mobile Phone Technology Adoption Model (MOPTAM) as per Figure 4-7.

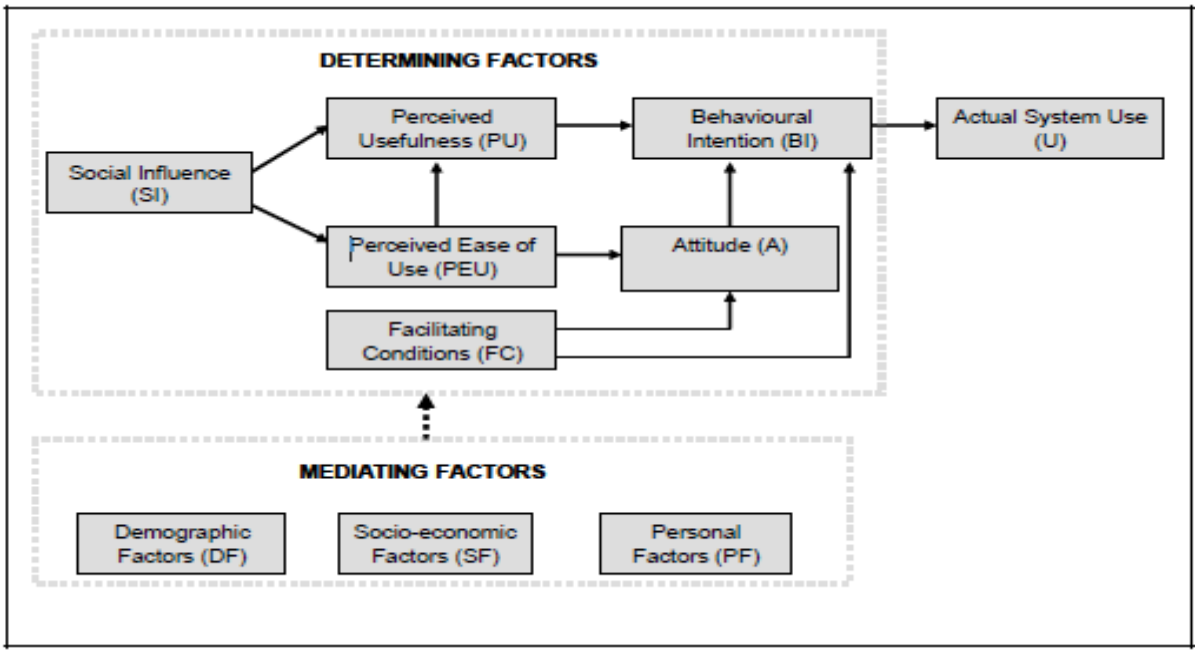


Figure 4-7: MOPTAM (Van Biljon & Kotzé, 2007).

In Figure 4-7, the model depicts the *determining* and *mediating* factors in mobile technology uptake and use.

Van Biljon et al. (2007) categorise the following six determining factors:

- Social influence: These conditions refer to the social burden placed on individuals, based on the opinions and beliefs of other people or groups. This category includes social influences and perceived usefulness and ease of use.
- Facilitating conditions: These refers to mobile phone infrastructure which comprises of: system services, cost of system services and cost of handset.
- Perceived usefulness: The degree to which an individual believes in the benefits of a mobile device.
- Perceived ease of use: The degree to which an individual believes that using the device will be effortless.
- Attitude: This involves the negative or positive associations of an individual with a targeted behaviour.
- Behavioural intention: Involves perceived performance while interacting with a mobile device.

The three mediating factors that determine mobile phone usage, as depicted in Figure 4-7, are outlined below (Van Biljon et al., 2007):

- Personal factors: These include an individual's personal preferences and/or beliefs regarding the benefits of technology. Therefore, relative advantage, compatibility, intricacy, image, trust and observability are considered.
- Demographic factors: Denotes an individual's age, gender, education level and technological expertise and ability.
- Socio-economic factors: Include variables like job status, occupation and earnings.

Together these determining and mediating factors affect the actual usage of a device (Van Biljon et al., 2007).

4.3.3 **Uptake**

Over time, improvements in mobile devices have led to an increase in the number of users (Mushi, Jafari, & Ennis, 2018). In support of this, Chipangura (2016) mentions that many South Africans prefer acquiring a more feature enabled smartphone which has resulted in a decreased demand for feature phones. The increase in smartphone usage could be due to two factors. Firstly, the increased broadband network coverage

reaching more or less 90% of South Africa (Chipangura, 2016) and, secondly, the reduction in the price of smartphones due to competitive pricing of devices (Kende, 2015). Poushter (2016) feels that the proper adaptation and use of mobile technology is currently the crucial factor in human progress. This leads to Sharples, Sánchez, Milrad, and Vavoula (2009) asking why people take to using mobile technologies. The following listed benefits of mobile technology use go a long way in answering Sharples et al. (2009) question:

- It is easy to use and requires only one hand engagement (Rashevska et al., 2018).
- Functionalities are rich and devices have many sensors, therefore many more abilities (Casey et al., 2016).
- It is smaller and ubiquitous (Bagot et al., 2018).
- It does not require lengthy boot up and shut down (Paily, 2016).
- It facilitates easy access to applications, like checking e-mails and shopping online (Casey et al., 2016).
- A very suitable personal device that keeps track of meetings etc. and thus helps one to organise his/her life (Mabila et al., 2017).

Literature suggests that learners are embracing mobile devices, so much so that they prefer group facilitated learning through social media platforms like Facebook and WhatsApp (Aventurier, 2014; Blodgett, 2017; Kasemsap, 2017). Rodriguez and Igartua (2018) strongly agree and note that social group education thrives due to quick response times and easy sharing of resources (Blodgett, 2017). Other scholars suggested that learners prefer e-mail as a method of communication with their educator (Krish & Salman, 2018; Savić, 2018). This preference was as a result of its formality, record being kept of conversations and ability to ask more detailed and comprehensive questions (Krish et al., 2018).

4.3.4 **Safe use of technology**

Despite the listed benefits, users need to have some knowledge of safety and security guidelines when using mobile devices (Chew, Cheng, & Chen, 2018; Collins & Halverson, 2018; Kluzer, 2015). Several precautions have been listed to safeguard

mobile devices and their owners (Chew et al., 2018; Collins et al., 2018; Kluzer, 2015). Some of these precautions include:

- A password to access devices deters other people from gaining access to the device and its personal content (Kluzer, 2015).
- Access should be gained via a secured connection. Unsecured connections can leak passwords (Collins et al., 2018).
- Software should be updated regularly (Collins et al., 2018).
- The terms and conditions of apps should be read before permission is granted (Chew et al., 2018).
- Users should be aware of scam messages that request personal details. Validity should be assessed (Kluzer, 2015).
- Users should be aware of what they post on social media as it leaves a digital footprint (Chew et al., 2018)

4.4 MOBILE DIGITAL LITERACY SKILLS

Mobile digital literacy is a subset of digital literacy, as suggested by Hansen (2018) and supported by Ng (2013). This study adopted the view presented by these authors as illustrated in Figure 4-8.

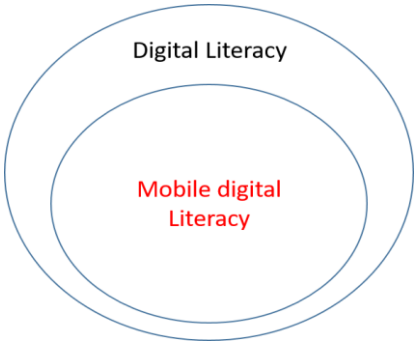


Figure 4-8: Mobile digital literacy as a subset (Source: The Researcher).

Figure 4-8 highlights the importance of first defining digital literacy. Digital literacy is progressive and adaptive and builds on initial skills which lead to the adaptation of new and emerging mobile devices requiring mobile digital literacy skills (Ng, 2012). Clark, Coward, Rothschild, Reynal, and Richter (2017) agree and state that the experience of using a mobile device differs to that of any other technological device. The *European Information Society* supplied a brief definition of mobile digital literacy

skills as an individual's ability to use mobile devices to manipulate digital data and to interact (Martin, 2018).

Mobile digital literacy is a subset of digital literacy. Significant research has been carried out on digital literacy but less on mobile digital literacy skills (Hansen, 2018). Traxler (2018) adds that significantly more research has been conducted on skills in *developed* countries than in *developing* countries. Many scholars strongly affirm that most digital literacy frameworks have failed to incorporate a mobile-centric orientation (Clark et al., 2017; Ng, 2012). Despite the lack of research, Ng (2012) believes that the dimensions of the digital literacy framework are very much applicable to mobile devices as well. Consequently, Clark et al. (2017) suggest that the internet cannot be used to its full potential if one lacks digital literacy skills. In agreement with this, Buzzetto, Elobaid, and Elobeid (2018) state that a mobile device and internet connectivity are of prime importance in digital literacy.

4.5 SUMMARY

The purpose of this chapter was to contextualise *mobile information* and *communication technology* in South Africa by providing the necessary background knowledge.

The chapter further discussed the changes in mobile technologies over time. Different categories of mobile technologies were mentioned. People, in general, seem to be embracing the use of smartphones and connecting to the internet via their devices.

The two main categories of mobile connectivity where discussed. The evolution of mobile cellular networks was highlighted, as well as different wireless connections.

To conclude the chapter, a few precautionary measures were listed to ensure the safe use of mobile devices.

From chapter 3, with reference to the digital literacy skills suggested by Ng (2012) who described the different categories of digital skills, as based on the digital literacy model; the following Table (Theoretical Framework v1) is repeated (Table 4-4), for ease of reading.

Table 4-4: Theoretical Framework v1: Literacies used for the framework, as extracted from digital literacy model (Ng, 2012).

Dimensions: Digital Literacy Model	Category of Digital literacy skills
Technical dimension	Operational literacy
Socio-emotional dimension	Social-emotional literacy Social networking functional literacy Online etiquette literacy Cyber safety Literacy
Cognitive dimension	Reproduction Literacy Branching Literacy Information Literacy
Literacy for all dimensions	Critical Literacy

The literature presented in this chapter provided a deeper understanding for the Theoretical framework. An updated Theoretical Framework v2 is presented in Table 4-5.

Table 4-5: Theoretical Framework v2: Refined Theoretical framework

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Ng, 2012)	Mobile digital literacy skills for the use of mobile technologies	Support from Literature
Technical dimension	Operational literacy	Getting started with a mobile device	(Martin, 2018)
		Personalisation of one's device	(Kelly et al., 2012)
		Underpinnings – basic skills to operate a device	(Jere, Thinyane, Boikhutso, & Ndlovu, 2013); (Kelly et al., 2012); (Pan, 2012); (Brown et al., 2015); (Caudill, 2007)
		Understanding mobile hardware operation, affordances and specifications of a device	(Kelly et al., 2012); (Brown et al., 2015); (Caudill, 2007); (Martin, 2018)
		Using basic functionalities on a mobile device to organise one's life	(Ventimiglia et al., 2016); (Kelly et al., 2012); (Sharon, 2003); (Rashevska et al., 2018)
		Adaptability	(Brown et al., 2015)
		Navigation - use of fingers to navigate	(Kelly et al., 2012); (Pan, 2012); (Bagot et al., 2018)
		Application management	(Casey et al., 2016); (Kelly et al., 2012); (Hausknecht et al., 2018)
		Securing one's device and its contents	(Kluzer, 2015); (Paasch & Duchene, 2012); (Hicks & Turner, 2013); (Voogt et al., 2013)
		Understanding the internet platform	(Clark et al., 2017); (Saxena et al., 2017)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Ng, 2012)	Mobile digital literacy skills for the use of mobile technologies	Support from Literature
Social-emotional dimension	Social-emotional literacy	Use the internet to search information	(Chipangura, 2016); (Qadir et al., 2018)
	Social networking functional literacy	Use of social networks for collaborative learning and teamwork	(Rodriguez & Igartua, 2018); (Zhang, 2018)
		Being part of online groups	(Krish et al., 2018)
		Sharing and storing of information –cloud computing	(Mitrovic, 2017)
		Using social networks for professional growth and collaboration	(Nagel & Verster, 2012); (Aventurier, 2014; Mayisela, 2013); (Bansal et al., 2014); (Rodriguez et al., 2018)
		Communication	(Nagel et al., 2012); (Chipangura, 2016); (Harper, 2003; Jones et al., 2006); (Kelly et al., 2012); (Dahlstrom, Walker, & Dziuban, 2013); (Martin, 2018)
	Online etiquette Literacy	Conduct and demeanour over the internet	(Voogt et al., 2013); (Dhir et al., 2012); (Chew et al., 2018)
	Cyber Safety Literacy	Being safe in the online world	(Kluzer, 2015); (Chew et al., 2018)
Cognitive dimension	Reproduction Literacy	Dealing with graphics, video and animation	(Kelly et al., 2012); (Dhir et al., 2012)
		Content recreation	(Dhir et al., 2012)
		Word processing and electronic spreadsheets	(Martin, 2018)
	Branching Literacy	Multidimensional skills at sourcing information	(Chipangura, 2016)
		Developing a connection between different forms of information	(Mabila et al., 2017); (Russell et al., 2018)
		Having visual and media knowledge	(Dhir et al., 2012)
	Information Literacy	Background knowledge in acquiring information	(Mabila et al., 2017); (Russell et al., 2018)
Literacy for all dimensions	Critical Literacy and other literacies like financial literacy and work around literacy		(Van Biljon et al., 2007); (Astill, 2017); (Supachayanont, 2011)

The next chapter will investigate the use of ICT in education towards a final refinement of the Theoretical framework (see Section 5.6).

CHAPTER 5: ICT IN EDUCATION: A RURAL SOUTH AFRICAN PERSPECTIVE

This chapter provides a scoping literature review of *ICT in education from a rural South African perspective*. The relevant data sources and keyword searches used in this chapter are presented in Table 2-2.

A flow chart, as per Figure 2-4, is applied to this chapter and presented in Figure 5-1.

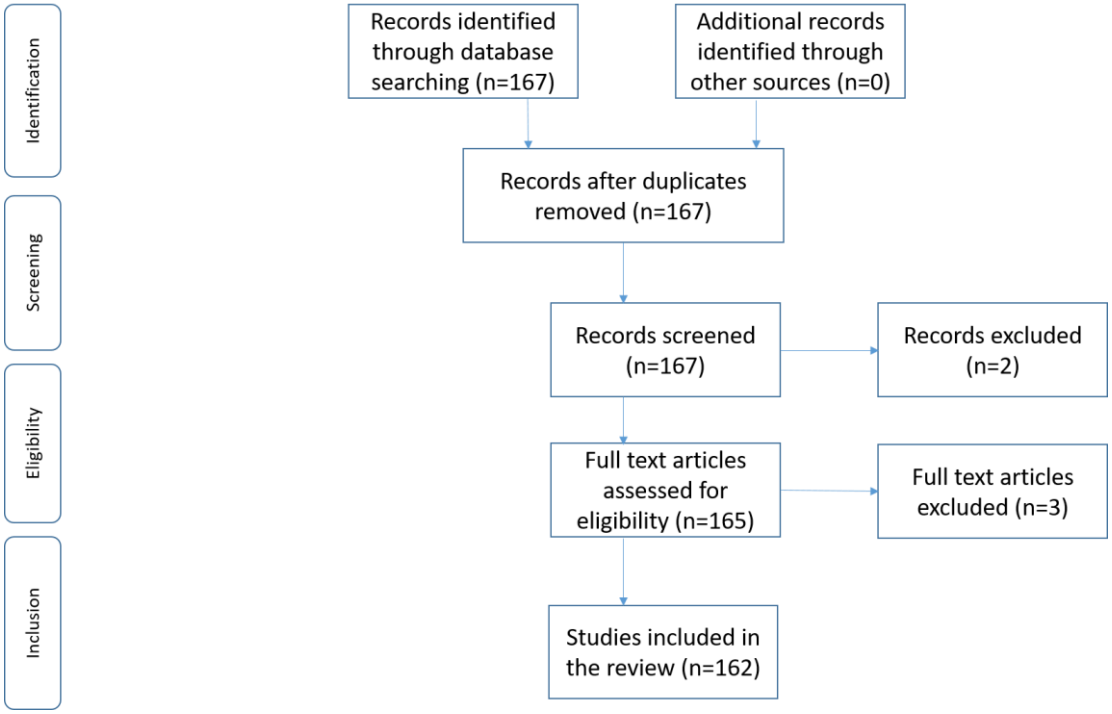


Figure 5-1: Flow chart of search phrases used in this chapter.

Figure 5-1 indicates that from the 167 articles found, 162 were included in this chapter's literature review.

5.1 ICTS IN EDUCATION

Uzunboylu, Bicen, and Cavus (2011) states that change is difficult and inevitable, but with technologies infiltrating different sectors of the economy, education is forced to follow. Whilst examining literature, it became evident that conventional learning has become inadequate. The use of ICT in education enhances access to both information *and* learning resources for both learner *and* educator, therefore improving the education process (Nkula & Krauss, 2014). Researchers suggest that ICT in education

serves as a 21st century skill developing tool (Koopman, 2014; Ozdamli & Cavus, 2011).

Koopman (2014) and Pheeraphan (2013) suggest that 21st century skills are made up of other skills as highlighted in Figure 5-2.

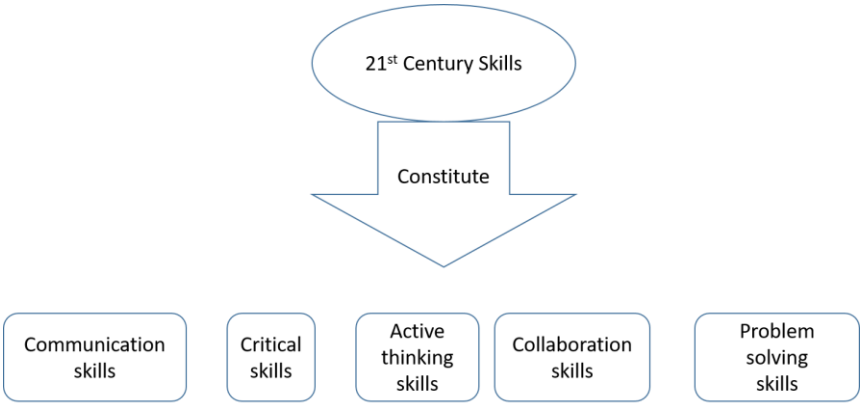


Figure 5-2: Constituent of 21st century skills (Adapted from: Koopman, 2014).

Despite the skills illustrated in Figure 5-2, Ford, Botha, and Herselman (2014) recommend that ICT should not be viewed as a tool for developing skills *only* but rather as an active tool for teaching and learning.

Examination of literature suggests that mobile technology in the classroom is gifting traditional schooling with a new edge and blurring the boundaries between formal and informal education (Batchelor & Botha, 2007), thus making m-learning possible (Caudill, 2007; Lan & Sie, 2010; Park, Nam, & Cha, 2012). M-learning can be defined as the transfer of learning content from the educator to the learner via the use of mobile devices (Anzai, 2018). Lan et al. (2010) add to the definition of m-learning, stating that it allows a learner to attain study content, anywhere and anytime, through a mobile device and internet connectivity. Singh and Ramshirish (2006) fully acknowledge Lan and Sie's definition and state that *anytime and anywhere learning* is the greatest advantage of mobile technologies. Ertzberger and Martin (2013, p. 1) refer to this learning as "here and now learning." *Here and now learning* ensures that a learner has access to information all the time, thus enabling learning to take place both inside and outside the classroom (Ertzberger et al., 2013). Thompson (2015) posits that anywhere and anytime learning helps to extend education beyond the customary classroom and is facilitated primarily by the portability and connectivity feature of mobile tools which eradicates the need of a desk, or traditional keyboard. Looi et al.

(2010) conclusively suggest that the focus of learning in the digital age has shifted from what learners learn to where and how they learn**.**

A classroom is a learning environment in which all types of learning takes place. This learning can be *formal* or *informal* in nature (Bocconi, Kampylis, & Punie, 2012). Kassim et al. (2013) suggest that to support mobile technology in a teaching and learning environment, a *creative classroom* is required. A *creative classroom* fully supports ICT integration (Bocconi et al., 2012).

Literature reveals that one significant mobile technology that has been adapted in classroom use is the tablet (Ford et al., 2014; Thompson, 2015). Thompson (2015, p. 5) defines a tablet as "a small, thin computer, with a power source of great autonomy. It is light, able to connect to networks through various protocols and has a touch screen, with fingers functioning as electric activators." Literature lists several reasons as to why schools have adopted the highly portable touch-screen tablets (Ford et al., 2014; Kassim et al., 2013; Lan et al., 2010; Thompson, 2015).These reasons include:

- Tablet size ranges between 7 and 12 inches, thus making it *an easy to hold in the palm* device (Kassim et al., 2013).
- Multi-touch screen enables quicker use and access to multiple functions (Lan et al., 2010).
- The high-screen resolution leads to increased clarity of images and facilitates easier reading of small text (Thompson, 2015).
- The features present in tablets, such as cameras and speakers, facilitate audio files, images and videos thus making it a multifunctional device (Thompson, 2015).

Figure 5-3 demonstrates characteristics of m-learning which are effectively used in education (Ozdamli, 2012).

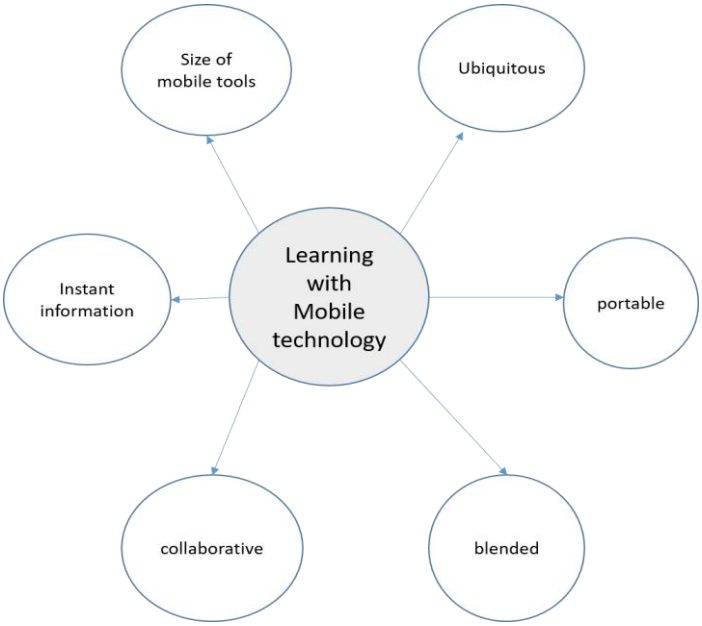


Figure 5-3: Characteristics of m-learning (Ozdamli, 2012).

Table 5-1 highlights some of the main characteristics of mobile devices use in pedagogy (Melhuish & Falloon, 2010).

An overview of the pedagogical benefits, as per the characteristics illustrated in Figure 5-3, are presented in Table 5-1.

Table 5-1: Pedagogical benefits of mobile devices (Melhuish et al., 2010; Ozdamli, 2012).

Benefits	Pedagogical potential
Portability and affordable	Makes technology 'invisible' (Melhuish et al., 2010) Highly portable devices (Cavus & Ibrahim, 2009) Encourages learning in the 3rd place (Melhuish et al., 2010) Places web access and other digital tools in the hands of more users than any other digital technology (Melhuish et al., 2010)
Interactive	Allows for different amounts of interaction between learners, as well as between learner and educator (Ozdamli, 2012)
Blended	Enables more constructivist learning using authentic contexts (Melhuish et al., 2010) Enables 'just in time' rather than 'just in case' learning (Melhuish et al., 2010) Blurs boundaries between formal and informal (Melhuish et al., 2010) Facilitates greater equity and inclusion in education (Melhuish et al., 2010)
Collaboration	Opportunities to 'create, share and connect with others' in authentic learning situations (Melhuish et al., 2010)
Instant information	Allows for imediacy (Cavus et al., 2009) Quick response times to attaining information (Ozdamli, 2012)
Ubiquitous	Changed where and when learning occurs (Melhuish et al., 2010) Very spontaneous, changed where and when learning occurs (Cavus et al., 2009) Learning can be tailored to individual needs and preferences (Melhuish et al., 2010)
Private	Allows learner the privacy whilst learning (Ozdamli, 2012)

Table 5-1 reveals some of the main affordances of mobile devices that are proving beneficial in the educational domain (Melhuish et al., 2010).

5.1.1 Elements of M-Learning

Figure 5-4 illustrates the basic elements of m-learning.

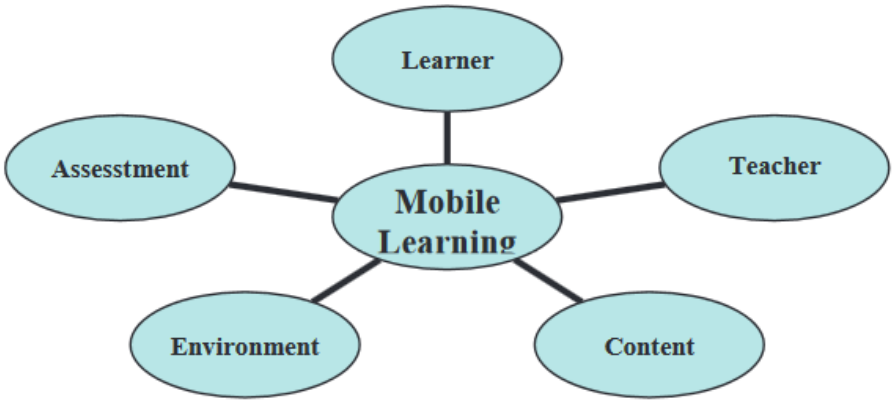


Figure 5-4: Elements of m-learning (Ozdamli et al., 2011).

An overview of the basic elements, as illustrated in Figure 5-4, will be provided forthwith.

Learner: A learner is central to the educational process, as per Makoe (2011). Some learner roles are defined below. A learner should:

- Be able to produce and gauge information (Herselman & Botha, 2015).
- Be able to analysis and synthesise information differently when compared to traditional recognition and reproduction (Gazette, 2004).
- Be equipped with sufficient co-creation skills to survive in the knowledge society (Gazette, 2004).
- Be able to access information as per his/her needs (Ozdamli, 2012).
- Study in groups with his/her peers (Kassim et al., 2013).
- Take responsibly for his/her own studies (Ozdamli, 2012).

Teacher: A/an teacher/educator is one who delivers information to learners (Ozdamli et al., 2011). In a traditional environment, teachers use books and other forms of stored information to deliver content to learners (Ozdamli, 2012).

Literature suggests that this has changed as educators are expected to not only use mobile technologies as personal devices but to further their use in the classroom and within their subject area/s (Ozdamli et al., 2011). Therefore, Herselman et al. (2015) state that a role shift has taken place and that the task of educator has evolved over the years (Ozdamli, 2012). Figure 5-5 depicts an overview of the changing roles of an educator:

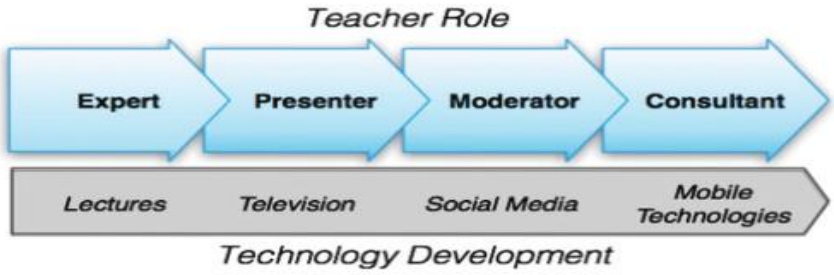


Figure 5-5: Evolving roles of the educator (Ozdamli, 2012).

Figure 5-5 suggests that the changes in technology and changing role of the learner has resulted in the educator's role evolving into that of a *consultant* or *facilitator.* Assuming this new role, an educator should enhance a learner's credibility as a competitive human resource (Gazette, 2004). Thompson (2015) suggests that this can be achieved by fostering creativity and innovative skills in learners. Educators, embracing the changes brought about by mobile learning, should:

- Collaborate more (Thompson, 2015). Learning activities should thus be organised to support group collaboration (Ozdamli, 2012).
- Encourage leaners to assist other learners (Thompson, 2015).
- Create group assessments to engage learners' creativity (Thompson, 2015).
- Balance liberating the learners with discipline and control (Thompson, 2015).
- Acquire the necessary skills to successfully use mobile tools and technologies (Ozdamli, 2012).
- Learn with the learner (Ozdamli, 2012).

Content: An educator should be very confident in his/her subject domain, suggests Ozdamli (2012), as this will help him/her cater to learners' pedagogical needs

(Siragusa, Dixon, & Dixon, 2007). Once an educator is familiar with course content, research suggests that he/she should be able to design graphical and media content to support the subject (Ozdamli, 2012).

Environment: Literature suggests that environment is normally a setting where a learner gains access to information (Ozdamli et al., 2011). In this study the environment is the *classroom* where both learner/s and educator have to abide by certain rules whilst using technology to do their tasks (Bronfenbrenner, 1977). Ozdamli (2012) suggests that to foster a positive learning environment, an educator and student/s should reach some agreement as to the rules within a classroom. Batchelor, Ford, and Botha (2009) created a list of *mobiquettes* applicable in the classroom or school. These are**:**

- Phones should be on silent during a meeting or in class.
- Approval should be attained from fellow colleagues when answering a call.
- Fellow colleagues' privacy should be respected.
- Ringtone and volume should not be disturbing and/or offensive.
- Do not browse another person's phone.
- Someone else's number may not be shared without their approval.
- Texting is not allowed whilst in the company of others, or during class.
- Always gain approval before taking a photo.
- Functionalities, like music, should be used outside the classroom.

Assessment: Research has shown that a learner can be assessed through mobile technologies using methods such as online quizzes, project evaluations, multiple choice questions and online exams (Ozdamli, 2012). Vavoula, Sharples, Lonsdale, Rudman, and Meek (2007) mentioned that assessments provide diagnosis and guidance and that both these factors are imperative to success.

5.1.2 **Role of ICT as a tool in education**

Several authors have suggested that ICT has had a significant beneficial impact on education (Cachia, Ferrari, Ala-mutka, & Punie, 2010; D'Alessio, Donnelly, & Watkins,

2010; Hoskins & Fredriksson, 2008; Kassim et al., 2013). The roles that ICT serve in education are illustrated in Figure 5-6.

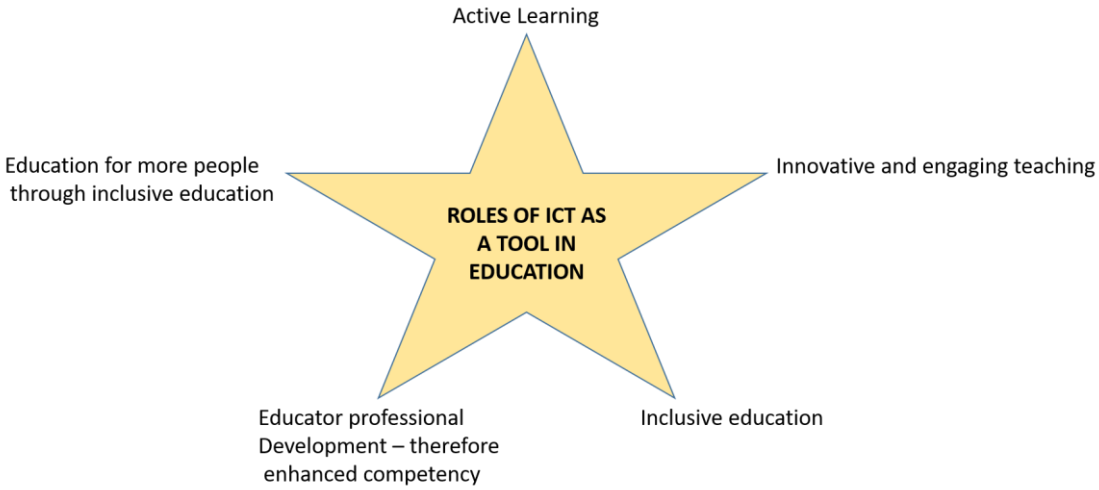


Figure 5-6: Roles of ICT in education (Adapted from: Haddad, Trucano, & Wacholz, 2007).

Figure 5-6 illustrates the roles of technology in education. For active learning to take place, Kassim et al. (2013) believe that inclusive education is needed. D'Alessio et al. (2010, p. 116) define *inclusive education* as the "transformation of the education system in general into a system capable of responding effectively to the totality of learner's diverse needs." As a result of inclusive education, technology in the classroom can help facilitate education for underprivileged learners in rural areas of South Africa (D'Alessio et al., 2010). In addition to inclusive education, Kassim et al. (2013) mention that technologies can address individual learners through the facilitation of specialised solutions and empowering said learners to express their creativity through technologies (Cachia et al., 2010). Specialised solutions allow for *personalisation*, and personalisation allows for content tailoring as per the learning needs of each learner (Kassim et al., 2013). Hoskins et al. (2008) argue that technology will help to build a future workforce from today's learners who, in turn, will be comfortable using technology to facilitate their tasks in the working world. Koopman (2014) added that technologies will play a significant role in the professional development of educators as well. In addition to the aforementioned authors, the UNESCO (2011) state that ICT in education will stimulate educational transformation and sustainable economic development.

However, findings from research by Cachia et al. (2010) reveal that technology *alone* cannot foster creative and active learning and/or innovative teaching. Other factors play a vital role such as curriculum, content, skills, culture and infrastructure (Cachia et al., 2010). Pheeraphan (2013) suggests that if an educator encourages the use of technology in the classroom, he/she encourages a learner to access, interpret and present information that has been attained from various sources using diverse techniques. Technologies also support the curriculum by facilitating individual and collaborative learning. This enhances the necessary skills for working effectively as a group.

In South Africa, support has been afforded to educators and schools in rural areas in diverse forms and from different organisations (Ndlovu & Lawrence, 2012). Farrel and Isaacs (2007) acknowledge that various government departments, in association with some private organisations and other stakeholders, have funded a number of projects to support teaching and learning with ICTs (Gazette, 2004). Koranteng (2012), in complete agreement with Farrel et al. (2007), acknowledges funding attained from the Government, parastatals and the private sector. Koranteng adds that these initiatives are helping rural educators in South Africa to achieve enhanced technological skills. Herselman and Botha (2013) underscored these initiatives and stated that funding was crucial in enhancing the integration of technology in rural formal education.

Some Government Initiatives

The South African government is continually looking for new ways to invest in ICTS. Nkula et al. (2014) believe that these continuous investments will help improve the quality of learning and growth in South Africa.

The South African government prioritised ICT development in three sectors in 2002, with education being one of these sectors (Gazette, 2004). The education sector acknowledged the most remote parts of the country (Gazette, 2004). Later, in 2004, the Government communicated their intent to approach education with a new set of learners and educators in mind (Gazette, 2004). To facilitate the inclusion of technology in schools they stated that each school in the country should be equipped with a specific teacher to coordinate the technological facilities and support their use in the school by ensuring successful application. Support was also promised in the

form of incentives to educators who successfully integrated technologies into their daily lives, as well as their subject domain. This initiative was known as the White Paper on e-education. A total of 365 000 tablets were issued to educators in the public schooling system of South Africa. Educators were expected to be the drivers of change (Gazette, 2004). In addition, The Department of Basic Education (BDE) hosted programmes and initiatives, such as Accelerated Schools Infrastructure Delivery Initiative (ASIDI), to speed up delivery of basic infrastructure to schools which lacked basic infrastructure and were, as such, unable to operate efficiently (Malgas, 2011).

Gauteng Education MEC, Panyaza Lesufi, mentioned to News24 in 2015 that the Department of Education has projected a roll out of mobile technologies in rural education by the end of the 2017/2018 financial year at a probable cost of R17bn. This project would target all Gauteng township and rural schools. Lesufi stated that the aim of this investment was to align South African education with the best performing countries globally, specifically South Korea. Lesufi felt that township and rural learners should not have to suffer as a result of where they stay. Lesufi wanted to evolve education in townships and rural areas in such a way that learners, from disadvantaged schools, would be able to compete with learners from urban areas. Each targeted school will have a qualified technician to assist educators and learners. The Department of Education was appreciative of the South African private sector which were very supportive from the onset of the project (News24, 2015).

In addition to the aforementioned interventions by the Department of Education, the Department of Science and Technology (DST) are making enormous efforts to improve the quality of rural education (Herselman et al., 2013). Steady progress towards a mobile facilitated learning environment is being made through the integration of mobile devices into traditional education (Van Biljon, Traxler, Van der Merve, & Van Heerden, 2015).

On the contrary, Daniel Linde, deputy director of the Equal Education Law Centre, disagrees with the aforementioned initiatives. He is unconvinced as to the fund outlays by the Department of Education. He feels that funds should rather be channelled into creating better environments for educating learners as some learners are not even motivated to attend school due to the critical learning environments. The lack of

motivation, suggested by Linde, is connected to a poor sanitation facilities and a unreliable sources of electricity and water (Macmillan, 2015).

Other initiatives

- A large-scale project was launched in the Nciba district in Cofimvaba involving 26 schools. The project was known as Information Communication Technology for Rural Education Development (ICT4RED) and aimed at using technology to address the gaps in leaners' education. This project was launched at an estimated cost of R71 million (Herselman, Ford, & Botha, 2014).
- Another South African initiative was MobiLED, which was aimed at enhancing education by integrating mobile technologies (Batchelor et al., 2009). Some regional initiatives were introduced as well, for example, Gauteng online and the Khanya projects (Farrel et al., 2007).
- In 2014 Via Afrika, a private organisation, supplied rural areas with digital education centres. These container structured library centres were equipped with 15 tablets, each located in schools in Mpumalanga, Free State and Limpopo. Educational programmes and e-textbooks were some of the applications loaded onto the tablet by Via Afrika. The initiative's aim was to offer support to rural educators and learners alike (Fin24, 2014).
- Network companies also play a role, albeit on a smaller scale, as network infrastructures facilitate increased coverage of rural areas in South Africa (Ndlovu et al., 2012).

Outcomes of a Western Cape case study conducted by Chigona, Chigona, and Davids (2014), highlighted that ICT implementation in schools made the teaching process easier and likable. Some educators mentioned that ICT made some subjects, for example Mathematics and Geography, easier to teach (Chigona et al., 2014).

Despite the initiatives, rural areas still lack basic amenities and trained educators (Mlitwa & Nonyane, 2008). In addition to the lack of amenities, past research has proven that technology has not been successfully integrated in education due to a lack of educator skills (Mishra & Koehler, 2006). Koranteng (2012) supports this and mentions that current government initiatives are insufficient to include technology in rural. Rural educators are consequently *not* acquiring adequate digital literacy skills.

The following section suggests some approaches the Department of Education could adopt to encourage the use of ICT in schools.

5.1.3 Ways in which the Department of Education can encourage ICT integration

Research indicates that it is very important for educators to understand that M-learning will not substitute educators but enhance their role (Gazette, 2004). Some rules for sustaining m-learning are:

- Invest in technological infrastructure (Engelbrecht, 2003).
- Build strategies for schools to attain long-term benefits (Engelbrecht, 2003).
- Adopt a successful e-learning model to suit local needs (Engelbrecht, 2003).
- Have a clear vision and be willing to change tactics (Ruby, 2006).

In addition to these guidelines, the Gazette (2004) reports that to facilitate m-learning an educator and learner need access to:

- Extensive, diverse and modern resources, in addition to what the school library is currently offering.
- A platform which enables leaners and educators to communicate.
- Prospective forms of knowledge creation.

5.2 RURAL EDUCATION

Rural areas are generally identified by population per designated area and the lack of metropolitan infrastructure and buildings (Herzon & Pittman, 1995). White and Reid (2008) highlight two fundamentals in the definition: rural is different from urban *and* ease of access to amenities and remoteness. Moletsane (1993) states that besides access to amenities, some rural inhabitants are deprived of basic human rights like elementary education, health and nourishment.

Rural areas are often underprivileged (Mphahlele, 2014), lack educational means (Batchelor et al., 2007) and are generally resource constrained (Langenhoven, 2015). Table 5-2 presents some factors that could be used to categorise an area as *resource constrained*, as per Tunstall and Lupton (2003).

Table 5-2: Determining factors for resource constrained rural areas (Tunstall et al., 2003).

Determining Factor	Explanation
Economic activity	Rate of unemployment and a person's earning ability.
Revenue	Whether one has a low or high income and whether one can afford basic resources, like a car.
Education	One's level of literacy and corresponding qualifications.
Health	Involves factors like death rate, low birth weight, mental health and long-term illnesses. Rural areas lack clinics, hospitals and health care personnel.
Housing	Involves conditions such as whether a home is densely packed, lacks basic amenities and, in some cases, is not fit to live in.
Transportation	Lack of public transportation facilitates and tarred roads (Langenhoven, 2015).
Access to services	Lack of services, such as postage and entertainment (Langenhoven, 2015).
Infrastructure	Buildings are poorly constructed with cheap materials such as iron sheets and many are dilapidated (Langenhoven, 2015).
Domestic violence	A sad reality of rural areas is increased domestic violence, possibly due to frustration, stress and poverty (DeKeseredy & Schwartz, 2009).
N.B. This list is not exhaustive	

From Table 5-2 it can be ascertained that the rural education sector includes officially recognised schools in areas that have not been classified as urban in South Africa (Statistics South Africa, 2004). White et al. (2008) suggest that rural schools accommodate learners from socio-economically constrained families, have a greater number of indigenous learners and are located in geographical settings of rural deterioration. Undertakings in rural formal education involves normal school-based chores and activities (Aabø, 2005). Therefore, Herselman (2003) believes that ICT in general has the potential to drive much needed change in literacy in the rural areas (Herselman, 2003).

5.2.1 **ICT in rural education**

Literature has proven that technology is changing education drastically in terms of where, how and when students learn (Melhuish et al., 2010; Ozdamli, 2012), thus enhancing the quality and experience of education (Valk, Rashid, & Elder, 2010). The Ministry of Education (2015) states that South African schools are facing a new generation of learners that were born in digitally infiltrated environments, thus emphasising that technology is not just a fun to have tool, but an imperative tool to facilitate teaching and learning.

Traditional technologies in education include, amongst others, the pencil, the microscope, the pendulum and the chalkboard. These traditional technologies have, over time, evolved into Information and Communication Technologies (ICTs) (Koehler et al., 2009). Roman, Colle, and Hall (2003) believe that ICT is not only about the device and connectivity but rather about *information* and *communication*. Unesco (2007, p. 1) elaborates on the view of Roman et al. (2003) describing ICT as "forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means."

Table 5-3 illustrates the different technologies which resort under the category of ICT.

Table 5-3: Different technologies in ICT (Paily, 2016).

Information	Technologies
Creation	Personal Computers, digital camera, scanner, smartphone
Processing	Calculator, PC, smartphone
Storage	CD, DVD, pen, drive, microchip, cloud
Display	PC, TV, projector, smartphone
Transmission	Internet, teleconference, video conferencing, mobile technology, radio
Exchange	E-mail, cellphone

In addition to the technologies listed in Table 5-3, applications can also be used for literacy purposes. These applications enable users to make notes on already printed texts, annotate existing diagrams and animations, record audio and import images from an external library (Hutchison et al., 2012). Other affordances of tablets and smartphones in education include the camera that enables capturing of images and videos and exporting these images through, for example, e-mail or just saving them on the device for later use. Collaboration is another important feature enabled by screen sharing amongst educator and learners (Hutchison et al., 2012). Hutchison and Reinking (2011) mention that despite the prospects, mobile devices need to be explored to the benefit of educators.

Rural educators are optimistic about the use of digital technology in rural education (Mabila et al., 2017). Digital technologies nurture dialogic and emancipatory practice in the classroom. Dialogic practice empowers students and encourage them to be active. Emancipatory practice encourages learners to gain knowledge beyond classroom boundaries, thus creating deeper understanding (Cambridge, 2015).

Studies have indicated that access to mobile devices in rural areas is not a significant issue (Aker et al., 2010; Bhavnani, Chiu, Janakiram, & Silarszky, 2009; Cellular News, 2009). Therefore, using this technology can help address information scarcity and the digital divide between urban and rural schools as disadvantaged students now have access to mobile devices (Thompson, 2015). Consequently, this access will serve as an educational tool to afford every learner fair access to education (Mphahlele, 2014). This access to education will eradicate the differences between urban and rural formal education, thus eliminating discrimination in education (Botha, Berg, Batchelor, & Sedano, 2008). Mobile devices can also eliminate the problem of learners not having access to hard copy material as e-books are widely available (Langenhoven, 2015). With all this in mind, efforts have been made to roll-out ICT for education through Africa (Farrel et al., 2007).

Many reports have indicated that broadband internet access is very slow in rural areas of developing African countries (ITU, 2014; UNESCO, 2015). In some rural parts of South Africa, broadband infrastructure is poor, or almost non-existent (Kennedy, George, Vitalice, & Okello-Odongo, 2015). Recent studies show that over 50% of South African households have one member who has some form of access to the internet (Stats SA, 2015). Dalvit, Kromberg, and Miya (2014) state that internet provision is vital in rural areas as lacking internet access will inhibit inhabitants from keeping abreast of global developments.

Huang, Guo, Xie, and Wu (2012) support Sibanda, Muyingi, and Mabanza (2008) by pointing out that network deployment in rural areas is challenged by the geographical landscape, thus making it difficult to erect infrastructure. The lack of reliable energy sources and supply, which are very important to network operators, also impacts negatively on infrastructure creation (Masonta, Olwal, & Ntlatlapa, 2010).

5.3 CHALLENGES

The DBE acknowledges challenges associated with the South African schooling system which result in poor academic performance by learners (Malgas, 2011). Challenges can be divided according to those faced generally in all classroom settings and those specifically encountered in schools situated in rural resource constrained areas.

5.3.1 General challenges for ICT in the classroom

Shuler (2009) lists a number of challenges experienced by the learner, the educator and the technology itself. Table 5-4 presents these experienced challenges.

Table 5-4: General challenges related to the learner, educator and the technology itself (Naismith & Corlett, 2006; Shuler, 2009).

Challenges related to the learner	Challenges related to the educator	Challenges related to the technology itself
Data protection issues. Health hazards for example to the eyes, the posture etc. (Shuler, 2009). Loss of focus and easily distracted (Shuler, 2009) Cyber bullying (Shuler, 2009). Text slang becomes the new accepted form of writing (Shuler, 2009). Less face-to-face socialisation amongst learners (Shuler, 2009).	Lack of sufficient training and support (Naismith & Corlett, 2006). Educators' mind-set is such that they still believe technology is rather intrusive in the class (Shuler, 2009). Educators lack confidence and perspective on the use of mobile devices in the classroom as it has not been sufficiently integrated into the curriculum (Naismith et al., 2006).	Connection services have to be improved (Naismith et al., 2006). Devices are diverse with so many different features and operating platforms therefore lacking standardisation (Shuler, 2009).

Table 5-4 illustrates general challenges, irrespective of whether a school is considered *urban* or *rural*.

In addition to the challenges already mentioned, Daccord (2012) notes five mistakes that schools make whilst integrating technology. These are:

- Educators concentrate on subject-specific apps, but sometimes a task could be better accomplished with a general app.
- Educators use mobile devices briefly in their traditional methods of teaching as they are not aware of the vast uses.
- Tablets cannot replace laptops.
- Effective use of tablets, or any other mobile device in the classroom, occurs if each pupil has his/her own device, rather than devices being shared.
- A school should present educators, learners and teachers with enough sufficient motivating factors for them to want to include technology in the classroom.

Shuler (2009) believes that these challenges and mistakes need to be addressed for successful technology integration in conventional education to occur. In addition to the

already listed limitations, rural education is faced with a different set of challenges as it is often resource-constrained (Jere et al., 2013). These resource-constrained specific challenges are discussed in the next section.

5.3.2 **ICT challenges specific to rural education**

Khumalo, Molepo, and Mji (2015) highlight that poor provision of infrastructure, electricity and educational resources negatively impact education. In addition, Rivers, Rivers, and Hazell (2015) mention that rural schools, in most cases, lack resources to support 21st century learning (Khumalo et al., 2015). Therefore, a lack of resources poses significant challenges and, consequently, creates a *digital divide* in terms of access to technology and internet when compared to urban areas (Cambridge, 2015).

A study, conducted by Jere et al. (2013), highlights challenges faced by rural schools. These challenges include:

- Lack of ICT upkeep and maintenance.
- Power shortages for ICT operation.
- Internet access and initial set up equipment is expensive.
- Lack of ICT awareness.
- ICT changes drastically.
- Lack of ICT regulations.
- ICT literacy deficiency.
- Resistance to change.

Supachayanont (2011) suggests that one should have workaround skills to the use of modern technologies to get as close as possible to desired outcomes. Thus, one should work around the limitations in an effort to overcome challenges and thus improve overall mobile technology efficiency and use. Workaround skills depend on the educators' work experience and his/her experience with technologies (Supachayanont, 2011).

Connectivity

Howley and Hough (2011); Takavarasha et al. (2018), suggest that connectivity is a major impediment. Generally, educators have access to some sort of ICT but complain about the quality of connectivity. Cambridge (2015) reported that internet connections were slow with connectivity as poor as a 56Kb line and, in addition, very unstable.

Electricity

In a study conducted by Herselman (2003) she noted that basic amenities, such as electricity, is still lacking in some rural areas of South Africa. She affirms that basic infrastructure is compulsory to the implementation of ICT. Dinkelman (2008) disagrees with Herselman's statement and notes that many areas in post-apartheid South Africa are, in fact, connected to the electricity grid. Despite access to electricity, Dlodlo (2009) mentions that the inhabitants of villages struggle to pay their electricity bills.

Financial constraints

Literature suggests that cost is a significant challenge in supplying rural schools with adequate ICTs (Dlodlo, 2009). Government institutions feel that finances can be channelled into other areas of rural society that are considered more deserving, for example sanitation, rather than equipping schools with ICT (Bhatnagar, 2000). Dlodlo (2009) explains that, due to the underprivileged nature of rural areas, crime is prevalent. Therefore, even if schools were equipped with some technologies, they might still lack funds to acquire the necessary security measures and alarm systems to safeguard ICT infrastructure (Jere et al., 2013).

The bias nature of technology

Koehler et al. (2009) study highlights significant challenges. These include, amongst others, the fact that technologies are not neutral, do not have their own functionalities, abilities or constraints deeming them suitable for a particular chore but not for another. These different affordances and constraints can be difficult to integrate in the classroom and need careful planning and teacher professional development (Jere et al., 2013; Koehler et al., 2009; Mishra & Koehler 2006).

Lack of technical skills

Several authors mention the lack of technical skills (Herselman, 2003; Herselman et al., 2015; Jere et al., 2013; Vosloo & West, 2012). Generally, rural educators lack digital skills as many teacher qualifications do not place sufficient focus on the integration of technology into the classroom (Koehler et al., 2009). This statement is supported by Herselman et al. (2014) who affirmed that educators in rural areas are willing to use ICT but lack content and pedagogical knowledge. Wang and Gu (2014) mention that attaining a new skill set can be challenging to educators as their everyday

task is already time consuming. Furthermore, Wang et al. (2014) suggest that training is generally insufficient and, despite availability of some training materials, these materials are often too abstract and thus difficult for educators to relate to. A framework delineating basic skills would thus prove helpful (Wang et al., 2014). Herselman et al. (2015) support Wang and Gu's concern by stating that literature lacks detailed guidance as to skill development for rural educators, specifically in relation to incorporating technology into classroom practice.

Educator confusion

Findings from literature suggest that educators are facing a dilemma: whether to *replace* or *supplement* traditional forms of teaching in the classroom (Craig, Price, & Howley, 1995; Jere et al., 2013; Pheeraphan, 2013). Kassim et al. (2013) mention that educators struggle to attain a balance between affording a learner *complete freedom* and *providing guidance*. Therefore, a strategy on how to integrate technology in the classroom would be beneficial in attaining the benefits of technology in the education sector (Kassim et al., 2013). Nash (2017) states that, in addition to formulating a strategy, there are some online websites dedicated to the use of technology for learning. On this website, educators can document and share their approaches and experiences. Kassim et al. (2013) suggest that an educator should foster a culture whereby learners and educators can learn together. Educators should thus communicate and collaborate *with* learners in such a way as to nurture a healthy discussion.

Lack of financial understanding

Kuo and Yen (2009) suggest that people still struggle to understand the cost implications of data usage on mobile devices. The use of this service, provided by cellular networks, thus remains limited.

Other educator concerns

A report by eSchoolMedia (2011), as well as other scholars including Jere et al. (2013), Mura and Diamantini (2014) and Mathevula and Uwizeyimana (2014), suggest that educators have other concerns. These include:

- The distraction caused by mobile devices.

- Whether all students would be able to afford a device and inequalities in device affordances, in accordance with spending power.
- Theft of devices.
- Learners being safe in the online world, cyber bullying and network security.

5.3.3 **E-readiness in rural education**

The readiness of the rural education sector in South Africa to adopt ICT related technologies is referred to as *e-readiness* (Sachs, 2000). E-readiness is "the degree to which a community is prepared to participate in the Networked World. It is gauged by assessing a community's relative advancement in areas that are most critical for ICT adoption and the most important applications of ICTs" Sachs (2000, p. 5). Darab and Montazer (2011) propagate the idea of e-readiness by mentioning criteria to assess this concept. They mention that the e-readiness of an educational institution can be assessed based on: its technological infrastructure, financial stability, personnel and curriculum content.

Chipangura (2016) supports e-readiness mentioning that educational institutions in developing countries should be willing to venture into the realm of using mobile devices in education. Craig et al. (1995) state that rethinking education, how and where people learn, can help with the successful integration of technology into schools. Any planning on the integration of technologies in rural education needs to carefully consider the surroundings as this will support rural education within its constraints. With over 80% mobile phone coverage in South Africa (Dlodlo, 2009), its proper implementation will make education more accessible and improve the quality of schooling (Unesco, 2007) in rural areas. Sharples et al. (2009) recommend a thought process in which mobile technology should not be seen as a *goal* but rather as a *means* to achieve activities that were difficult, or impossible, and to enhance the learning experience. Koehler et al. (2009) add that any curriculum and training should be designed creatively to accommodate this new method of teaching and learning.

Literature suggests that technology in rural schools has possibly helped with effective administration (Craig et al., 1995). Educators prefer using technology for printing newsletters, keeping track of students' marks on spreadsheets and printing students' report templates which are then filled out by hand (Muir-Herzig, 2004). On the contrary,

other research highlights that educators appreciate technology in the classroom and expressed satisfaction at bringing reality into the classroom via the internet platform (Deaney, Ruthven, & Hennessy, 2006). Other literature also suggested that educators are already fostering new technologies required for reading, writing and communication (Hutchison et al., 2011). The latest technology has built-in features that enables one to: read texts using audio, track individual words, find the meaning of a certain word in an online thesaurus, add notes and highlight text (Hutchison et al., 2012). Larson (2010) agrees with the affordances by stating the positive outcomes of personalised and engaging experiences.

To successfully implement mobile technology in the classroom, Naismith et al. (2006) suggest five success factors:

- Easy access to technology.
- Owning the technological device.
- Having stable connectivity.
- Curriculum material being supported by technological devices.
- Support from the school.

These success factors require a change process that will target the curriculum, content and the teacher's skills (Naismith et al., 2006).

In addition to Naismith and Corlett's five success factors, Cochrane (2010) also lists some success factors:

- Choice of appropriate device and software.
- Technical and academic support.
- Developmental and constructive feedback from both learner and educator.
- Educator's emphasis on integration of device in education.
- Extent to which technology is successfully integrated into courses and assessment criteria.

Research suggests that a strong course outline should emphasise the use of mobile devices (Cochrane, 2010; eSchoolMedia, 2011; Naismith et al., 2006). Caudill (2007) supports this idea by stating that content needs to be designed to take into

consideration the different operating systems of mobile devices and should be user-friendly for the learner as end-users.

The choice of technology for learning will be based on the learning activity itself. The learning activity can be broken down into five smaller activities, as suggested by Floricel et al. (2018):

- Location of activity: It is important to consider the setting of an activity. Is it in a class, on the field, in the lab?
- Human factors of the learning activity: Will the learner be seated, standing or running? Will his/her hands be preoccupied?
- Availability of technology: What is the device availability like in a setting? Are learners allowed to bring their own device and is there a network infrastructure in place?
- User interface technical requirements: Amounts of data to be collected and represented? Input/output specifications?
- Cost of transition involved from one activity to the next: Can a learner transition from one activity to the next on the same mobile device, or does he/she need to use another device?

In order to accommodate several roles, the educator needs to be adaptable (Van Biljon et al., 2017) and open to new sets of skills in order to deal with mobile technology infiltration (Chang et al., 2018). The next section considers the technology pedagogical skills of an educator.

5.4 MOBILE DIGITAL LITERACY SKILLS FOR THE EDUCATOR

Research highlights that with the influx of mobile technologies there is a growing movement for the use of technologies in education as well (Alazam, Bakar, Hamzah, & Asmiran, 2012; Buabeng-Andoh, 2012). Therefore, there is a high expectation for educators to integrate technology into the teaching and learning process (Buabeng-Andoh, 2012).

Ng (2012) and Zapata (2018) believe that an educator already exhibits a certain degree of mobile digital literacy skills by doing the following on a mobile device: using social media, sending textual information in the form of e-mails and messages, finding information on a web browser, saving information, listening to music and watching

videos, downloading graphical and audio content, accessing online services like online banking and online shopping and using the global positioning system (GPS) application. However, using mobile technologies for personal use does not guarantee the necessary skills to implement it in a classroom (Steyn, Rampa, & Marais, 2013).

From an educator's point of view, research suggests that digital literacy should include pedagogic, cognitive and evaluative skills. These skills will enable an educator to understand the following (Hadjerrouit, 2010; Mura et al., 2014):

- How can digital technology support educational goals?
- How can subject specific content be altered by the use of technologies?

An educator thus needs mobile digital literacy skills for pedagogical usability (Hadjerrouit, 2010). Ouma, Awuor, and Kyambo (2013) support this idea and further suggest that m-learning is still failing due to a lack of skills.

A study conducted by Alazam et al. (2012) refers to an initiative launched by the Ministry of Education in Malaysia known as Malaysia 2020. This initiative highlighted ICT skills needed by Malaysian teachers to develop a skilled and competitive workforce. The only drawback of this study was that the skill set was more specific, concentrating on Engineering and Science, for example AutoCAD and drafting skills (Alazam et al., 2012). The focus of this research study is a general skill set applicable to a diverse group of educators.

The EdTech Team (2015) compiled a list of skills which they deemed important for an educator. These skills include:

- Venturing into blogs and wikis, thus enabling an online platform for learners.
- Adapting digital images for use in the classroom.
- Using videos to involve learners.
- Using social networking for professional growth and collaboration amongst colleagues.
- Creating and delivering presentations.
- Creating a digital e-portfolio for professional development.
- Identifying plagiarism in learners' work.
- Using screen shots and creating videos and online tutorials.

- Adapting web content to the classroom.
- Empowering learners with task management tools, thus enabling them to plan their learning.
- Allowing for real time surveys through polls.
- Understanding the implications of copyright material.
- Creating online quizzes through the use of digital assessment tools.
- Finding web content and evaluating for authenticity.
- Using digital tools for time management.
- Using note-making tools for sharing notes with learners.
- Using online sticky notes to capture the thought process.

Previous literature concludes that mobile technologies, paired with the right skills of an educator, should enable positive learning experiences as well as progressive learning outcomes (Cavus et al., 2009; Ozdamli et al., 2011; Van Biljon et al., 2015) and thus avoid challenges due to mobile technology infiltration (Clark et al., 2017). Furthermore, sufficient skills will enable an educator to understand the abilities and restraints of mobile technology and to what extent it can be used in education (Ng, 2013).

5.5 MOBILE TECHNOLOGICAL PEDAGOGICAL SKILLS IN RURAL EDUCATION

Developments in ICT have necessitated the attainment of skills that were non-existent a decade or two ago (Finn-Stevenson, 2018). Thus, an innovative set of skills, *mobile technological pedagogical skills,* will be used in the classroom (Voogt et al., 2013). The technological pedagogical knowledge subsection of the TPACK framework will assist in developing educators' skills to enable a classroom transformation for 21st century learning (Koehler et al., 2009).

The technological pedagogical knowledge involves comprehending the effects of using technologies in teaching and learning. To understand this category of knowledge, a profound understanding as to the limitations and abilities of technologies and the subject area within which they are needed, is required. These skills are vital as most technologies are *not* designed specifically for education (Koehler et al., 2009)

although, recently, software apps are being created specifically for education (Vega, 2017).

To nurture technological pedagogical skills an educator needs to look *beyond* the basic functionalities of mobile devices. The educator needs to be inventive, resourceful and open-minded regarding the uses of technology in education. An understanding as to the different mobile devices and applications available, choosing the most suitable tool and application and devising a plan of action to use the technology and tools in pedagogy all play a vital role in honing technological pedagogical skills (Koehler et al., 2009).

In spite of the educators' willingness to use technology, the development of educator skills in technology-enriched rural formal schooling is significantly challenging (Buabeng-Andoh, 2012).

5.5.1 **Skills required**

Very few literatures explore skills development for rural educators using mobile technology (Zhai, Zhang, & Li, 2018).

With similar perceptions in similar studies, a general pattern of skills can be seen (Clark, Coward, Rothschild, Reynal, & Richter, 2017). Andreea-Diana (2014) discusses basic ICT and advanced ICT skills in her study, whereas Umar and Jalil (2012) identified a third category in their study. Umar and Jalil's categories are discussed along with other skills by other authors that fall in similar categories (Cerda-Diaz, 2017; Chan, 2014; Clark et al., 2017; Herrington, 2009; Herselman et al., 2015; Kluzer, 2015; Kong, 2014; Martindale, 2015; Ng et al., 2013; Prieto, Migueláñez, & García-Peñalvo, 2013):

1. Basic ICT skills:
    - getting started with a mobile device
    - basic skills for mobile device operation
    - personalisation of one's device
    - understanding the affordances and specifications of one's device such as storage and transfer of data
    - understanding mobile hardware operation
    - use of basic mobile device features in one's personal life

- adapting to a mobile device
- navigation
- management of applications
- securing one's device

2. Advanced ICT skills:
    - dealing with graphics, video and animation
    - word processing and electronic spreadsheets
    - transferring, sharing, uploading and downloading files
    - understanding one's device through the use of applications
    - exploring applications and games for learning
    - managing, installing and uninstalling apps and games
    - creating content through many sources
    - gauging information
    - being skilful at acquiring information and real-time thinking
    - ability to multitask (Tapscott, 2009).
3. Internet application:
    - understanding the internet platform
    - using the internet to search information through search engines
    - recording information and downloading and uploading information and communication purposes
    - understanding cloud computing
    - use of social media for communication and professional development
    - using applications for communication thus including social media, use of chat rooms, use of web cameras, tele-conferencing and email
    - rules of conduct for being online
    - being a part of online groups and collaboration
    - privacy and safety measures while being online
    - being able to create content safely

Mura et al. (2014) further mention in their research that educators play a vital role in teaching a learner skills with regard to online safety and netiquette (Bradshaw & Park, 2011; Park, 2011). Mura and Diamantini, through their study, concluded that educators were efficeint in online general functions like using e-mail, searching for information, reading the news, conducting online banking, editing images and blogging. They also revealed that educators readily used social media but *not* professional social networking sites, like LinkedIn. Their findings show that educators are eager to receive further training regarding the safe use of the internet and instructional use of ICT in education. In addition, Chipangura (2016) mentions that an educator should be able to use online Web searches to navigate potential sources of information. Some methods of sourcing information could be: searching for answers to particular questions, seeking advice and finding information sources that lead to other useful resources.

This chapter presented an overview of the literature on ICT in education as well as identifying the challenges faced by the education domain. Some available initiatives were also elaborated on. This chapter highlighted the fact that mobile technologies are available in South Africa and that other factors, like content, curriculum and skills, need to be addressed to make mobile technology use a successful and worthwhile experience.

5.6 THE THEORETICAL FRAMEWORK

The proceeding narrative, as presented in Chapters 3, 4 and 5, describe the development and iterative refinement of the Theoretical framework v3. The penultimate refinement, outlined in this chapter, provided the Theoretical framework for this study (see Table 5-6).

A framework, in the context of this study, is described as a structured outline of skills and competencies that make up digital literacy (Ferrari, 2008). The developing of a Theoretical framework from literature is in keeping with the suggestions from Yin (p.9) stating that “a literature review is therefore a means to an end” (Yin, 1996). The Theoretical framework will serve to inform a questionnaire that will be completed by purposefully chosen (Creswell, 2007) educators and experts. The outcome of the

exploration will further refine the framework towards presenting *a framework for mobile digital literacy skills of educators using mobile technology in rural formal education*.

Figure 5-7 outlines how Chapters 3 to 5 *individually* contributed to the iterate development of the Theoretical framework (versions 1 to 3) and *collectively* to the development of the final Theoretical framework presented in this section.

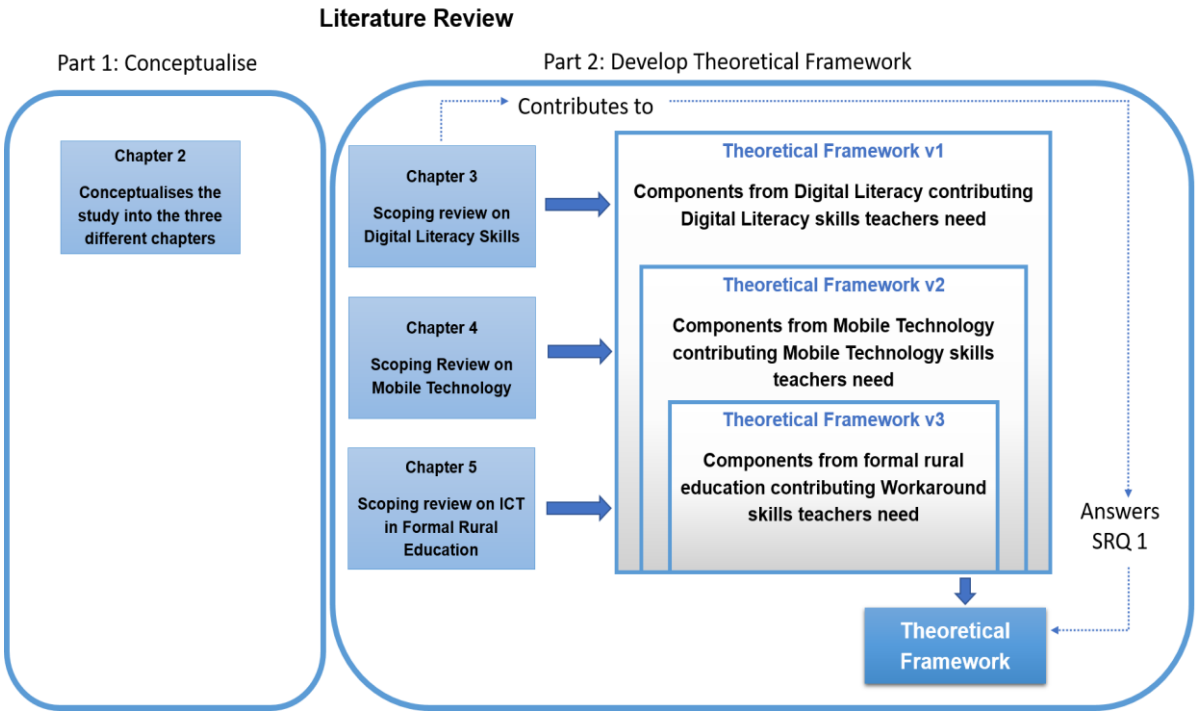


Figure 5-7: Developing the Theoretical Framework.

The literature study was operationalised as follows:

Table 5-5: Operationalising the literature study.

Chapter	Chapter 3:	Chapter 4:	Chapter 5:
Topic	Educators' technological pedagogical skills	Mobile Information and communication Technology (ICT)	ICT in education: A rural South African perspective
Outcome	Theoretical framework v1 Components from Digital Literacy contributing Digital Literacy skills teachers need. (Section 3.2: Table 3-3)	Theoretical framework v2 Components from Mobile Technology contributing Mobile Technology skills teachers need. (Section 4.5: Table 4-5)	Theoretical framework v3 Components from formal rural education contributing workaround skills teachers need. Domain experts reviewed to present Theoretical framework (Section 5.6: Table 5-6)

The Theoretical framework for this study is presented in Table 5-6. The first column shows the dimension of the digital literacy model, as derived from the digital literacy model by Ng (2012). The second column indicates the literacy corresponding to the particular dimension. The third column categories the principle factor for mobile digital literacy skills found in the literature regarding the use of mobile technology. The forth column presents the proposed mobile digital literacy skills for rural educators. The last column indicates the evidence from literature, thus indicating scholarly support for the propositions offered in the third column.

This Theoretical framework answers the SRQ1: *How can mobile digital literacy skills, from literature, support educators when using mobile technology in rural formal education?*

Two domain experts evaluated the Theoretical framework v3. This version was updated and is presented in Table 5-6 as the *Theoretical framework for mobile digital literacy skills for a rural educator using mobile technologies*.

Sections that were altered on suggestions from the domain experts are presented in blue.

Table 5-6: Theoretical framework for mobile digital literacy skills for a rural educator using mobile technologies.

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
Technical dimension	Operational literacy (Ng, 2012)	Getting started with a mobile device (Martin, 2018)	The educator should know how to operate multiple devices, including his/her own device/s in the classroom.	(Herselman et al., 2015)
			The educator should be able to charge the devices.	(Herrington, 2009)
			The educator should use technology in the classroom to support subject specific content.	(Koehler et al., 2009); (Ford et al., 2014)
			The educator should work electronically with the aim of going paperless in the classroom.	(Ramey, 2014)
		Personalisation of one's device (Kelly et al., 2012)	The educator should be able to maintain uniformity across all devices by creating a standard practice to facilitate efficient learning	(Ng et al., 2013)
		Underpinnings - skills to operate a device (Brown et al., 2015; Caudill, 2007; Jere et al., 2013; Kelly et al., 2012; Pan, 2012)	The educator should be able to connect a device to a Wi-Fi network.	(Ferrari, 2008); (Prieto et al., 2013)
			The educator should understand the usage of data and the financial implications associated to the data service providers.	(Kuo et al., 2009)
			The educator should be able to use Bluetooth in the classroom for data sharing and communication.	(Herselman et al., 2015)
			The educator must be able to connect input and peripheral devices to facilitate teaching e.g. a projector.	(Ng, 2013)
			The educator should access and use the troubleshooting guide on a device for basic problem solving.	(Ng, 2013)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
		Understanding mobile hardware operation, affordances and specifications of a device (Brown et al., 2015; Caudill, 2007; Kelly et al., 2012; Martin, 2018)	The educator should know the affordances of a mobile device for learning and teaching, with the aim of digitising an activity to add value	(Ng, 2013); (Patten et al., 2006)
			The educator should know devices' capabilities and specifications, as available in rural areas, thus maximising their use in the classroom.	(Park, 2011); (Granger et al., 2002); (Patten et al., 2006);
		Using basic functionalities on a mobile device to organise one's life (Jansen & Ayers, 2007; Kelly et al., 2012; Mellow, 2005; Rashevska et al., 2018; Ventimiglia et al., 2016)	The educator should use time management apps for productivity and planning of school activities.	(EdTech Team, 2015)
			The educator should be able to create worksheets.	(Park, 2011); (Granger et al., 2002)
			The educator should know how to record data using appropriate affordances.	(Ng, 2013); (Patten et al., 2006)
		Adaptability (Brown et al., 2015)	The educator should be able to create content, for example low cost videos in the local language to facilitate better learning.	(Ramey, 2014)
			An educator should be able to scan textbooks to create e-books for learners as rural areas lack textbooks.	(Jere et al., 2013)
			An educator should be able to assist learners in their transitioning to mobile devices as some learners may be using a mobile device for the first time.	(Jere et al., 2013)
			An educator should be able to teach learners the many benefits a mobile device has to offer, therefore making up for what rural areas are lacking e.g. library, computer labs for research, using as a dictionary.	(Jere et al., 2013)
			An educator should be able to manage lack of sufficient devices due to learners not being able to afford a device, or school not being able to	(eSchoolMedia, 2011); (Jere et al., 2013); (Mura et al., 2014);

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
			facilitate a device for each learner, by having knowledge on shared computing facilities to overcome the challenge of lack of one device per learner.	(Mathevula et al., 2014); (Daccord, 2012)
			The educator should be able to plan proficiently how learners will share a device efficiently amongst each other.	(eSchoolMedia, 2011)
			The educator should be able to work around power shortage issues by charging devices on time and in designated areas.	(Supachayanont, 2011); (Jere et al., 2013)
			The educator should know how to use the different back up power supplies e.g. power bank, UPS, generator and solar power in classrooms.	(Takavarasha et al., 2018); (Cambridge, 2015)
			The educator should be able to save content for offline use in case the educator does not have connectivity in the class.	(Takavarasha et al., 2018); (Cambridge, 2015)
			The educator should know how to use caching and distribution of digital content, thus enabling off-line access to vast online educational content.	(Takavarasha et al., 2018); (Cambridge, 2015)
			The educator should be able to access digital books to share amongst learners.	(Takavarasha et al., 2018); (Cambridge, 2015)
			The educator should encourage file sharing and transfer using Bluetooth when there is no connectivity.	(Jere et al., 2013)
			If there is a lack of training facilitates in rural areas, educators should know how to obtain online training and tutorials to adapt mobile technology in the class.	(Jere et al., 2013)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
		Navigation - use of fingers to navigate (Bagot et al., 2018)	The educator should understand how touch screens operate and know how to navigate between screens whilst teaching.	(Prieto et al., 2013); (Herselman et al., 2015)
			The educator should know how to multitask whilst teaching, e.g. cross-referencing, making notes, searching information etc.	(Tapscott, 2009)
			The educator should be able to navigate between his/her device and the learner whilst addressing the classroom.	(Jere et al., 2013); (Kassim et al., 2013); (Pheeraphan, 2013)
		Application management (Casey et al., 2016; Hausknecht et al., 2018; Kelly et al., 2012)	The educator should know how to use the different user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.	(Ng, 2013)
			The educator should know how to disable automatic updates of applications to avoid increased data charges.	(Herselman et al., 2015)
			The educator should know how to use educational games and apps that support learning in the classroom.	(Ng, 2013); (Vega, 2017); (Herselman et al., 2015); (Ramey, 2014)
			The educator should know how to use appropriate applications specific to their subjects e.g. a geography teacher should be able to use a maps application.	(Ng, 2013); (Ferrari, 2008); (Voogt et al., 2013)
			The educator should be able to use digital assessment tools like an online quiz and real time survey through electronic polls.	(EdTech Team, 2015)
		Securing one's device and its contents (Hicks et al., 2013; Kluzer,	The educator should educate learners regarding the safe keeping of devices by setting an example.	(Jere et al., 2013)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
		2015; Paasch et al., 2012; Voogt et al., 2013)	The educator should avoid damages caused by power surges due to sporadic electricity supply.	(Dinkelman, 2008); (Dlodlo, 2009)
			The educator should lock away devices after use.	(Jere et al., 2013); (Mura et al., 2014); (Mathevula et al., 2014)
Social-emotional dimension	Social-emotional literacy (Ng, 2012)	Understanding the internet platform (Clark et al., 2017; Saxena et al., 2017)	The educator should understand browser elements, search engines, tabs, bookmarks, new window, hyperlinks, hypertexts, browsing history and navigation.	(Umar et al., 2012); (Clark et al., 2017); (Saxena et al., 2017)
			The educator should be able to manage learners on the internet platform to cater for the slow connections.	(Takavarasha et al., 2018); (Cambridge, 2015)
			The educator should be able to use an online browser on his/her device as well as the cache memory for offline use.	(Takavarasha et al., 2018); (Cambridge, 2015)
		Use the internet to search information (Chipangura, 2016; Qadir et al., 2018)	The educator should be able to find relevant information using the internet, especially e-books for rural learners who lack access to textbooks.	(Ng, 2012); (Mura et al., 2014); (Zapata, 2018)
			The educator should be able to share information from the web by sending links.	(Ferrari, 2008); (Matusiak, 2010)
	Social networking functional literacy (Ng, 2012)	Use of social networks for collaborative learning and teamwork (Rodriguez et al., 2018; Zhang, 2018)	The educator should be able to collaborate with colleagues and learners by using social media.	(Cerda-Diaz, 2017); (Aventurier, 2014); (Bansal et al., 2014); (Mayisela, 2013); (Nagel et al., 2012); (Mura et al., 2014)
			The educator should be able to tele-conference with colleagues and learners through skype.	(Herselman et al., 2015); (Granger et al., 2002)
		Being part of online groups (Krish et al., 2018)	The educator should understand the different social media available and be able to create an online learning group.	(Clark et al., 2017); (Patten et al., 2006)
			The educator should be able to use a mobile device as a blogging tool.	(Herselman et al., 2015)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
		Sharing and storing of information – cloud computing (Mitrovic, 2017)	The educator should be able to share content and thoughts with learners and fellow colleagues e.g. drop box.	(Ng et al., 2013); (Gopalan et al., 2011); (Granger et al., 2002)
			The educator should be able to use blogs and wikis to create content online and receive feedback.	(EdTech Team, 2015); (Ng, 2013)
			The educator should be able to partake in knowledge generating activities e.g. through wikis and Google Docs.	(Ng, 2013); (Granger et al., 2002)
		Using social networks for professional growth and collaboration (Aventurier, 2014; Bansal et al., 2014; Nagel et al., 2012; Rodriguez et al., 2018)	The educator should be able to create a digital e-portfolio for professional development e.g. LinkedIn and to use educational networks like EduBlogs, MindMeister and ePals.	(EdTech Team, 2015); (Mura et al., 2014); (Herselman et al., 2015)
		Communication (Chipangura, 2016; Dahlstrom et al., 2013; Harper, 2003; Jones et al., 2006; Kelly et al., 2012; Martin, 2018; Nagel et al., 2012)	The educator should be able to communicate with learners and colleagues through e-mail, social networks, via phone and text messages.	(Martin, 2018); (Ng, 2012); (Herselman et al., 2015); (Dahlstrom et al., 2013); (Zapata, 2018)
	Online etiquette Literacy (Ng, 2012)	Conduct and demeanour over the internet (Chew et al., 2018; Dhir et al., 2012; Voogt et al., 2013)	The educator should behave in a decent manner over the internet and avoid vulgarity.	(Ng, 2013)
			The educator should be aware of netiquette.	(Mura et al., 2014); (Kluzer, 2015); (Granger et al., 2002)
	Cyber Safety Literacy (Ng, 2012)	Being safe in the online world (Chew et al., 2018; Kluzer, 2015; Paasch et al., 2012)	The educator should be aware of what to publish on social media as this leaves a print in the online world, therefore private information should not be disclosed.	(Voogt et al., 2013); (Mura et al., 2014); (Bradshaw et al., 2011)
			The educator should ensure that learners are safe by educating them as well e.g. on cyberbullying.	(Bradshaw et al., 2011); (Shuler, 2009)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
			The educator should understand the dangers of unsafe networks.	(Ng, 2013)
			The educator should be able to identify threats and know how to deal with such situations.	(Ng, 2013); (Bradshaw et al., 2011)
			The educator should avoid copying published work.	(Ng, 2013)
			The educator should know about legal rights when using online services.	(Ng, 2013); (Bradshaw et al., 2011)
Cognitive dimension	Reproduction Literacy (Ng, 2012)	Dealing with graphics, video and animation (Dhir et al., 2012; Kelly et al., 2012)	The educator should know how to differentiate different file formats by understanding different file formats e.g. Audio, video, text.	(Voogt et al., 2013); (Kong, 2014)
			The educator should be able to create a YouTube video or a podcast or lesson video and online tutorials on their device.	(Ng, 2013); (Herrington, 2009); (Chan, 2014); (Martindale, 2015); (EdTech Team, 2015); (Patten et al., 2006); (Chan, 2014); (Granger et al., 2002)
		Content recreation (Dhir et al., 2012)	The educator should be able to integrate information and create meaningful information.	(Ferrari, 2008); (Matusiak, 2010); (Ventimiglia et al., 2016); (Granger et al., 2002)
			The educator should be able to find information and experiences across a number of means e.g. through photos, audio, videos, numerical representations and text.	(Gilster, 1997); (Matusiak, 2010); (Ventimiglia et al., 2016); (Chipangura, 2016); (Eshet-alkalai et al., 2009)
			The educator should be able to adapt web content to the classroom.	(EdTech Team, 2015)
		Word processing and electronic spreadsheets (Martin, 2018)	The educator should be able to edit in a word processor e.g. by copying and pasting.	(Cerda-Diaz, 2017); (Jones et al., 2006)
			The educator should be able to use tools, such as Excel, to generate reports with statistical and graphical representation.	(Cerda-Diaz, 2017) (Herselman et al., 2015)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
	Branching Literacy (Ng, 2012)	Multidimensional skills at sourcing information (Chipangura, 2016)	The educator should know how to find answer to a particular question and seek advice and also find information sources that lead to other useful information.	(Chipangura, 2016)
		Developing a connection between information (Mabila et al., 2017; Russell et al., 2018)	The educator should know how to access, manage, integrate, evaluate and synthesize digital resources.	(Martin, 2018; Ventimiglia et al., 2016)
		Having visual and media knowledge (Dhir et al., 2012)	The educator should be able to assign a meaning to images and graphics.	(Eshet-Alkalai, 2004); (Eshet-alkalai et al., 2009)
			The educator should be able to express themselves through edited photos, videos, sketches, blogs, podcasts and other forms.	(Ng et al., 2013)
			The educator should be able to listen to music and watch videos.	(Ng, 2012); (Zapata, 2018)
			The educator should be able to understand information in different forms like in text, video, audio, maps.	(Warschauer, 2007); (Martindale, 2015); (Zheng et al., 2018)
			The educator should be able to understand media expressions.	(Martin, 2018)
			The educator should be able to capture images.	(Ng, 2013); (Herselman et al., 2015)
	Information Literacy (Ng, 2012)	Background knowledge in acquiring information (Mabila et al., 2017; Russell et al., 2018)	The educator should be able to contribute, search and construct knowledge.	(Ng, 2013); (Ferrari, 2008); (Martin, 2018)
		Real-time thinking (Jere et al., 2013)	The educator should be able to process and evaluate large amounts of information at the same time.	(Eshet-Alkalai, 2004); (Eshet-alkalai et al., 2009)

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educators' mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Scholarly support from literature for rural educators' mobile digital literacy skills for the use of mobile technologies in learning
			The educator should be able to assess quality and validity and be able to create information through different domains.	(Jones et al., 2006)
			The educator should be able to access e-publications and e-books.	(Herselman et al., 2015)
Literacy for all dimensions	Critical Literacy (Ng, 2012)	Being a data critique (Ng, 2012)	The educator should be able to use information responsibly by sourcing information from credible sites and giving credit to the respective authors. In addition, the educators should discourage learners from committing plagiarism by copying and pasting.	(Ng, 2013)
			The educator should be able to teach learners how to analyse information for authenticity, quality, usefulness and free from bias.	(Kong, 2014); (Ventimiglia et al., 2016); (Ferrari, 2008); (Gilster, 1997); (Matusiak, 2010); (Ng, 2013)
			The educator should be able to evaluate web content for authenticity.	(EdTech Team, 2015); (Herselman et al., 2015)
Other literacies identified	Financial literacy (Astill, 2017; Van Biljon et al., 2007)	Understanding data cost implications (Astill, 2017; Van Biljon et al., 2007)	The educator should have an idea of the data costs implications whilst using a device in the classroom.	(Ng, 2013); (Kuo et al., 2009)
	Workaround literacy (Supachayanont, 2011)	Adapting to the rural context (Supachayanont, 2011)	An educator should have workaround skills to deal with challenges of a rural nature, like lack of electricity.	(Supachayanont, 2011)

The overall concept of mobile digital literacy skills was divided into three concepts namely: digital literacy skills, mobile information and communication technology and ICT in education (a rural South African perspective).

To synthesise these different concepts, a mind map of the connections between the concepts is presented in Figure 5- 8.

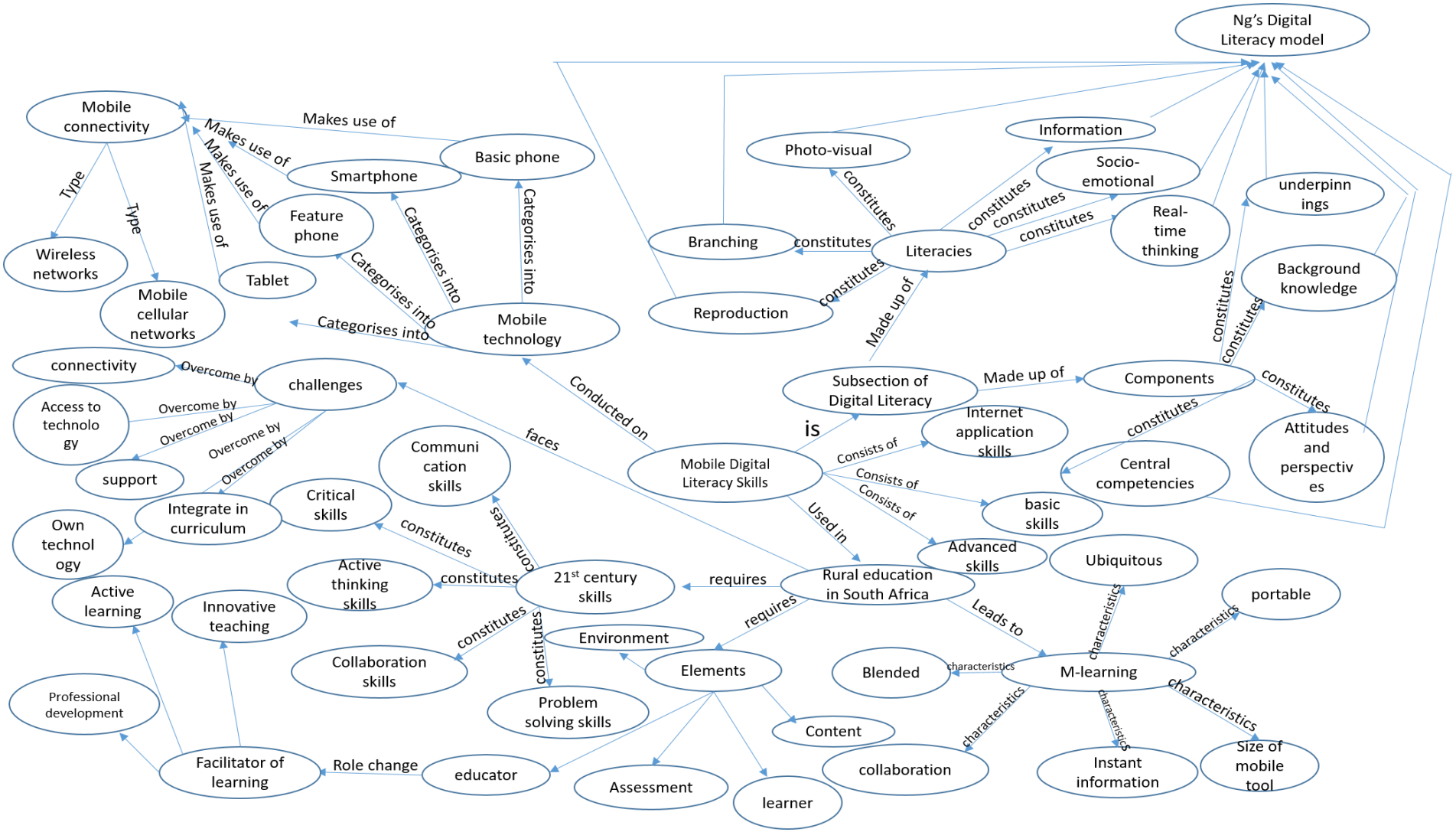


Figure 5-8: Concept map of components of mobile digital literacy skills for the rural educator.

Figure 5-8 summarises how all the concepts and ideas fit together.

5.7 SUMMARY

The Theoretical framework, presented in Table 5-6, and illustrated in Figure 5-8, answers SRQ1: *How can mobile digital literacy skills, from literature, support educators when using mobile technology in rural formal education?*

In summary, Figure 5-9 is a high level view of the findings to conceptualise a Theoretical framework for mobile digital literacy skills for an educator using mobile technologies in rural formal education.

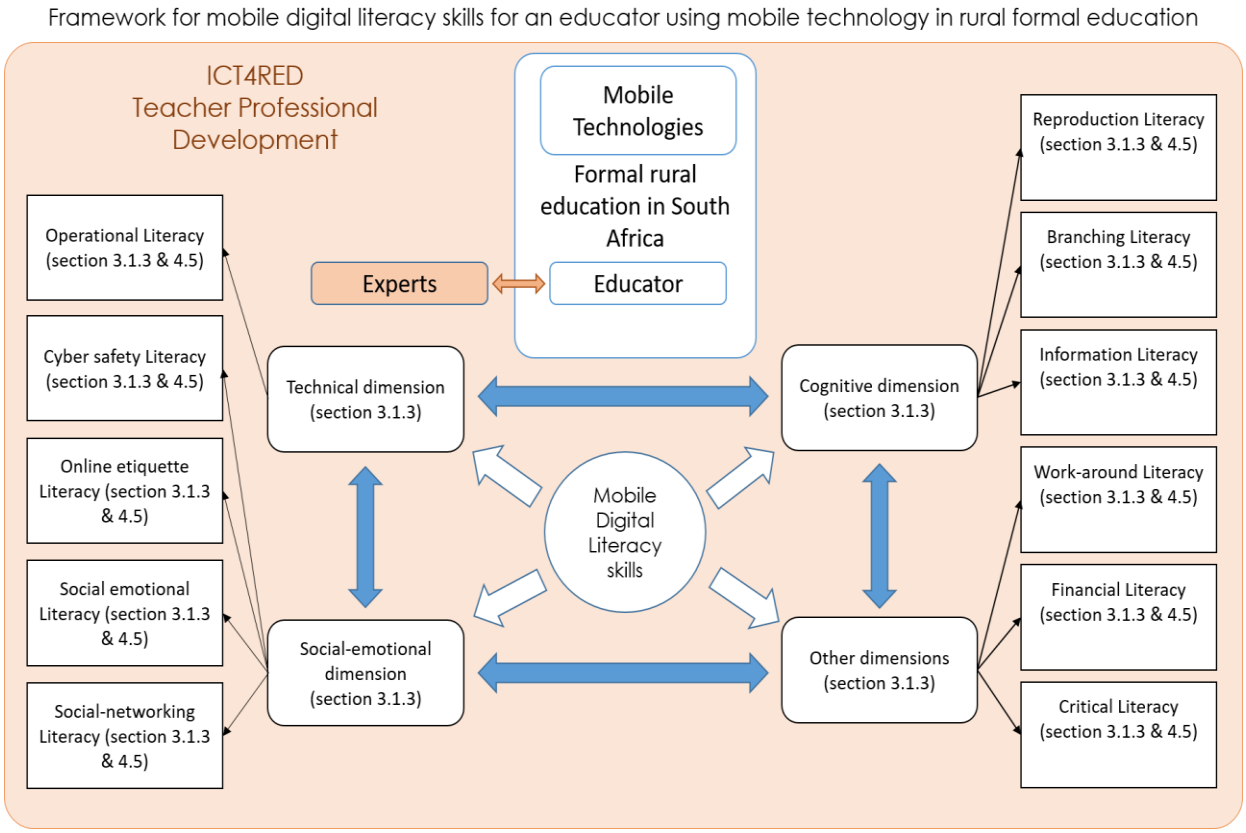


Figure 5-9: Theoretical framework for mobile digital literacy skills for an educator using mobile technologies in rural formal education.

CHAPTER 6: RESEARCH METHODOLOGY

6.1 INTRODUCTION

In Chapters 3, 4 and 5, literature engagement led to the construction and validation of a Theoretical framework, presented at the end of Chapter 5. This chapter outlines the research design and methodology used in this study. Research methodology is the principle of how a research task should be undertaken (Saunders & Lewis, 2017). The research methodology will provide structure to the researchers, thus allowing for new knowledge to be discovered and enabling the formulation of answers to the research questions (Saunders et al., 2017).

This chapter details the research process adopted for this study and explains the data collection and analysis techniques used by the researcher, including reasons for the chosen approach and methods. The researcher then discusses the sampling method used together with the necessary justification and limitations to the chosen study design.

Adom, Hussein, and Agyem (2018) suggest a definition for a framework that includes identifying all the ideas and rules associated with a problem. Heeks' (2006) definition of a framework concentrates on the theorising aspect, as he mentions that a framework results from theory. Hassan, Albakr, and Al-Dossari (2014) support Heeks (2006) view of theory generation by mentioning that theory can help build the framework which, in turn, resolves a problem and allows for further generation of future research questions.

For the purpose of this study, a framework is viewed as Heeks' (2006) and Hassan et al. (2014) described it. They describe it as *theorising*, which takes place when the researcher identifies and confirms mobile digital literacy skills, as required by an educator, towards using mobile technologies in rural education from available literature.

Heeks (2006) and Hassan et al. (2014) further explain a *framework* as informing a discipline or solving a problem. In this case, the framework provided a categorised structure of mobile digital literacy skills to assist with one of the subsets of 21st century skills in terms of ICT for education (Longmore, Grant, & Golnaraghi, 2018).

The aim of this study was to explore the components of a framework for mobile digital literacy skills for an educator using mobile technologies in rural education.

The aim was reached via a three-phased research process illustrated in Figure 6-1.

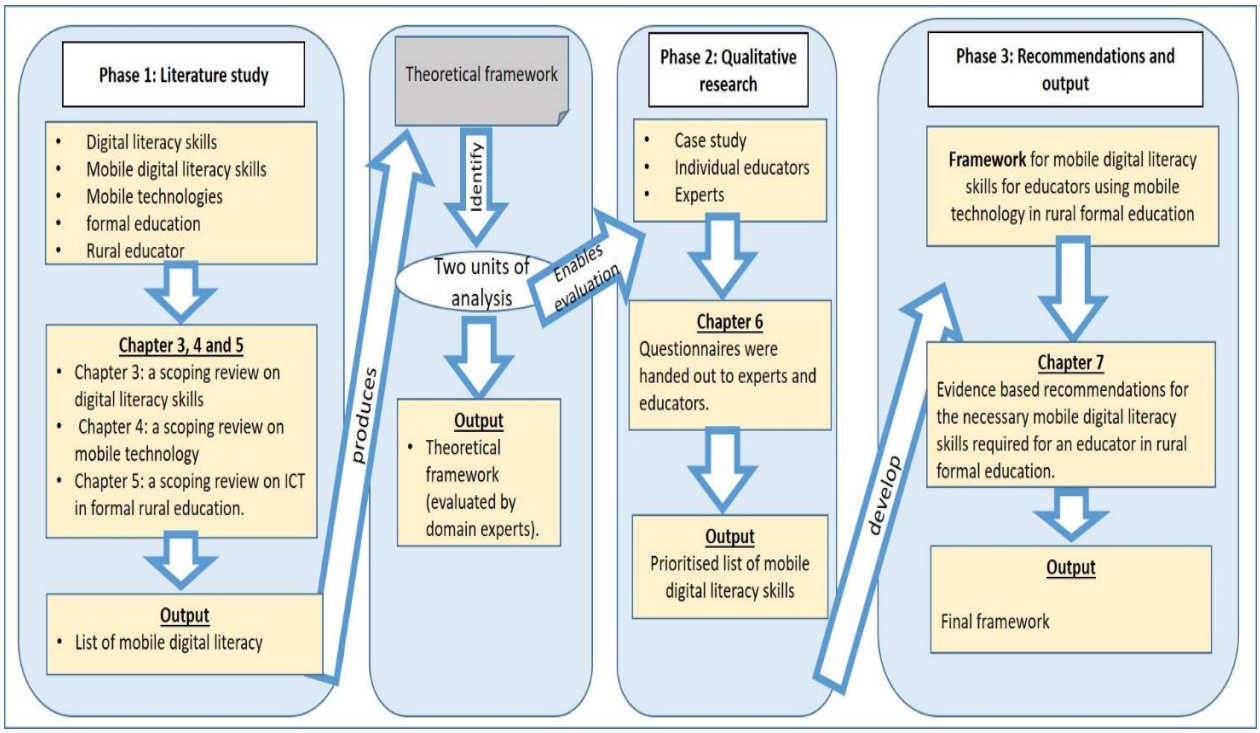


Figure 6-1: Researcher's process to conduct the research.

The results of each of the phases in Figure 6-1 assisted in grounding the next phase.

Each of these phases are elaborated upon in the following section of this chapter.

6.1.1 **Phase 1: Literature study**

Yin (2017) argues that a case study requires theory development before a researcher engages with the real world. The literature study done in Phase 1 aims to answer sub research question 1: How can mobile digital literacy skills from literature inform educators when using mobile technologies in formal education? and contextualised in Chapters 2, and presented in Chapters 3 (Theoretical framework v1), 4 (Theoretical framework v2), and 5 (Theoretical framework v3). The Theoretical framework v3 that resulted from the literature study was reviewed by two domain expert reviewers (Creswell et al., 2017). Their inputs were incorporated in the Theoretical framework v3 to present the final *Theoretical Framework for mobile digital literacy skills for educators using mobile technology in formal education.*

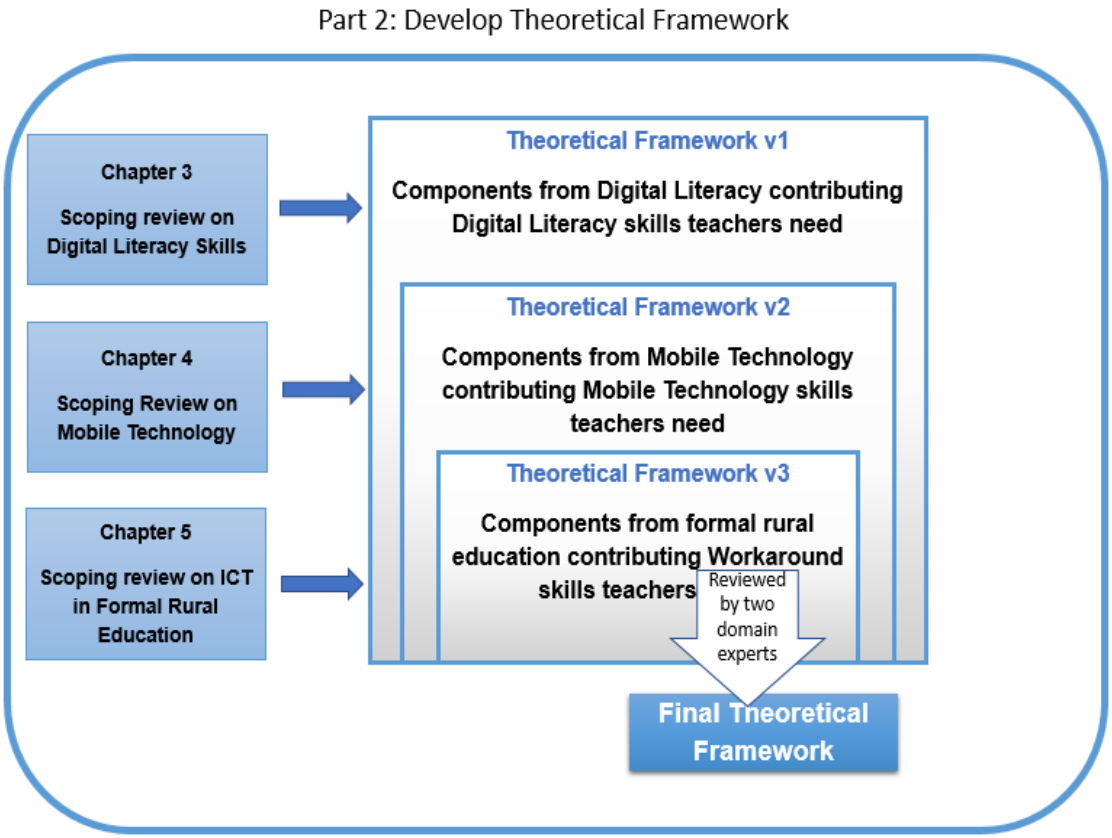


Figure 6-2: Conceptualisation of the literature study.

In order to conceptualise this framework, literature was surveyed to gain insights into likely frameworks that could be adopted for this study. Some scholars did not explicitly present a framework, but offered a set of categorised skills. The following frameworks were assessed for relevance:

- The European Union Joint Research Centre's Digital Competence Framework (DIGCOMP) (Ferrari, Brečko, & Punie, 2013)
- Skills mentioned by the Conference Board of Canada (2014)
- Ng's (2012) Digital literacy model
- Patten, Sanchez and Tangney's (2006) functional framework
- Ng and Nicholas's (2013) framework for sustainable mobile learning
- A framework for ICT literacy in the Digital Transformations report (2002)

The frameworks and skills were reviewed for relevance and applicability. Many of the frameworks were based on: learners' perspectives (Tobergte & Curtis, 2013), digital skills in general or focused on computer based skills (Ferrari et al., 2013). There are

only a few sustainability frameworks which address mobile technologies and education (Hsu & Ching, 2015). This could be, according to Crompton et al. (2016), due to mobile technologies being a relatively newer field of study, thus not much information exists yet on skills required by educators (Crompton et al., 2016).

The outcome of the first phase is a refined and reviewed Theoretical framework (Table 5-6).

6.1.2 Phase 2: Data collection and analysis

This phase endeavoured to answer sub research question 2: How do the identified mobile digital literacy skills influence educators' practice in rural formal education? To answer this, a questionnaire was created based on the insights gained from the Theoretical framework (Phase 1) (Appendix D, see Section 6.8.2.1). This questionnaire was distributed to 20 educators and four experts (See section 6.8.3.2). Analysis of the qualitative data was done in accordance with Creswell et al. (2017) criteria for qualitative evaluation using the hermeneutical principles of Harrison, Birks, Franklin, and Mills (2017) (Section 6.9).

6.1.3 Phase 3: Framework for mobile digital literacy skills of educators using mobile technology in formal education

This phase answered the main research question: How can a framework for educators' mobile digital literacy skills support educators' use of mobile technology in formal rural education?

The results obtained from assimilating the data were integrated into the Theoretical framework (derived in Phase 1) to compile a contextualised revised *framework for mobile digital literacy skills as a representation of a skills framework for educators using mobile technology in education*.

6.1.4 Research contribution

The contribution of this research is, a *framework for mobile digital literacy skills for an educator using mobile technologies in rural formal education.*

This framework can support mobile digital literacy skill development for educators using mobile technology in rural formal education.

The framework can serve as:

- A guide to identify and enable teacher professional development planning to facilitate the various skills that support the successful adoption of mobile technology in the rural classroom.
- A mechanism through which mobile digital literacy skills can be grouped, contextualised and prioritised with the view of successful long-term integration of mobile technology in rural formal education.

6.2 RESEARCH METHODOLOGY APPROACH

A research design ensures that the research objectives are successfully achieved through systematic and methodological implementation (Houghton, Casey, & Smyth, 2017). Figure 6-3 presents the 'research onion' by Saunders et al. (2017). The research design is represented in the form of layers. The outer layers guide the direction that the research takes which, in turn, affects the inner layers (Saunders et al., 2017).

The research onion, by Saunders et al. (2017), is indicated in Figure 6-3 and applied to this study in Figure 6-11. The research onion imitates the peeling off, of the different layers of an onion to reach its core. This theory can be applied to research, the core being data collection (Saunders et al., 2017).

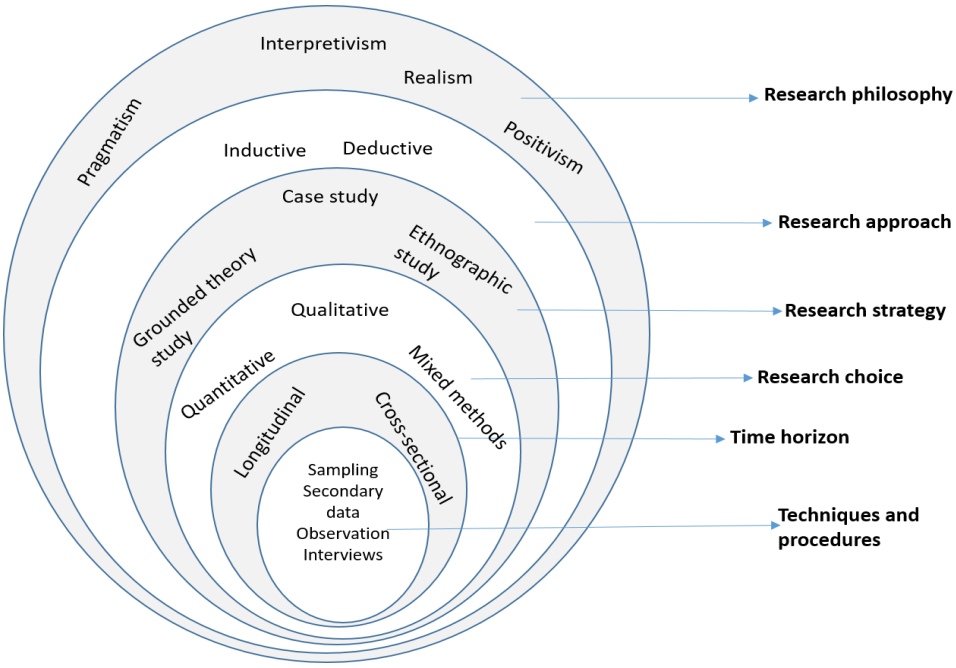


Figure 6-3: The research onion (Adopted from: Saunders et al., 2017).

The research onion layers depicted in Figure 6-3 will help guide the explanation of the sections of this chapter.

6.3 RESEARCH PHILOSOPHY

A paradigm is a collection of values and assumptions that leads to a pattern of thinking, thus creating an individual's perception of the world (Guba & Lincoln, 1994). The paradigm will guide the researcher's perception of the world and what is in it. Orlikowski and Baroudi (1991) mentions different paradigms including:

- Positivism – in this paradigm reality is objective and measurable, thus free from bias (Myers, 2016). Positivists are most likely to use quantitative methods (Orlikowski et al., 1991).
- Critical realism – this type of research allows the researcher to criticise findings based on already known and available facts (Orlikowski et al., 1991).
- Interpretivism – involves an understanding of a human's feelings and perceptions in a particular situation (Myers, 2016). Interpretivism is fitting for studies that delve into social concepts (Saunders et al., 2017). Qualitative studies can be applied to any research philosophy (Eisner, 2017), however, Lewis (2015) established that studies that follow the interpretivist approach are generally qualitative in nature.

The researcher acknowledges different paradigms, but adopted interpretivism as the chosen paradigm. In interpretivism, social constructs assign meaning to reality (Myers, 2016). Much of the focus in interpretivism is on the complexity of making sense of the meanings ascribed by humans (Myers, 2016). The interpretivist philosophy is appropriate in this case as it helps to examine the *how* research questions (Sections 1.2.2. and 1.2.3) (Creswell et al., 2017). Hermeneutics is the guiding method of analysis in interpretivism (Introna, Kavanagh, Kelly, Orlikowski, & Scott, 2016) and strongly supports the interpretivist philosophy (Kafle, 2011). Hermeneutics is further explained in Section 6.9.

Thomas (1998) suggests that there are four characteristics to a research philosophy namely: epistemology, theoretical perspective, methodology and methods. Creswell (2007), however, suggests five assumptions that characterise a research philosophy

namely: ontology, epistemology, axiology, rhetoric and methodology. Table 6-1 shows the effects of interpretivism on this study.

Table 6-1: Philosophical assumptions with implications for this study (Adapted from: Creswell, 2007a, p. 17).

Assumption	Characteristics of interpretivist research philosophy	Implication for this study
Ontological (The nature of reality)	Reality has several meanings and is interpreted through participants' views (Levitt et al., 2018).	Researcher will use participants' words to construct reality, in this case a framework for mobile digital literacy skills.
Epistemological (The relationship between the researcher and what is being researched)	The researcher investigates in order to acquire knowledge (Levitt et al., 2018).	Researcher will assess educators and experts in the field of education, through a questionnaire, to gain a deeper understanding on their use of mobile technologies for learning.
Axiological (The role of values)	The researcher accepts that the research is value bound and is subjective (Levitt et al., 2018).	The researcher is value bound due to the qualitative nature of the research and is a part of the research process, hence an element of subjectivity will be present.
Rhetorical (The Language of the research)	The researcher writes in either a formal, or informal tone (Levitt et al., 2018).	The researcher will report on what the research participant has mentioned. The language used will be informal to suit qualitative research.
Methodological (The process, strategy or plan)	The researcher uses qualitative methods that can be interpreted in several ways (Levitt et al., 2018).	The inductive process is used in this study. The researcher will collect data before generalising and then propose the specific framework.

Table 6-1 assumes that participants respond *subjectively* (Levitt et al., 2018). Saunders et al. (2017) suggest that the interpretivist approach induces meaning through event analysis and aims to understand the subjective reality of the participants in an effort to make sense of their motives, actions and purposes.

6.4 RESEARCH APPROACH

Saunders et al. (2017) suggest that a research approach revolves around a researcher's reasoning and perceptions. Thomas (2006) adds that a research approach can be either *deductive* or *inductive*.

The research approach chosen for this study is an inductive approach for the analysis of qualitative data. This method is also known as the grounded approach (Saunders et al., 2017). This process involves data collection and analyses as the researcher develops a conceptual framework as a result of the analysis (Saunders et al., 2017).

Thomas (2006) also notes that the inductive approach enables the researcher to create a connection between the research objectives and the findings garnered from the research process, therefore allowing the researcher to develop a framework from the data collected in the research process.

An inductive approach provides for a planned way of analysing qualitative data, through the research objectives (Thomas, 2006). This study is an inductive, theory generating case study. A conceptual framework was built from the literature study and refined through input from practising educators and experts to form a theory as to a framework for mobile digital literacy skills of educators using mobile technology in formal education (Saunders et al., 2017).

The researcher used inductive logic to study the literature and identify mobile digital literacy skill components for educators using mobile technology in rural formal education. Before any generalisations were made, the researcher carefully explored relevant data to create a Theoretical framework.

6.5 RESEARCH STRATEGY

A research strategy outlines *how* the researcher intends to answer the research questions (Saunders et al., 2017). The research strategy is dependent on the research questions, research philosophy, research approach, choice and the available literature (Saunders et al., 2017).

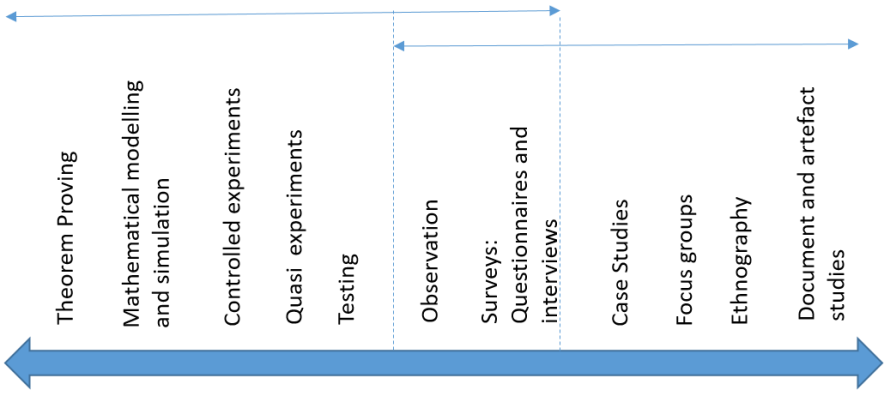


Figure 6-4: Research strategies (Van Greunen, 2009).

Figure 6-5 presents research strategies that can be used for either quantitative, or qualitative, research or for both (Gustafsson, 2017). Some strategies, supported by the qualitative strategy, are: ethnography study, case study and interpretive qualitative

study (Eisner, 2017). Table 6-2 reviews the strategy best suitable to answer the research questions posed in this study.

Table 6-2: Research approach, characteristics and applicability to research questions (Adapted from: Van der Merwe, Kotze & Cronje, 2005).

Approach	Characteristics	How can a framework for educators' mobile digital literacy skills support educators in using mobile technology in formal education?	How can mobile digital literacy skills, from literature, influence educators when using mobile technology in rural formal education?
Experiments	Control and experimental groups		
	Treats situations like a laboratory		
	Causes due to experimental investigation		
	Does not judge worth		
Survey	Describes and explains		
	Represents wide population		
	Gathers numerical data		
Case Study	In-depth, detailed data derived from wide data sources	✓	✓
	Participant and non-participant observations	✓	✓
	Non-interventionist	✓	✓
	Empathic	✓	✓
	Holistic treatment of phenomenon	✓	✓
	What can be learned from a particular case	✓	✓
Grounded Theory	Meaning emerges from the phenomenon		
	Collection and analysis of data is a simultaneous process		
	Hierarchical coding processes		
	Categories/concepts and their qualities/properties are generated from the data		
	Conceptual relationships are grounded in the data		
	Data collection proceeds until so called Theoretical saturation is achieved		
Ethnography	Context specific	✓	✓
	Formative and emergent		
	Responsive to emerging features		
	Allows room for judgements and multiple perspectives		✓

Approach	Characteristics	How can a framework for educators' mobile digital literacy skills support educators in using mobile technology in formal education?	How can mobile digital literacy skills, from literature, influence educators when using mobile technology in rural formal education?
	Wide data base gathered over an extended period		
	Time consuming to process data		
Action Research	Context-specific		
	Participant as researcher		
	Reflection on practice		
	Interventionist, leading to solution of 'real' problems and meeting 'real' needs		
	Empowering participants		
	Collaborative		
	Promoting praxis and equality		
	Stakeholder research		

As inferred from Table 6-2, the most suitable qualitative strategy for this study is *case study*, as per the representation of Van Der Merve, Kotze, and Cronje (2005).

Case study research comprises the study of a problem using a single, or multiple, case/s (Levitt et al., 2018) within a specific context (Yin, 2017) in detail for a distinctive period of time (Leedy & Ormrod, 2010).

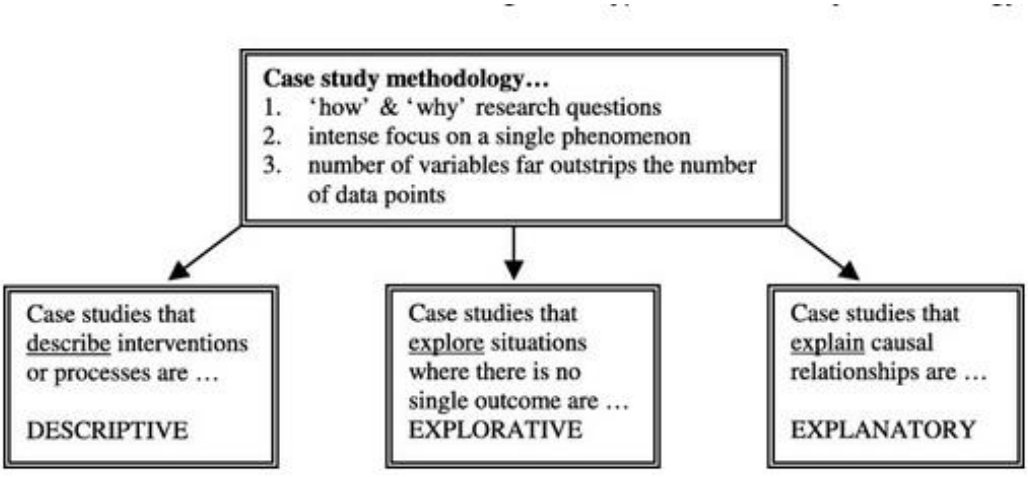


Figure 6-5: Types of case study methodology (Fisher & Ziviani, 2004).

Yin (2017) identified three particular case studies as per Figure 6-6. The case study appropriate for this study is *explorative case study* as there is no single outcome as to which mobile digital literacy skills an educator needs to enable the use of mobile

technologies in rural education. Yin (2017) mentions that there are four types of case studies: holistic single-case design, holistic multiple-case design, embedded single-case design and embedded multiple-case design. A researcher can choose to conduct a single-case study or multiple-case study which, in turn, can then be either holistic or embedded.

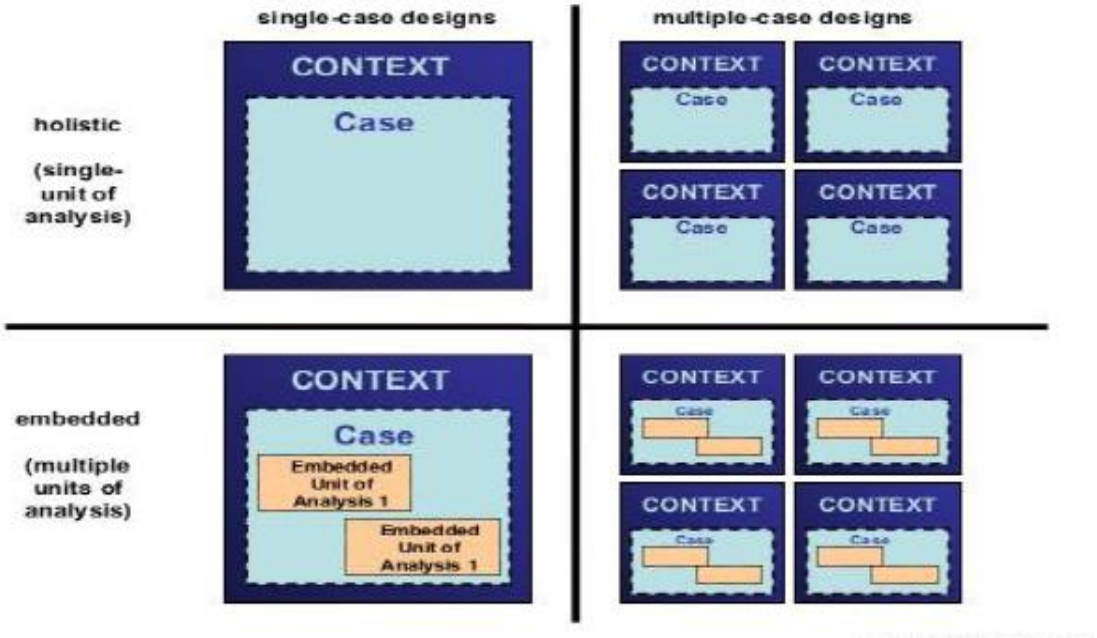


Figure 6-6: Basic types of case study designs (Tsai, Shillair, & Cotten, 2017; Yin, 2003).

This research makes use of a single case design and a multiple unit of analysis as per Figure 6-7.

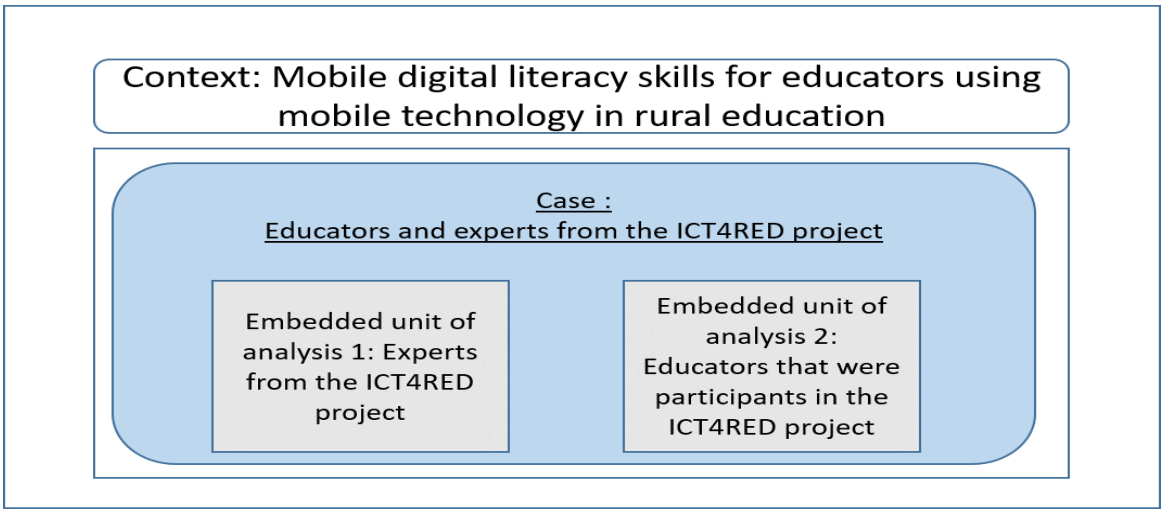


Figure 6-7: Case study design for this study (Adapted from: Yin, 2017).

Figure 6-8 represents the single case design and multiple units of analysis adapted for this study. This case study consists of a single case: educators and experts from the ICT4RED project. This case has a double unit of analysis. The case was selected based on the selection criteria suggested by Myers (2013) and applied in Table 6-3.

Table 6-3: Criteria for case study selection (Adapted from: Myers, 2013).

Criteria for case evaluation	ICT4RED
The case must be 'interesting' thus revealing something unknown.	The case is an experimental (from first principles) deployment of a holistic ICT implementation in education.
Case must display sufficient evidence.	The scope and extent of the case, as well as the duration and practical nature of rollout, provides sufficient activities and interactions from which to collect evidence. It includes implementation, as well as extension, of learning to general strategy.
The case should be 'complete', thus all relevant evidence for, or against, the case should be collected.	The project life cycle allows for development of decision models within the scope of the ICT4RED implementation, and testing of models and decision processes in other contexts, based on learning.
The case must consider alternative perspectives, i.e. it must reflect real life situations (including contradictions).	The experimental nature of the project, and adaptation of project design, to fit local conditions, create sufficient information to reflect contradictions.
The case study should contribute to knowledge by being generalised to one, or more, Theoretical concepts.	The uncoordinated decision environment within which the project is implemented, as well as innovative project design elements, provides sufficient scope for the development of new theoretical concepts.

Table 6-3 represents the criteria for case selection as applied to the ICT4RED case. Therefore, each criterion was applied to the ICT4RED case to see if it was a suitable selection.

6.5.1 **Case Description: ICT for Rural Development (ICT4RED)**

The Department of Science and Technology (DST), together with the DRDLR, funded a project entitled: *ICT for Rural Development (ICT4RED)* (Pillay & Dzinotyiweyi, 2014). This project was carried out in the Nciba circuit of the Cofimvaba school district in the Eastern Cape Province (Meyer & Neethling, 2017). This project equipped 26 schools and 255 educators with the ability to use mobile tablets in the classroom environment to facilitate teaching and learning, over a three-year period (Meyer, Marais, & Dlamini, 2016). ICT4RED successfully integrated tablets into classrooms that are considered resource constrained. The teacher professional development (TPD) in this project aimed to equip educators with 21st century pedagogical skills. The TPD model was

constructed based on: past literature, gaming fundamentals, a reward system which acknowledged the acquisition of competencies, innovative and flexible methods (Mabila et al., 2017). The TPD was constructed according to a 13 level model whereby educators had to obtain 13 compulsory badges to thus indicate that they had acquired the necessary skills and were able to put these to use in the classroom (Dlamini et al., 2017).

The Nciba circuit of the Cofimvaba school district in the Eastern Cape Province is considered a resource constrained environment due to macro-economic factors such as (Meyer et al., 2016):

- Less commercial opportunities.
- High unemployment rates.
- Very low income.
- A lessening number of economically active inhabitants.
- An increase in the number of school-going children.

The main aims of the ICT4RED project was to: introduce technology, in the form of tablets, and support hardware to improve education and enable the continuation of the project *beyond* its inception by ensuring that it is truly and properly integrated into classroom practice. These aims were addressed whilst trying to overcome the hurdles inherent to a resource constrained environment (Mabila et al., 2017).

The ICT4RED formed part of the Technology for Rural Development (TCH4RED) project and was aimed specifically at elucidating *how* technology could support teaching and learning. To achieve the outcome of this project, 12 components were identified which play an important role in ICT development in resource constrained areas. The ICT4RED project made use of a design science approach that assisted in developing the TPD course (Meyer, Ford, et al., 2017).

Botha and Herselman (2015 p. 106) defined ICT4RED TPD as “a supported process to guide the development of relevant teacher knowledge and proficiency to enable classroom practice to portray a 21st century technology enhanced teaching and learning engagement.” The TPD course duration was more or less 12 months and consisted of 10 modules. The course outline is illustrated in Table 6-4.

Table 6-4: ICT4RED TPD module outline (Botha & Herselman, 2015).

Module	Compulsory badges
	ICT4RED badge. Pledging yourself.
Module 1	Jigsaw strategy and understanding your tablet.
Module 2	Storytelling as a strategy and the personal technology journey.
Module 3	Role-play as a teaching strategy and navigation of problems that arise during teaching in the classroom.
Module 4	Learning ranks as a teaching strategy and how to produce digital content.
Module 5	Mind mapping strategy and applying a satisfactory user's policy in your class.
Module 6	Flipped classroom as a teaching strategy producing lesson ideas for ICT integration.
Module 7	Game-Based Learning strategies and generating educational videos. Understanding copyright and plagiarism issues.
Module 8	Field trips as a teaching strategy.
Module 9	Gallery walks as a teaching strategy. Digital identities, phishing, online safety, cyberbullying, personal learning. Professional learning communities.
Module 10	Reflecting on the journey and presenting it.

Table 6-4 portrays an initiative that would help equip educators with mobile digital literacy skills and competencies to empower them to incorporate technology meaningfully into classroom practice and thus facilitate 21st century learning. The technology used to facilitate the course content, as illustrated in Table 6-4, was the Android tablet. Android tablets were chosen specifically for their open operating system as well as the availability of a large number of free apps. The TPD course did not need internet connectivity. However, despite this, educators were exposed to an 'internet like' familiarity supported by a local Wi-Fi hotspot and content server (Platz & Herselman, 2018).

Successful completion of a module resulted in a badge being awarded to the educator. Every badge earned resulted in a reward, as indicated in Table 6-5.

Table 6-5: Badges and resulting technology reward for the educator (Botha & Herselman, 2015).

Total badges earned	Tablet accessory rewarded
Commitment badge	Tablet cover
N = 4	SD card
N = (4 already earned) +5	Earphones
N = (4+5 already earned) +2	Tablet pen
All compulsory badges earned N= (4+5+2 already earned) +1	Tablet

Figure 6-9 illustrates an estimation of how long it would take for schools to qualify for the hardware rewards.

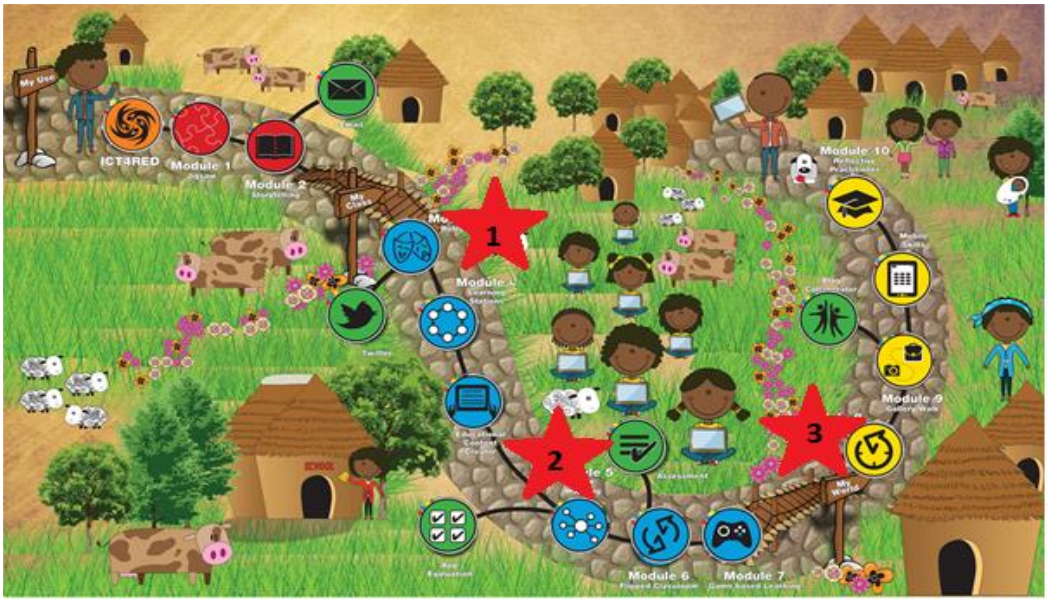


Figure 6-8: Technology earnings for schools (Meyer & Neethling, 2017).

In Figure 6-9, the first star indicates the *projector*, the second star a *Mobikit* and the third star *additional Mobikits.*

In addition to educators being rewarded, ICT4RED also rewarded the schools. Table 6-6 indicates the criteria along with the technology reward for schools.

Table 6-6: School achievement linked to technology reward (Botha & Herselman, 2015).

Criteria	Technology award
Eighty % of 5 badges per participant. For the school to earn a projector: each educator should try, at least, 4 new teaching strategies. Thus, a total of 5 badges per educator. The school is expected to have achieved 80% of this total. So, for a school with 10 educators on the course, they can earn a total of 50 badges. Eighty % of this is 40 badges. To give the school some motivation, this indicates that the total needs to be 80% of 5 badges per participant. If educators achieve more badges, they will achieve the total sooner. If not, all educators do compulsory badges which will be achieved much later in the intervention. This motivates the champions to take lead and obtain a sense of ownership with respect to the earned technology.	Projector
Eighty % of 7 badges per participant. For the school to earn Mobikits: each educator used 5 new strategies. Educators are creating digital content by contributing to the Educational Content Creator Badge. Therefore, educators became contributors by sharing with learners.	Mobikit
Eighty % of 9 badges per participant. For the school to have tablets for learners: each educator tried 8 new strategies and the Mobikit is actively being used. Teachers are creating digital content and incorporating technology into teaching and learning. Educators and schools are now ready to cope with the commotion of technology.	Additional Mobikit or tablets to learners.

Table 6-6 indicates the efforts of the ICT4RED in motivating the school as well.

6.5.2 Case study and information systems research

Orlikowski et al. (1991) suggest that case study is the most commonly used qualitative research method in information systems research. They further mention that the dominating philosophical assumptions in information systems research is *positivist* and *interpretive*. These philosophical assumptions help in the understanding of the interactions between IT related innovations and organisational context. In this study, *IT innovations* would be the use of mobile technologies for education and *context* would be the rural formal classroom.

6.6 RESEARCH CHOICE

Research startegy involves the researcher's plan of action in answering the research questions formulated for the case study (Saunders et al., 2017). The strategy thus refers to an overall approach to answering research questions (Oates, 2005). A research strategy is a decision made by the researcher as to the best approach to answer a research question (Marshall & Rossman, 2006). Marshall et al. (2006) further suggest that a research strategy frames a study by delineating boundaries and thus helping the researcher to identify the focus point. A research strategy should be chosen based on its suitability to the study (Saunders et al., 2017). A research strategy can be either quantitative or qualitative (Saunders et al., 2017). Qualititave resarch investigates research, or phenomena, that occurs in a real world or natural setting. Quanititave research design involves the identification of features of an observed occurrence (Williams, 2011). The main characterisitcs of the quantitative and qualitative method are summarised in Table 6-7.

Table 6-7: Main features of qualitative and quantitative research (Myers, 2016).

Criteria	Qualitative research	Quantitative research
Purpose	Comprehend and interpret social interactions.	Test hypothesis and make predictions.
Group studied	Small and not random samples.	Large and random samples.
Variables	Study the whole and not specific variables.	Specific variables considered.
Type of data collected	Words and images.	Numbers and statistics.
Forms of data collected	Open-ended responses, interviews, observations, field notes.	Data collection instruments enable precise data collection.
Type of data analysis	Patterns and themes.	Statistical relationships and representations.
Most common research objectives	Explore and construct meaning.	Describe, explain and predict.

Focus	Wide, examines breadth and depth of topic at hand.	Narrow and very specific.
Results	Generalised and directional findings.	Projectable findings per designated population.

Table 6-7 suggests that qualitative methods are best suited to research on topics about which little is known, therefore the researcher hopes to gain a better insight (Strauss & Corbin, 1998). Emphasis is placed on interpretive analysis and constructing meaning (Myers, 2016).

The choice for this study is qualitative research. Levitt et al. (2018) suggest that qualitative research involves investigating human problems in their natural settings, thus understanding their experiences. This method is interactive (Saunders et al., 2017). Table 6-8 highlights some important characteristics of qualitative research adapted from Levitt et al. (2018) and list how they apply to this study.

Table 6-8: Check of characteristics of qualitative research present in this study (Levitt et al., 2018).

Characteristics	**Brief description adapted from Levitt et al. (2018)**	**How they are presented in this study**
Natural setting	Research conducted at location where participants are based.	Data will be collected within educators' setting. In this case, schools.
Researcher as key instrument	Researcher accumulates information by themselves.	The researcher will be involved in data collection.
Multiple sources of data	Different sources of data are used.	Data will be collected by interviewing two different sets of people namely educators and experts.
Inductive data analysis	Data analysis is inductive.	The researcher will move back and forth between the literature study and data attained from field work until a framework can be developed from significant themes.
Participants' meanings	Participants' meaning is very important.	The researcher will take participants' views into consideration and infuse meaning.
Emergent design	Initial design is not narrowly stated.	The researcher broadly states research objectives and data collection methods and is aware that this can change.
Theoretical lens	A lens is used to view the study.	The researcher uses a historical lens to identify the skills from the era of "digital literacy" to the more specific domain of "mobile digital literacy".
Interpretive inquiry	Reseracher interprets what is seen, heard and understood.	The researcher will interpret what she sees, hears and understands in the study.
Holistic appraoch	Researcher develops complex picture of the topic being investigated.	The researcher starts the research with a large Theoretical framework which will be created by identifying the factors involved.

6.7 TIME HORIZON

For the purpose of this study, cross-sectional survey was chosen as data was collected at a single time. Educators and experts would be selected to portray their digital literacy skills at a specific point in time (Saunders & Bezzina, 2015). Cross-sectional studies are not as laborious or expensive as longitudinal studies and participants will thus not lose interest (Olckers, 2011). The weakness of the cross-sectional method is that it does not account for changes over a period of time (Olckers, 2011). Another drawback of the cross sectional method, as noted by Sedgwick (2014), is that if the researcher chooses to conduct this study again, a new set of participants will be used. This makes it difficult to deduce trends.

6.8 TECHNIQUES AND PROCEDURES

The following elements of the research method, as applied in this research, are discussed in this section: population and sampling, data collection, data analysis and data verification.

6.8.1.1 Population and sampling

For the research questions to be answered, a sample of the population needs to be selected. There are two main sampling techniques (Saunders et al., 2015):

- Non-probability sampling: The researcher cannot ascertain that the chosen population is a representation of the population chosen for the study. This technique is suitable when it is difficult to identify all potential cases in the population.
- Probability sampling: In this type of sampling the researcher is certain that the sample represents the population for a particular study. In probability sampling each case has the same probability of being chosen. This sampling is normally used with surveying.

Sampling techniques can be classified as either random, or non-random (Bouma & Ling, 2004). These different classifications are summarised in Table 6-9.

Table 6-9: Classification of sampling methods (Adapted from: Bouma et al., 2004).

Random sampling	Non-random sampling
Simple random sampling – assumption that each candidate has equal chances of being chosen. Systematic sampling – selection of participants at regular intervals from a participant sampling pool. Stratified random sampling – division of participants into groups based on similar attributes. Cluster sampling – segments in the population that occur due to natural groupings.	Accidental sampling – using readily available samples. Accidental quota sampling – samples chosen based on some criteria. Purposive sampling – participants are chosen at the researcher's discretion, based on the needs of the study. Snowball technique – researcher has access to a small sample, thus using the available sample to obtain access to other participants. Systematic matching sample – matches similar participants but differentiates based on one critical characteristic.

The current research used purposive sampling as per the recommendation of Saunders et al. (2015) stating that this method is appropriate for case study research. Purposive sampling falls within the non-random sampling category (Bouma et al., 2004).

Educators and experts were chosen based on the following criteria:

- Completed the TPD modules.
- Educator and experts are current users of mobile technology in the classroom.
- Educators and experts are based in the rural areas of South Africa.
- Educators and experts are part of the ICT4RED project.

There are no set rules when deciding on a sample size in qualitative research and it can best be determined by: time available, resources available and research objectives (Patton, 1990). For this study, 20 educators which took part in the TPD course in the ICT4Red project were selected. In addition to the educators, four experts from the ICT4RED project were also selected.

6.8.2 **Data collection techniques**

Data collection enables the researcher to collect the needed evidence for research using either quantitative or qualitative methods (Oates, 2005).

Leedy and Ormrod (2005) propose four guiding requirements which need to be addressed prior to data collection. These principles are:

- data requirements

- data location
- data safety and security
- data interpretation

The current research made use of qualitative methods. The section below provides an overview of the data collection techniques used in this research.

6.8.2.1 Questionnaires

A questionnaire presents a set of questions which requires the response of an individual (Lazar, Feng, & Hochheiser, 2010). Hoinville and Jowell (1978) and Siniscalco and Auriat (2005) note that questionnaires could be open-ended, closed, or both. The difference between closed and open-ended questionnaires is that open-ended questions allow a participant to express his/her views whereas closed ended question are more restrictive in nature (Siniscalco et al., 2005). In *this* study, both open and closed-ended questions were designed and presented in a questionnaire. The closed-ended questions were designed in accordance with the four-point Likert scale.

The Likert scale is one of the most common ways to rate assessments (Allen & Seaman, 2007) and measure behaviour (Joshi, Kale, Chandel, & Pal, 2015) . The most common Likert scale is the five-point, least to most, which requests participants to rate their level of agreement and disagreement (Allen et al., 2007) for given statements (Joshi et al., 2015).

This study adapted an asymmetrical Likert scale whereby fewer selections where afforded on the neutral side (Joshi et al., 2015). The Likert scale for this study was constructed in terms of 4 points, as follows:

1 = very important

2 = moderately important

3 = slightly important

4 = not important

The interval scale in this study does not represent any form of quantitative scale difference between each point and is thus considered an *ordinal scale* (Joshi et al.,

2015). Allen et al. (2007) define an ordinal scale as data presented in an ordering or ranking as per the responses but no measure of distance is probable.

The purpose of this study was to ascertain educators' and experts' opinions regarding which mobile digital literacy skills they deem important for an educator to be able to use to facilitate the effective use of mobile technologies in rural formal education. Therefore, the Likert scale designed for this study helped to formulate a precise perspective of the phenomenon under investigation (Joshi et al., 2015). The principal interest of the researcher in this study is to capture educators' and experts' feelings, opinions and pragmatic perspectives regarding the phenomenon being studied (Joshi et al., 2015).

6.8.2.2 Literature reviews

Leedy and Ormrod (2012) suggest that literature reviews help a researcher to gain insight regarding other researchers' views of a similar research area. Therefore, a literature review enables a researcher to validate his/her own research for future research (Cronin, Ryan, & Coughlan, 2008). A literature review also enables a researcher to gauge whether there is a need for his/her study and to what extent the topic being considered has been addressed in literature (Strauss et al., 1998). In the first phase of this study, a literature review was considered to gather information regarding necessary mobile digital literacy skills for an educator using mobile technology in rural education. The purpose of this literature study was to answer sub-research question 1 (Section 1.2.3). The literature review for this study is presented in Chapters 3, 4 and 5.

6.8.2.3 Expert reviews

Richey and Klein (2014) mention that expert reviews are essential in validating research study outcomes. Expert opinions help to determine the *relevance* and *accuracy* of the proposed solution (Richey et al., 2014). Domain expert reviewers are employed in phase 1 of the study and expert reviews are employed in Phase 2 of this study and are further elaborated on in the next Section (6.8.3). To validate the findings derived from the literature study, two domain experts and a panel of experts were requested to corroborate the findings.

6.8.3 **The expert and domain expert reviewers**

6.8.3.1 Defining a domain expert and an expert

A domain expert can be defined as a person who has specific valuable skills and exceptional knowledge in a specific area of speciality (IGI Global, 2015). This definition implies that a domain expert has very specific knowledge in a particular field and are highly specialised. Domain experts specifically in the field of ICT in education were selected. Domain experts helped to evaluate (Creswell, 2017) the Theoretical framework v3 to create a final Theoretical framework. The final Theoretical framework was then validated by experts.

An expert can be defined as one who can think effectively and strategically about a problem (Maclellan & Soden, 2003) due to the vast amount of knowledge he/she has (Glaser & Chi, 1988). This definition implies that an expert has sufficient insight in a particular field, thus enabling him/her to make sound decisions to a problem and enabling him/her to critically evaluate information. Experts in the field of computing and mobile ICT will be selected based on their knowledge and experience.

Expert reviews help to expose potential weaknesses regarding the subject under evaluation (Holbrook, Krosnick, Moore, & Tourangeau, 2007). Expert reviews are mostly used by researchers to facilitate the proper assessment of their work (Jansen & Hak, 2005).

6.8.3.2 Selecting the number of experts

Holbrook et al. (2007) advocate that the number of experts used in the evaluation of a process should be no less than 2 and no more than 5. Therefore, any number of experts between 2 and 5 are sufficient for an evaluation process (Holbrook et al., 2007). Nielsen (2000) supports Holbrook et al. in suggesting that 5 experts are sufficient to obtain good results. Figure 6-10 presents a graph which illustrates the relation between number of test users and the percentage of usability problems found.

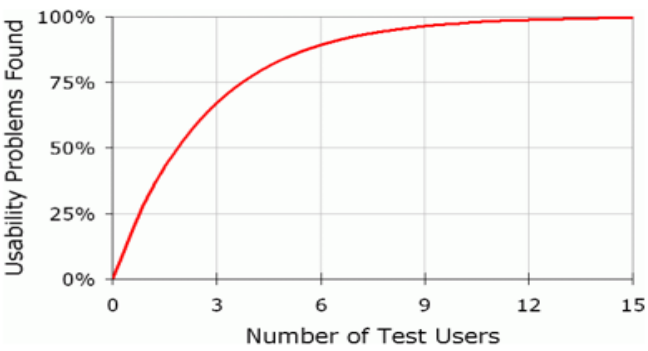


Figure 6-9: Number of experts to determine a certain percentage of errors (Nielsen, 2000).

As per Figure 6-10, 0% of the errors can be detected by 0 experts and after the fifth expert the number of errors diminish and become very marginal. This could be due to the same errors being repeated (Nielsen, 2000). Therefore, five experts are sufficient, picking up at least 85% errors (Nielsen, 2000). The aforementioned authors state that anything between 2 to 5 experts is sufficient (Holbrook et al., 2007; Nielsen, 2000), therefore, 2 domain experts were used to evaluate Theoretical framework v3 to create a final Theoretical framework (see Table 5-6), which was then validated by 4 experts. Domain experts that specialise in ICT for education driven research were selected. Experts, specifically from the field of information systems within the ICT4RED project, were chosen. The focus was to determine a perspective regarding the importance of various mobile digital literacy skills from literature. Experts consisted of individuals who had participated in the ICT4RED as developers of the training material for the course. Domain experts' and experts' qualifications are presented in Table 6-10.

Table 6-10: Expert reviewers' qualifications.

Domain/ Expert Reviewer	Years of experience	Role	Field of expertise
Expert Reviewer 1	22	Teacher, ICT4RED facilitator	Education, finance, mobile ICT
Expert Reviewer 2	17	E-learning instructor from the University of Fort Hare	Mobile ICT, m-learning
Expert Reviewer 3	15	Mobile digital literacy skills instructor	Science and information technology, mobile technology
Expert Reviewer 4	35	Principal, ICT4RED facilitator	Mathematics, Science and information technology, m-learning
Domain Expert reviewer 1	20	Chief researcher	ICT in education, Mobile technology
Domain Expert reviewer 2	25	Chief researcher	ICT in education, M-learning

6.8.3.3 What would the experts review?

Experts were invited to evaluate the comprehensiveness of the framework, correct language usage and the applicability and relevance of the framework to the rural education system. Their valued feedback and suggestions would help to make improvements to the framework.

6.8.3.4 How would they be contacted?

The review entails completing an expert review questionnaire on mobile digital literacy skills (Appendix C) which was distributed electronically via Google Forms. Reviewers were contacted via telephone to facilitate an introduction of the researcher and the study and were then invited to participate in the survey. Upon an expert's approval to participate, they received additional information regarding the research and the questionnaire via e-mail. The survey contained a brief description of the study, as well as a detailed examination of the different elements of the framework. Experts were assured as to their anonymity during analysis and consequent presentation of results. The experts were requested to rate the stated mobile digital literacy skills, according to their own opinion, based on a Likert scale as: very important, moderately important, slightly important and not important (Section 6.8.2.1). As for the domain experts, they were personally contacted and a one on one interview was conducted. The interview entailed revising each skill in the Theoretical framework v3, thus arriving at a refined final Theoretical framework (see Table 5.6).

6.8.4 Linking the data collection techniques: Operationalised Theoretical framework

This study aimed to establish a close relationship between literature and the exploration of the phenomena in practice. Therefore, an operationalised Theoretical framework is presented in Appendix E. This Table links the literature study conducted in Chapters 3, 4 and 5 to the relevant data collection methods namely questionnaires (Section 6.8.2.1) and expert reviews (Section 6.8.2.3). For ease of understanding the following example is extracted from the operationalised Theoretical framework and presented in Table 6-11, and the remainder of it is in Appendix E.

Table 6-11: Example extracted from the operationalised Theoretical framework in Appendix E.

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
Technical dimension	Operational literacy (Ng, 2012)	Getting started with a mobile device (Martin, 2018)	The educator should know how to operate multiple devices including his/her own in the classroom	Questionnaire and expert review	Manage multiple devices in the class at the same time
			The educator should be able to charge the many devices	Questionnaire and expert review	Charge multiple devices at the same time
			The educator should use technology in the classroom to support subject specific content	Questionnaire and expert review	Use mobile technology to support teaching syllabus
					Conduct a lesson using mobile technology as a medium of instruction
			The educator should work electronically with the aim of going paperless in the classroom	Questionnaire and expert review	Reverting to electronic means instead of paper

6.9 DATA ANALYSIS

Data analysis takes place after a research study has been concluded to facilitate an understanding of the findings. Non-statistical data were derived from this study. Data were analysed in an on-going process, thus knitting together the data collection, processing, analysis and reporting phases (Maree, 2007). A qualitative approach was used to analyse the data collected in this study (Creswell et al., 2017). Data analysis in an interpretive study aims to attain an in-depth understanding of the context (Yin, 2017), therefore the value of the analysis lies in the interpretation of data and the explanations assigned to the study (Creswell et al., 2017).

Schutt (2009), Patterson and Williams (2002) and Saunders et al. (2015) mention different forms of data analysis which include: hermeneutics, content analysis and grounded theory. Patterson et al. (2002) suggest that, based on the interpretivist research paradigm, the guiding analysis technique used would be hermeneutic

analysis (Introna et al., 2016). Hermeneutics involves the understanding of interpretation (Meszaros, 2008).

Klein and Myers (1999) categorise a set of principles that can be used to evaluate interpretative research known as the hermeneutic circle. The hermeneutic circle helps the researcher to make presumptions regarding small parts of the research and how they are related. This process eventually offers an understanding of the whole study (Klein et al., 1999). Table 6-12 illustrates how the hermeneutics circle of principles was applied to this study.

Table 6-12: Principles for interpretive field research and its applicability to this study (Klein & Myers, 1999, p. 6).

Fundamental principles	Explanation	Applicability to this study
Hermeneutic Circle	Human understanding is derived through iterating between the parts and the whole (Klein et al., 1999).	An understanding will be created by using different sources of data. Thus, data triangulation will be used.
Contextualisation	Understanding the current situation in the light of what emerged from the past (Klein et al., 1999).	The study will highlight the gradual inculcation of technology in the lives of people, and how the skill sets have evolved.
Interaction between the researcher and the subjects	Reflects on the construction of data resulting from the interaction between the researcher and participants (Klein et al., 1999).	Data will be constructed as the relationship between the researcher and the participants' progresses. The participants being the educators and experts.
Abstraction and generalisation	Entails applying the data collected from Principles 1 and 2 to theory and practice (Klein et al., 1999).	The data collected will be compared to the Theoretical framework and also used by educators that use mobile technology for rural formal teaching.
Dialogical reasoning	Revising the differences that arise from the Theoretical preconceptions to the data actually collected (Klein et al., 1999).	The researcher will constantly revise the data to account for the differences that arise between the Theoretical framework and the actual framework.
Multiple interpretations	Requires accounting for different interpretations by participants (Klein et al., 1999).	Different interpretations will be applied to account for the differences.
Suspicion	Understanding possible "biases" and "systematic distortions" in data collected (Klein et al., 1999).	Data will be collected and interpreted as bias-free as possible.

Applying hermeneutics in this study is relevant, as seen in Table 6-12, as the researcher needed to understand the questionnaires and the literature review.

6.9.1 **Data analysis tools used in this study**

Data analysis is a key part of the research process (Leech & Onwuegbuzie, 2007). This study made use of computer-assisted qualitative data analysis software (Leech et al., 2007). Although the use of computers for analysis is still growing, the use of this software can considerably enhance analysis due to a wide variety of features available to the researcher (Leech et al., 2007).

The software used was Atlas.ti version 8. This software is a potent platform for qualitative analysis. Atlas.ti makes use of coding and annotating activities (Smit, 2010), thus allowing the researcher to draw annotated diagrams to represent transcribed data.

Qualitative data analysis aims to collect rich data and thus an understanding as to the skill requirements of educators using mobile technologies in rural education (Eisner, 2017). In conjunction with the interpretive research focus, the researcher was mindful to understand what the educators were concerned about and what they were least worried about.

Qualitative data analysis was used to interpret and code descriptions and statements from participants and was collected through the open-ended questions in the questionnaire (Blanche, Durrheim, & Painter, 2006).

Data was collected via the questionnaires (Smit, 2010). The researcher read through the data to obtain an overall understanding (Creswell et al., 2017).The researcher then began the analysis by transcribing data and dividing it into segments (Creswell et al., 2017). The researcher inserted these segments into the software. The researcher used the software to code and theme the data, which helped her draw certain conclusions (Smit, 2010).

Atlas.ti version 8 is very beneficial, provided the researcher can draw a fair analysis from the data (Smit, 2010). The software facilitates analyses of data in the form of ordering, structuring, retrieving and visualising the data. It therefore provides the researcher with strong results from which to draw conclusions (Smit, 2010).

The closed-ended questions in the questionnaire were analysed using Microsoft Excel (as illustrated in Chapter 7).

6.10 DATA VERIFICATION

A study should display *internal* and *external* validity and reliability and should, in addition, aim to decrease biasness (Bekhet & Zauszniewski, 2012). Two common ways in which to increase reliability and validity is to reduce the researcher's bias and to use data collection methods involving triangulation (Thurmond, 2001).

Triangulation involves a combined use of more than one data collection method in the same study, therefore providing opportunities for validating research findings (Bekhet et al., 2012; Hussein, 2009; Thurmond, 2001). In this study, data were triangulated using qualitative research methods. The research methods used to facilitate triangulation were an expert review, educator questionnaires and a study of existing literature. Brewer and Hunter (2006) and Thurmond (2001) suggest that data garnered from two or more sources are more significant than evidence from one source.

Triangulation is a vital technique which validates data through verification of multiple sources (Hussein, 2009). Two or more aspects of research should be used in order to increase the interpretation capabilities (Blanche et al., 2006). Denzin (1970) mentions four types of triangulation:

- *Data triangulation*: makes use of several data sources in a study. Data are gathered through several sampling strategies, at different times, situations and from different people.
- *Investigator triangulation*: facilitates the use of more than one researcher in the field for the purpose of gathering and interpreting data.
- *Theoretical triangulation*: involves the use of more than one theoretical situation in data interpretation.
- *Methodological triangulation*: facilitates the use of more than one data gathering method.

Kimchi, Polivka, and Stevenson (1991) identified another form of triangulation, in addition to those listed above:

- *Analysis triangulation*: various data analysis techniques are applied to the results of the study.

This study employed two methods of data triangulation, as explained below:

- Methodological triangulation: this includes the use of literature reviews as well as the use of questionnaires and expert reviews of the Theoretical framework, thus constituting different forms of data collection used in this study.
- Data triangulation: the use of primary sources, in the form of expert reviews and questionnaires, as well as the use of secondary sources namely literature reviews in the data collection process. These constitute the different forms of data triangulation used in this study.

6.11 TRUSTWORTHINESS

Trustworthiness is an important aspect in assessing the reliability and quality of a qualitative research study (Golafshani, 2003). Validity and reliability cannot be specifically applied to qualitative research but *credibility* and *trustworthiness* can (Maree, 2007). Therefore, some strategies are enlisted, as per Table 6-13, to help the researcher increase the credibility of the study (Noble & Smith, 2015). Credibility is determined by four characteristics namely: truth value, consistency, neutrality and applicability (Morse, Michael, Maria, Karin, & Jude, 2002).

Table 6-13: Strategies to improve credibility of this study (Adapted from: Guba and Lincoln, 1985, in Noble et al. (2015).

Credibility characteristics	Strategy to be followed by researcher
Truth value	The researcher should account for personal bias that could have an influence on the outcomes (Morse et al., 2002). The researcher will aim to collect rich and in-depth data, as per the words of the participants, to avoid making a biased decision (Patton, 1990). Use of data triangulation (Hussein, 2009).
Consistency	The researcher will keep records of data collected as this will ensure transparency and consistency (Guba & Lincoln 1985 in Noble et al., 2015).
Neutrality	This will be achieved when the researcher achieves truth value, consistency and applicability (Guba & Lincoln 1985 in Noble et al., 2015).
Applicability	The researcher will assess to what extent the information is generalisable (Creswell, 2007) as it is difficult to generalise in qualitative research (Nieuwenhuis, 2014).

6.12 LIMITATIONS

Hofstee (2006) suggests that even good research has limitations. This study is limited to identifying the *mobile digital literacy skills* of *educators* in *rural education*. Therefore, results will be valid for educators in rural areas currently using mobile technologies in the classroom. The study is thus limited to classroom practice.

This study only considered the technological knowledge and technological pedagogical knowledge of the TPACK model.

The purposeful selection of participants affects the generalisability of results. There were time constraints in conducting the research and rural formal schools using mobile technologies were scarce.

The study was limited to one sub-category: mobile digital literacy skills of the 21st century skills (Longmore et al., 2018).

6.13 SUMMARY

This chapter outlined the research design for this study to help map research questions to research objectives.

The research process, research philosophy, research strategy, data collection methods and data analysis techniques, as applied in this research, were discussed.

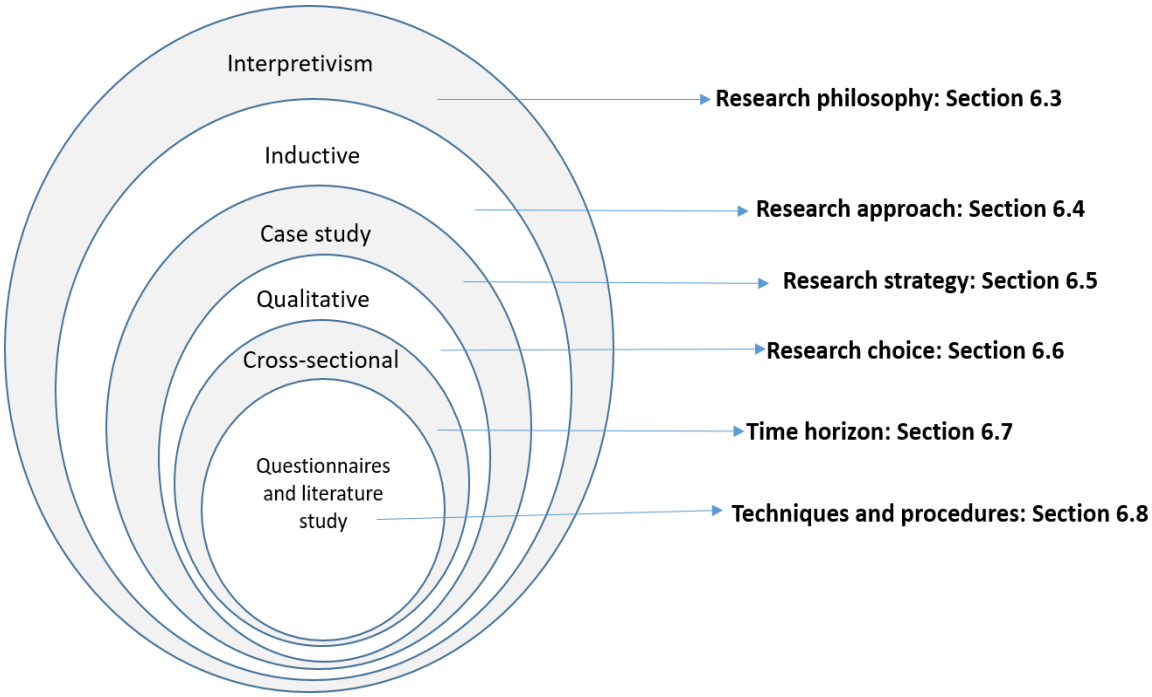


Figure 6-10: The research onion applied in this study (Saunders et al., 2017).

As described in this chapter and summarised in Figure 6-11, the study adopted an interpretivist research philosophy, based on the hermeneutic principles and applied to a single case study as research strategy. Qualitative methods of data collection were used. Chapter 7 will outline the analysis of the data collected in this research.

CHAPTER 7: FINDINGS AND ANALYSIS

7.1 INTRODUCTION

This chapter aims to answer the main research question for this study: *How can a framework for mobile digital literacy skills support educators using mobile technology in formal rural education?* (Section 1.2.2).

In order to answer the main research question, two sub-research questions were designed (Section 1.2.3). Sub-research question 1: *How can mobile digital literacy skills, from literature, influence educators using mobile technology in rural formal education?* was answered through a literature study conducted in Chapters 3, 4 and 5. The Theoretical framework (as per Table 5-6) assisted in building an expert review (Appendix C) and questionnaires (Appendix D).

Mobile digital literacy skills were investigated through a single case study consisting of two units of analysis (Figure 6-8). The units of analysis were: the perspectives of educators and experts. The case was the ICT4RED initiative that was deployed in 24 purposefully chosen rural schools in Cofimvaba, Eastern Cape in South Africa (Section 6.5.1).

Implementing a single case study as a research strategy, with two units of analysis, enabled the researcher to gain an in-depth perspective as to mobile digital literacy skill needs, as perceived by an educator, when using mobile technologies in rural formal education. The two units of analysis, sharing a symbiotic relationship for the purpose of this study, are represented in Figure 7-1.

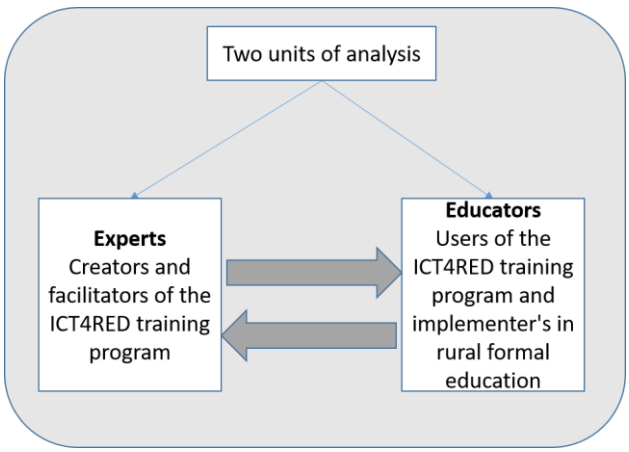


Figure 7-1: Relationship between the two units of analysis.

This research argued that the attainment of mobile digital skills was crucial to educators for the efficient use of mobile technologies in the classroom.

In order to achieve the aim of this chapter the analysis process mentioned in the following section was deployed.

7.2 ANALYSIS PROCESS

The process employed in this section is summarised in Figure 7-2.

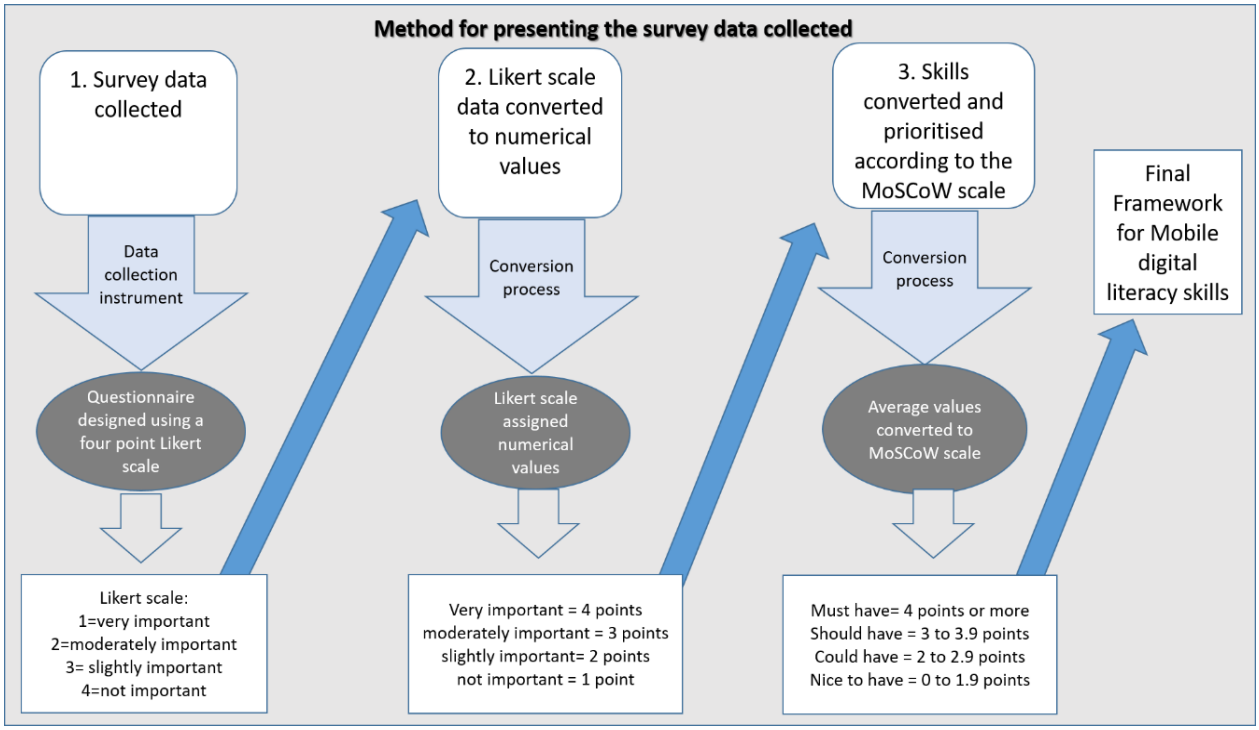


Figure 7-2: Analysis and presentation of survey data.

Step 1: data collection process administered through a questionnaire (Appendices C and D) designed in accordance with a four-point Likert scale (Section 6.8.2.1).

Step 2: converting Likert-scale data to numeric values which enables the researcher to gain a single average response per skill (Likert, 1932; Sullivan & Artino, 2013).

The numerical values assigned were as follow:

Very important = 4 points

Moderately important = 3 points

Slightly important = 2 points

Not important = 1 point

This data conversion process would enable a single number to be generated, thus making it easier to draw assessments and contrasts across the different skills.

Step 3: converting the numeric values generated in Step 2 into the MoSCoW method of prioritisation. The MoSCoW method of prioritisation is a commonly used technique (Kukhnavets, 2016), founded by Dai Clegg of Oracle UK Consulting (Pandey, 2011). Dai Clegg established this technique during his work on Rapid Application Development projects (Pandey, 2011). The notion of the MoSCoW method of prioritisation, is that all requirements are grouped into four categories (Kukhnavets, 2016). These categories, and their application in this study, are shown in Figure 7-3.

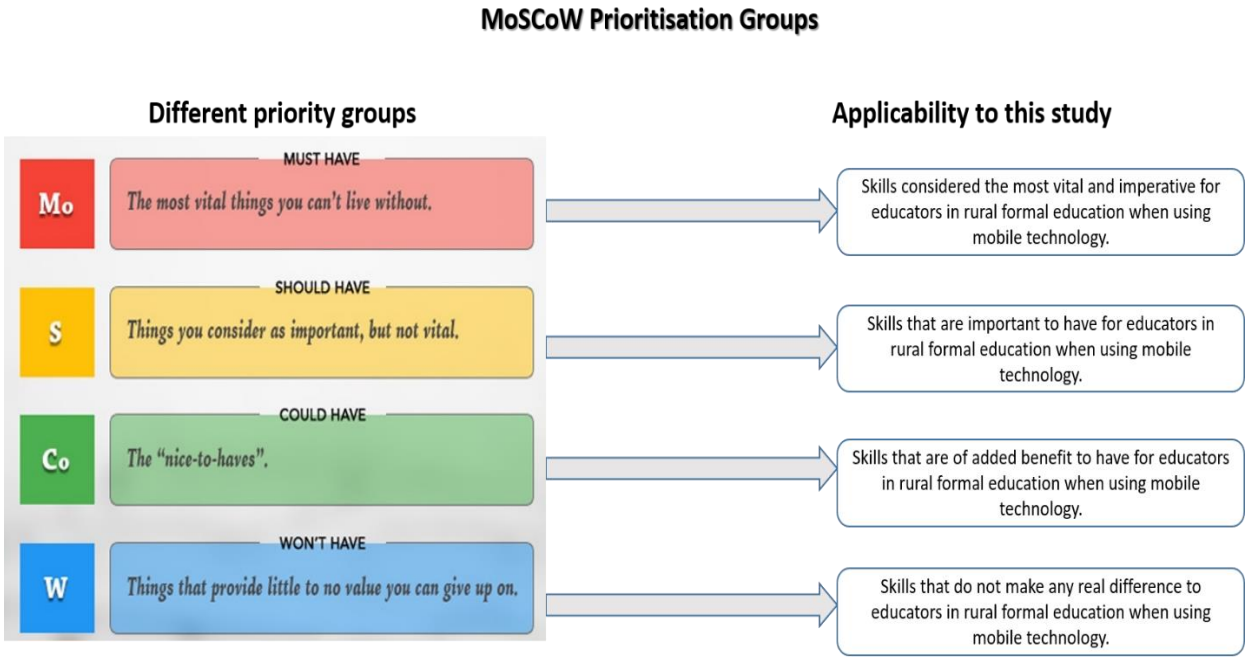


Figure 7-3: Groups in the MoSCoW method and its application to this study (Adapted from: Kukhnavets, 2016).

A design decision made for this study is that all skills contained in the different priority groups, as indicated in Figure 7-3, would signify equal importance (Kukhnavets, 2016). This design approach is subject to criticism and different interpretations by other researchers wanting to adapt this study to different scales. Despite this study's aim to develop beneficial categories of skills for a framework, this is not essentially the finest set of skills as a 'best set of skills' cannot be defined for this study. This problem is usually termed a *design as a search process* in design science (Peffers et al., 2006) and only represents a small version of the case at hand (Hevner & Chatterjee, 2010).

The MoSCoW technique has its advantages and disadvantages.

Advantages:

- The MoSCoW technique takes expert opinion/s into account (Kukhnavets, 2016), which is the case in this study as an expert review was conducted.
- This technique is relatively quick and easy (Kukhnavets, 2016) which benefited this study as it enabled the researcher to take the results of the many skills into account fairly quickly.
- This technique is good for work-in-progress tasks, as is the case in this study (Kukhnavets, 2016). This study aims to provide a framework that will prioritise skills, which can be further used by other researchers, or TPD developers, thus enabling them to rebuild or re-prioritise for that particular timeframe.
- This technique enables one to take into account what a person wants (Madsen, 2017). It therefore enables the researcher to understand what the educators feel about each mobile digital literacy skill.

The major drawback of the MoSCoW technique is that it is subjective in nature, thus not entirely free from bias. In most cases, there is no evident rationale of ranking the components (Madsen, 2017). The researcher will consequently assess the skills against the results and draw conclusions thereof.

The MoSCoW method will assist in prioritising the mobile digital literacy skills for the framework. By prioritising the skills, users of the framework will be able to focus their efforts and energies on the most needed skills (Kukhnavets, 2016). TPD courses can focus on specific crucial skills, for the available training time (Pandey, 2011), thus dividing resources and time between the *must*, *could* and *should* categories.

Based on the numerical values attained in Step 2, the researcher will convert the information to a MoSCoW scale, based on the criteria presented in Table 7-1.

Table 7-1: Researcher's understanding and analysis of the different ratings.

The MoSCoW scale	The MoSCoW Rule
Must have	These set of skills will have an average rating of 4
Should have	These skills could range between a rating of 3 to 3.9
Could Have	These skills could range between a rating of 2 to 2.9
Nice to have	These skills could range between a rating of 0 to 1.9

Having consigned the skills to the different categories, the outcomes are analysed and presented in a scatter graph (Section 7.13, Figure 7-53) that will assist in tabulating the *final framework for mobile digital literacy skills for an educator using mobile technology in rural formal education* (Section 7.13, Table 7-43).

The findings are presented in two parts as reflected by the two units of analysis:

- the expert as the designer and facilitator of the TPD program (see Figure 7.1), and
- the teacher as the recipient of the TPD (see Figure 7.1).

Part A will analyse the findings from the experts' perspective, whereas,

Part B will analyse the findings from the educators' perspective.

7.3 PART A: UNIT OF ANALYSIS: EXPERTS

A Theoretical framework for educators' mobile digital literacy skills was developed through a critical review of the literature which, in turn, led to identification of various mobile digital literacy skills for educators in the rural formal education domain (Chapters 3, 4 and 5). Consequently, the framework was submitted to four experts (biographical details in Table 6-10). These individuals participated in the ICT4RED as facilitators and designers of a Teacher Professional Development course, and thus have experience in designing, evaluating and implementing mobile technology in the rural educational setting.

This will be presented as follows:

- Technical Dimension (Section 7.4)
- Social-Emotional Dimension (Section 7.5)
- Cognitive Dimension (Section 7.6)
- Other dimensions (Section 7.7)

7.4 TECHNICAL DIMENSION

The technical dimension consists of operational literacy as indicated in Figure 7-4. This will be discussed and then a summary will be provided.

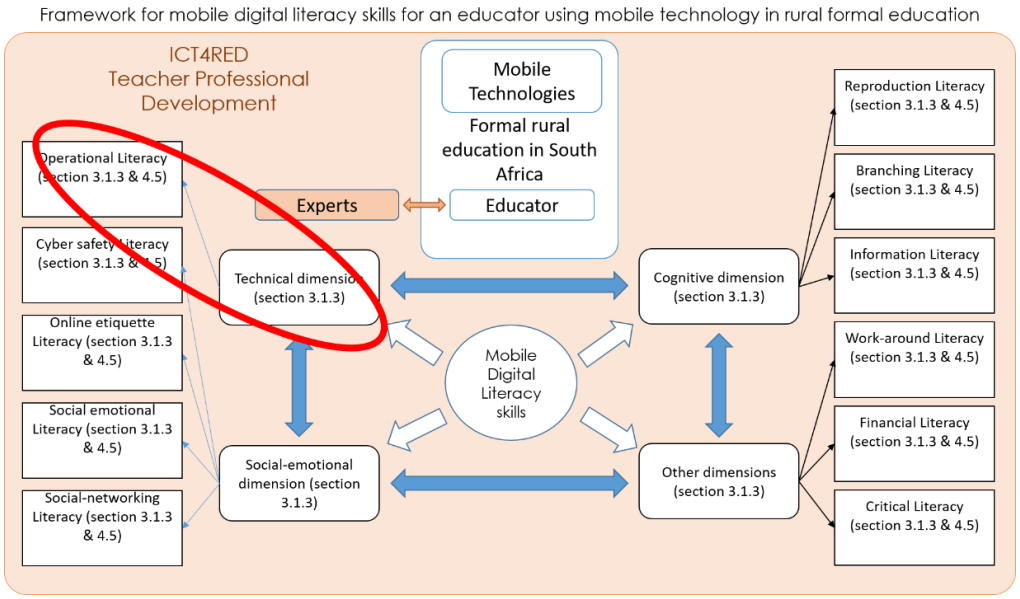


Figure 7-4: Findings of the highlighted section - the technical dimension (experts).

The following categories are presented and analysed:

- Operational Literacy (Section 7.4.1)
- Operational Literacy summary (Section 7.4.1.1)
- Technical dimension summary (Section 7.4.2)

7.4.1 **Operational Literacy**

This section will look into the operational literacy category of skills for the technical dimension, as highlighted in Figure 7-4.

Table 7-2 indicates the results of expert reviews for the operational literacy category of skills of the technical dimension.

Table 7-2: Findings from the expert review of operational literacy, technical dimension.

Category of the technical dimension: Operational literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Very important	Moderately important	Slightly important	Not important
Getting started with a mobile device (GS)	(GS-1) Mobile device operation	The educator should know how to operate multiple devices including his/her own in the classroom.	2 (3, 4)	2 (1, 2)		
	(GS-2) Charge multiple devices	The educator should be able to charge the many devices.	4 (1, 2, 3 ,4)			
	(GS-3) Support subject material	The educator should use technology in the classroom to support subject specific content.	2 (2, 3)	2 (1, 4)		
	(GS-4) Encourage mobile technologies	The educator should work electronically with the aim of going paperless in the classroom.	1 (3)	2 (2, 4)	1 (1)	
	(GS-5) Maintain common settings across devices	The educator should be able to maintain uniformity across all devices by creating a standard practice to facilitate efficient learning.	2 (2, 3)	1 (1)		1 (4)
	(GS-6) Connect device to Wi-Fi	The educator should be able to connect a device to a Wi-Fi network.	2 (3, 4)	1 (1)	1 (2)	
	(GS-7) Data usage and financial cost	The educator should understand the usage of data and the financial implications associated to the data service providers.	4 (1, 2, 3, 4)			
	(GS-8) Use Bluetooth in class for file sharing	The educator should be able to use Bluetooth in the classroom for data sharing and communication.	2 (3, 4)	1 (1)	1 (2)	
	(GS-9) Connect to peripheral devices in class	The educator must be able to connect input and peripheral devices to facilitate teaching e.g. a projector.	3 (2, 3, 4)	1 (1)		
	(GS-10) Basic problem solving through troubleshoot guide	The educator should access and use the troubleshooting guide on a device for basic problem solving.	1 (4)	3 (1, 2, 3)		
	(GS-11) Use mobile device affordances to enhance learning	The educator should know the affordances of a mobile device for learning and teaching, with the aim of digitising an activity to add value.	2 (3, 4)	1 (1)	1 (2)	

Category of the technical dimension: Operational literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Very important	Moderately important	Slightly important	Not important
	(GS-12) Understand device specifications	The educator should know devices' capabilities and specifications for devices that are available in rural areas, thus maximising their use in the classroom.	2 (1, 4)	2 (2, 3)		
Using basic functionalities on a mobile device to organise one's life (BF)	(BF-1) Use time management apps in planning	The educator should use time management apps for productivity and planning of school activities.	2 (2, 4)	2 (1, 3)		
	(BF-2) Create worksheets	The educator should be able to create worksheets.	3 (1, 3, 4)	1 (2)		
	(BF-3) Use device to record data	The educator should know how to record data using appropriate affordances.	2 (3, 4)	1 (2)	1 (1)	
Adaptability (AD)	(AD-1) Create videos	The educator should be able to create content, for example, low cost videos in the local language to facilitate better learning.	1 (4)	2 (1, 3)	1 (2)	
	(AD-2) Scan textbooks	An educator should be able to scan textbooks to create e-books for learners as rural areas lack textbooks.	2 (3, 4)	1 (2)	1 (1)	
	(AD-3) Enable transition to mobile devices for learners	An educator should be able to assist learners in the transition to mobile devices as some learners may be using a mobile device for the first time.	3 (2, 3, 4)	1 (1)		
	(AD-4) Educate learners for device functionality to adapt to rural areas	An educator should be able to teach learners the many benefits a mobile device has to offer therefore making up for what rural areas are lacking e.g. library, computer labs for research, using as a dictionary.	3 (2, 3, 4)			1 (1)
	(AD-5) Enable shared computing	An educator should be able to manage lack of sufficient devices due to learners not being able to afford a device, or school not being able to facilitate a device for each learner by having knowledge of shared computing facilities to overcome challenge posed by lack of one device per learner.	1 (3)	2 (2, 4)		1 (1)
	(AD-6) Enable device sharing amongst learners	The educator should be able to plan proficiently how learners will share devices efficiently.	2 (2, 3)	1 (4)		1 (1)

Category of the technical dimension: Operational literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Very important	Moderately important	Slightly important	Not important
	(AD-7) Charge devices always	The educator should be able to work around power shortage issues by charging devices on time and in designated areas.	1 (4)	2 (2, 3)		1 (1)
	(AD-8) Use different power supplies	The educator should know how to use the different back up power supplies e.g. power bank, UPS, generator and solar powered classrooms.	1 (4)		2 (1, 2)	
	(AD-9) Save content for offline use	The educator should be able to save content for offline use in case the educator does not have connectivity in the class.	2 (1.4)	2 (2, 3)		
	(AD-10) Use cache memory	The educator should know how to use caching and distribution of digital content. Thus, enabling off-line access to vast online educational content.	3 (1, 2, 3)	1 (4)		
	(AD-11) Access digital textbooks	The educator should be able to access digital books to share amongst learners.	4 (1, 2, 3, 4)			
	(AD-12) Encourage file sharing via Bluetooth	The educator should encourage file sharing and transfer using Bluetooth when there is no connectivity.	3 (2, 3, 4)			1 (1)
	(AD-13) Use online tutorials	If there is a lack of training facilitates in rural areas, educators should know how to obtain online training and tutorials to adapt to mobile technology in the class.	3 (1, 3, 4)	1 (2)		
Navigation- use of fingers to navigate	(NV-1) Use of touch screens and navigating between screens	The educator should understand how touch screens operate and navigate between screens whilst teaching.	4 (1, 2, 3, 4)			
	(NV-2) Multi task on device whilst teaching	The educator should know how to multitask whilst teaching e.g. cross-referencing, making notes, searching information etc.	2 (2, 3)		1 (1)	1 (1)
	(NV-3) Navigate between educator and learner device	The educator should be able to navigate between his/her device and the learners' whilst addressing the classroom.		1 (1)	3 (2, 3, 4)	
Application management	(AM-1) Use different phone interfaces	The educator should know how to use the different user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.	4 (1, 2, 3, 4)			

Category of the technical dimension: Operational literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Very important	Moderately important	Slightly important	Not important
	(AM-2) Disable automatic app updates	The educator should know how to disable automatic updates of applications to avoid increased data charges.	3 (1, 2, 3)	1 (4)		
	(AM-3) Use educational games in class	The educator should know how to use educational games and apps that support learning in the classroom.	4 (1, 2, 3, 4)			
	(AM-4) Use subject specific applications	The educator should know how to use appropriate applications, specific to their subjects e.g. a geography teacher should be able to use a maps application.	4 (1, 2, 3, 4)			
	(AM-5) Use online quizzes and electronic polls	The educator should be able to use digital assessment tools like online quiz and real time survey through electronic polls.		1 (1)		3 (2, 3, 4)
Securing one's device and its contents	(SO-1) Educate learners on device safe-keeping	The educator should educate learners on safe keeping of devices by setting an example.	4 (1, 2, 3, 4)			
	(SO-2) Deal with power surges	The educator should avoid damages caused by power surges due to sporadic electricity supply.	4 (1, 2, 3, 4)			
	(SO-3) Lock away devices for safety	The educator should lock away devices after use.	4 (1, 2, 3, 4)			

The Likert values for Table 7- 2 are presented in a diverging stacked bar chart in Figure 7-5.

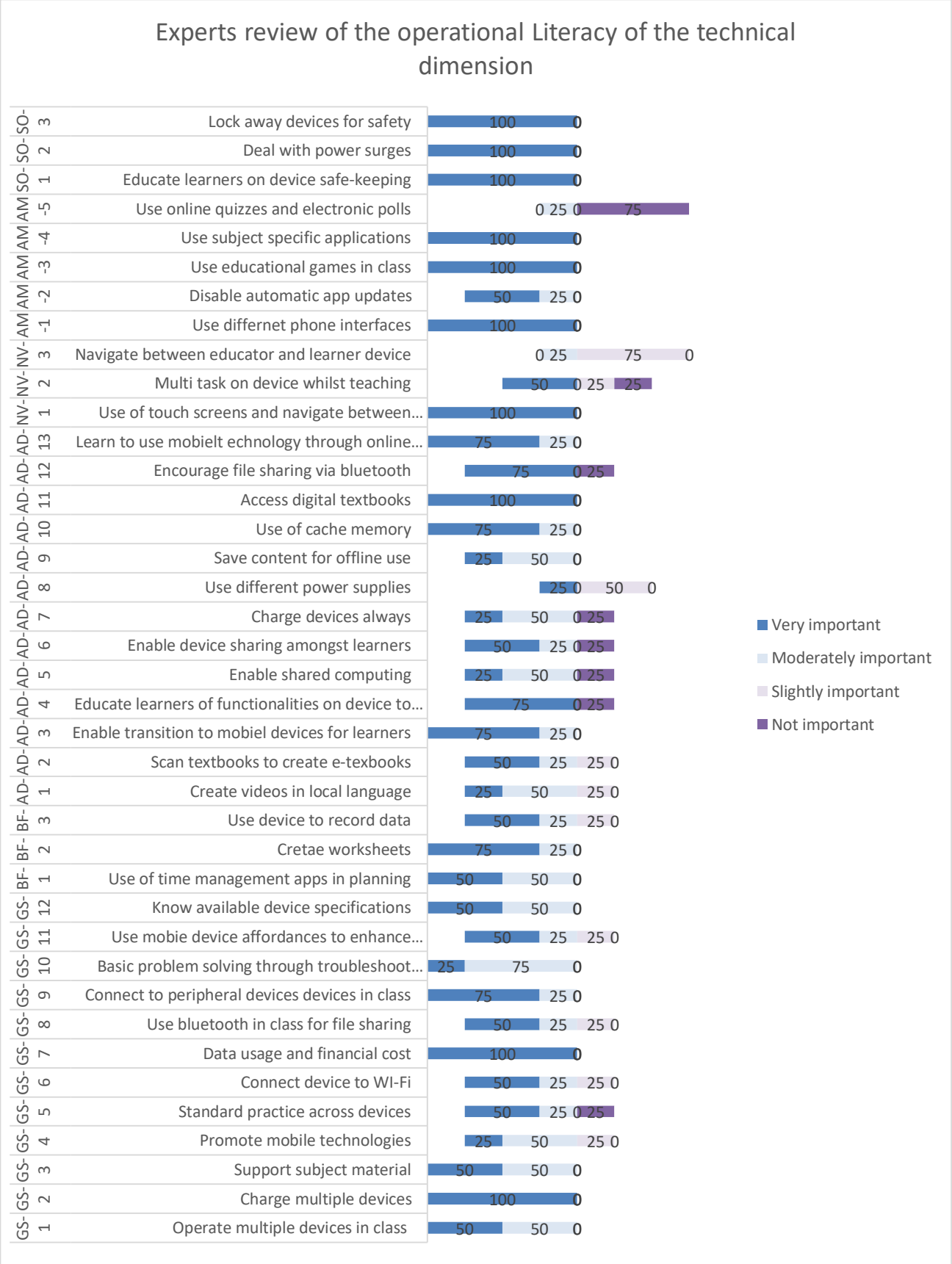


Figure 7-5:Diverging bar chart with Likert scale values for operational literacy.

The Likert scale data were converted to a numerical value using a point system. The numerical values assigned were as follow:

- Very important = 4 points
- Moderately important = 3 points
- Slightly important = 2 points
- Not important = 1 point

Figure 7-6 indicates an example of how the average agreement value is calculated.

Skill GS-1 – Operating multiple devices in a classroom, the ratings were
2 very important * 4 points = 8
2 moderately important * 3 points = 6
0 slightly important * 2 points = 0
0 not important * 1 point = 0
14 points / 4 experts that answered the questionnaire =
3.5 average for Skill GS-1.

Figure 7-6: Average agreement value calculation for experts.

Figure 7-6 above, is the method applied to all the skills.

Table 7-3 indicates the average agreement value for the operational literacy category of skills.

Table 7-3: Average agreement value for operational literacy (experts).

Category of the technical dimension: Operational literacy		
Skills	**Skill number and brief description**	**Average agreement value** *(n=4)*
Getting started with a mobile device (GS)	(GS-1) Mobile device operation	3,5
	(GS-2) Charge multiple devices	4
	(GS-3) Support subject material	3,5
	(GS-4) Encourage mobile technologies	3
	(GS-5) Maintain common settings across devices	3
	(GS-6) Connect device to Wi-Fi	3,25
	(GS-7) Data usage and financial cost	4
	(GS-8) Use Bluetooth in class for file sharing	3,25
	(GS-9) Connect to peripheral devices in class	3,75
	(GS-10) Basic problem solving troubleshoot guide	3,25
	(GS-11) Use mobile device affordances to enhance learning	3,25
	(GS-12) Understand device specifications	3,5
Using basic functionalities on a mobile device to organise one's life (BF)	(BF-1) Use time management apps in planning	3,5
	(BF-2) Create worksheets	3,75
	(BF-3) Use device to record data	3,25
Adaptability (AD)	(AD-1) Create videos	3
	(AD-2) Scan textbooks	3,25
	(AD-3) Enable transition to mobile devices for learners	3,75
	(AD-4) Educate learners regarding device functionality to adapt to rural areas	3,25
	(AD-5) Enable shared computing	2,75
	(AD-6) Enable device sharing amongst learners	3
	(AD-7) Charge devices always	2,75
	(AD-8) Use different power supplies	2
	(AD-9) Save content for offline use	2,5
	(AD-10) Use cache memory	3,75
	(AD-11) Access digital textbooks	4
	(AD-12) Encourage file sharing via Bluetooth	3,25
	(AD-13) Use online tutorials	3,75
Navigation - use of fingers to navigate (NV)	(NV-1) Use of touch screens and navigate between screens	4
	(NV-2) Multi task on device whilst teaching	2,75
	(NV-3) Navigate between educator and learner device	2,25
Application management (AM)	(AM-1) Use different phone interfaces	4
	(AM-2) Disable automatic app updates	2,75
	(AM-3) Use educational games in class	4
	(AM-4) Use subject specific applications	4
	(AM-5) Use online quizzes and electronic polls	1,5
Securing one's device and its contents (SO)	(SO-1) Educate learners on device safe-keeping	4
	(SO-2) Deal with power surges	4
	(SO-3) Lock away devices for safety	4

The average agreement value per skill for the operational literacy category of the technical skill dimension from Table 7-3 is presented in Figure 7-7.

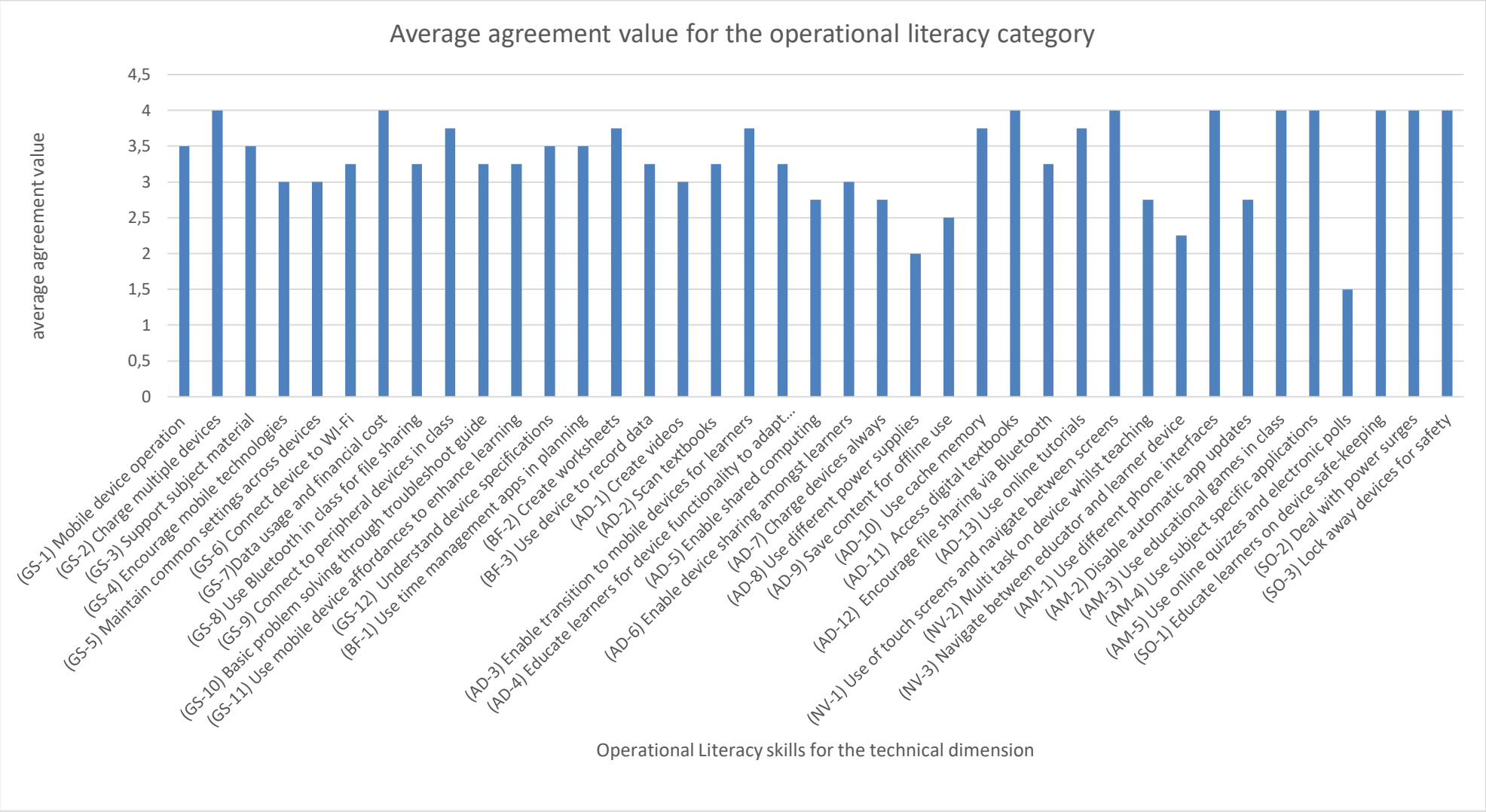


Figure 7-7: Average agreement value bar graph for operational literacy (experts).

7.4.1.1 Operational literacy summary

Operational literacy is meant to equip an educator with the technical functionality and know-how of daily using a technological device (Ng, 2012) in the classroom. Figure 7-7 indicates that 10 out of 39 skills had an average agreement rating of four and are thus considered ‘very important’. Only one skill had a rating of less than 2, thus considered a ‘nice to have’ skill. This skill involved using online quizzes and electronic polls. Most experts felt that this skill was least important and Wi-Fi was a bigger issue in rural areas, thus not facilitating the efficient use of online quizzes and electronic polls. Educators’ concerns as to reliable internet connectivity were in agreement with concerns expressed by Jere et al. (2013) and Takavarasha et al. (2018), as mentioned in the literature. Expert reviewer 4 mentioned his/her agreement with skill set SO – securing one’s device and its contents. This skill set consisted of three skills with an average rating of four. Expert reviewer 4 suggested that these skills are vital considering that rural areas are already constrained for resources. Masonta et al. (2017); Tunstall et al. (2003) mention that rural areas do not have any extra funds to deploy for lost, or stolen, devices.

7.4.2 **Technical Dimension summary**

In this dimension, 31 out of the 39 skills were rated as ‘should have’ to ‘must have’ skills as depicted in Figure 7-7. These skills’ average rating is 3 points and above. Experts felt that the skills mentioned as part of the technical dimension were vital and relevant. They stated that such skills can support 21st century learning and enhance the learning experience. This aligns with literature where Nieveen et al. (2018) and Koopman (2014) emphasise the importance of ICT in education for the development of 21st century skills. Expert reviewers 2 and 4 also suggested that educators need sufficient training and guidance throughout the process to facilitate the development of the above mentioned skills. Floricel et al. (2018) mentioned lack of training and support as major challenges for educators whilst implementing technology in the classroom.

7.5 SOCIAL-EMOTIONAL DIMENSION

This category deals with the social-emotional dimension and it consists of four categories, as per Figure 7-8. The outline is presented through the following categories:

- Social-emotional literacy (Section 7.5.1)
- Social-emotional literacy summary (Section 7.5.1.1)
- Social-networking functional literacy (Section 7.5.2)
- Social-networking functional literacy summary (Section 7.5.2.1)
- Online etiquette literacy (Section 7.5.3)
- Online etiquette literacy summary (Section 7.5.3.1)
- Cyber safety literacy (Section 7.5.4)
- Cyber safety literacy summary (Section 7.5.4.1)
- Social-emotional dimension summary (Section 7.5.5)

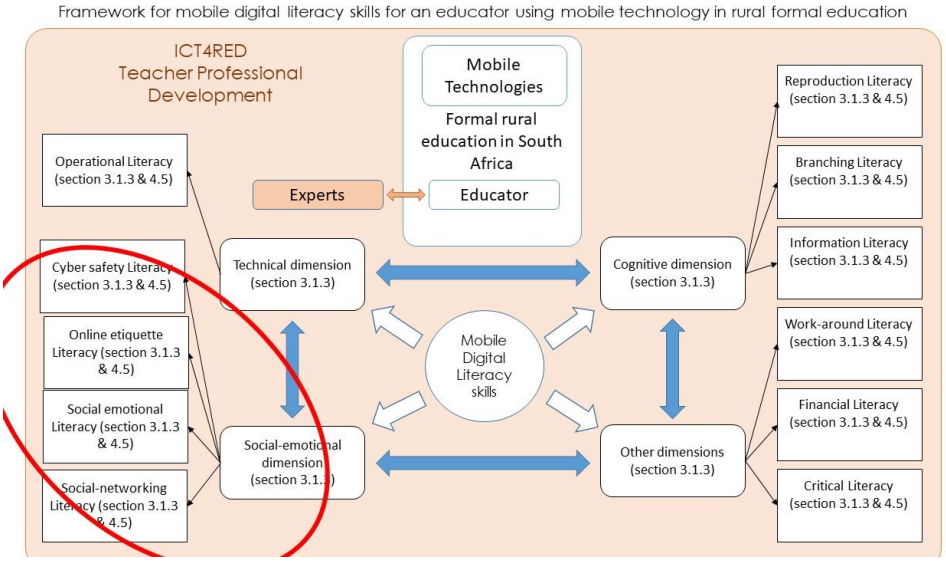


Figure 7-8: Findings of the highlighted section – social-emotional dimension (experts).

7.5.1 Social-emotional literacy

This section consists of the social-emotional literacy skills of the social-emotional dimension.

Table 7-4 depicts the findings of the expert reviews from the social-emotional literacy category of the social-emotional dimension.

Table 7-4: Findings from the expert review of the social-emotional literacy, social-emotional dimension.

Category of the social-emotional dimension: Social-emotional literacy						
Skills	**Skill number and brief description**	**Skills required by a rural educator**	**Importance of each skill**			
			Very important	**Moderately important**	**Slightly important**	**Not important**
Understanding the internet platform (UI)	(UI-1) General understanding of internet	The educator should understand browser elements, search engines, tabs, bookmarks, new window, hyperlinks, hypertexts, browsing history and navigation.	3 (1,2,3)	1 (4)		
	(UI-2) Manage slow connection efficiently	The educator should be able to manage learners on the internet platform to cater for the slow connections.	2 (2, 3)	2 (1, 4)		
	(UI-3) Use online browser and cache memory	The educator should be able to use an online browser on his/her device as well as the cache memory for offline use.	4 (1, 2, 3, 4)			
Use the internet to search information (SI)	(SI-1) Find relevant information	The educator should be able to find relevant information using the internet, especially e-books for rural learners who lack access to textbooks.	4 (1, 2, 3, 4)			
	(SI-2) Share information via web links	The educator should be able to share information from the web by sending links.	3 (2, 3, 4)		1 (1)	

Table 7-4 is illustrated graphically in Figure 7-9.

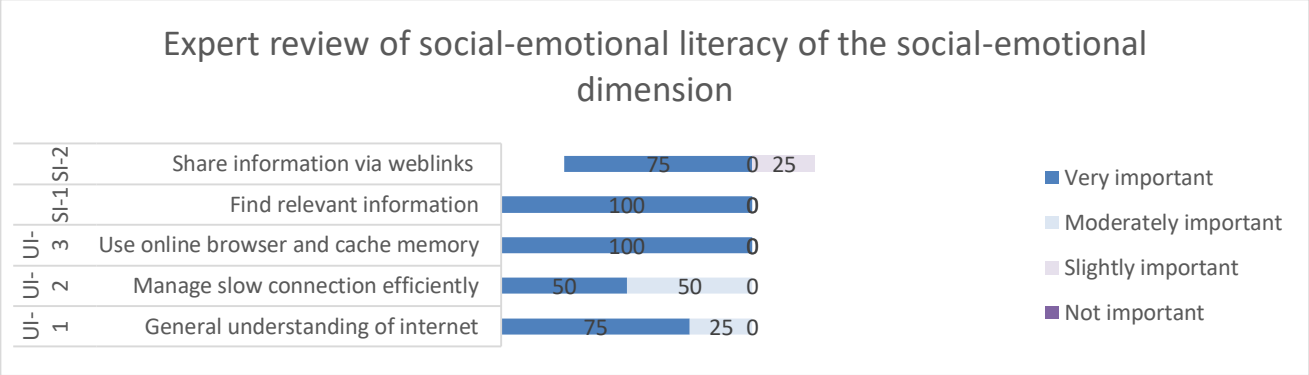


Figure 7-9: Diverging bar chart with Likert scale values for social-emotional literacy.

Table 7-5 depicts the average agreement value for the social-emotional literacy category.

Table 7-5: Average agreement value for social-emotional literacy (experts).

Category of the social-emotional dimension: social-emotional literacy		
Skills	Skill number and brief description	Average agreement value *(n=4)*
Understanding the internet platform (UI)	(UI-1) General understanding of internet	3,75
	(UI-2) Manage slow connection efficiently	3,5
	(UI-3) Use online browser and cache memory	4
Use the internet to search information (SI)	(SI-1) Find relevant information	4
	(SI-2) Share information via web links	3,5

The values from Table 7-5 are presented in a bar graph in Figure 7-10.

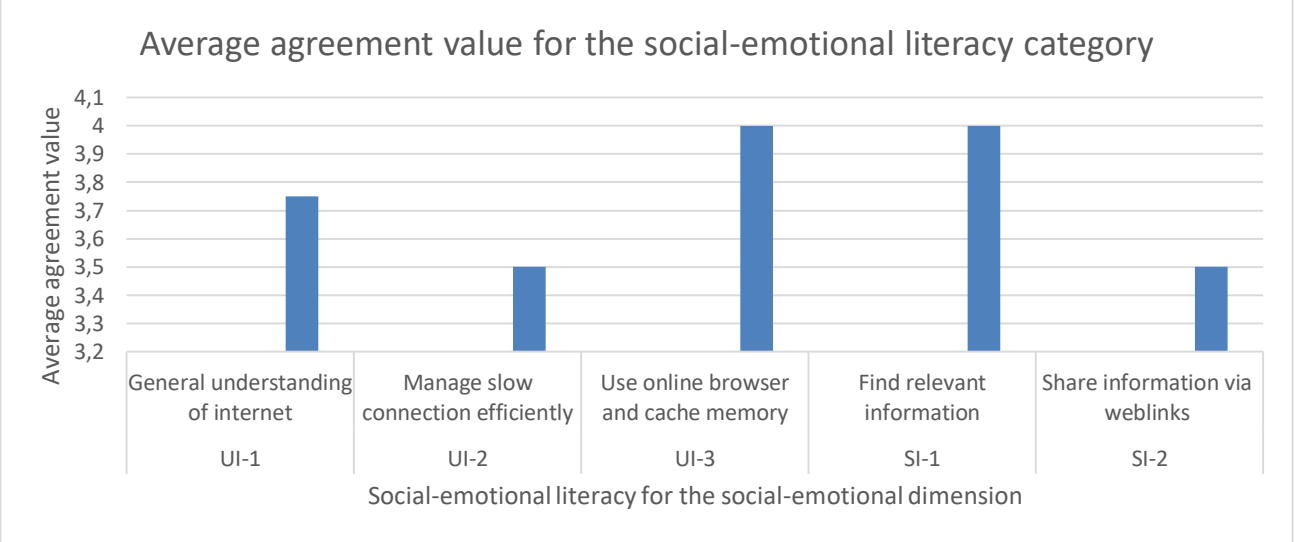


Figure 7-10: Average agreement value bar graph for social-emotional literacy (experts).

7.5.1.1 Social-emotional literacy summary

The social-emotional literacy consisted of skills required to use the internet to search information and understanding and the internet platform in general. Figure 7-10 indicated the average agreement for five skills that formed part of the social-emotional category of skills. The two skills rated as 'must have' skills, scoring 4 points each, was UI-3 (using online browsers and cache memory) and SI-1 (finding relevant information). All five skills had an average agreement rating of 3.5 and above, as represented on the graph in Figure 7-10. This indicates that all five skills were considered important and ranged between 'should have' to 'must have' category. Expert 1 felt that cyber safety should have been listed as a skill in the social-emotional category, but according to the digital literacy model that was adapted for this study, Ng (2012) mentions cyber safety as a separate category due to its significance and importance.

7.5.2 **Social networking functional literacy**

This category of literacy covered the collaboration and communication aspect via social platforms. Table 7-6 summarises experts' opinions regarding these skills.

Table 7-6: Findings from the expert review of the social networking functional literacy, social-emotional dimension.

Category of the social-emotional dimension: social networking functional literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Importance of each skill			
			Very important	Moderately important	Slightly important	Not important
Use of social networks for collaborative learning and teamwork (CT)	(CT-1) Collaborate via social media	The educator should be able to collaborate with colleagues and learners by using social media.	2 (1, 3)	2 (2, 4)		
	(CT-2) Tele-conference with learners and colleagues	The educator should be able to tele-conference with colleagues and learners through skype.	1 (1)	2 (2, 4)	1 (3)	
Being part of online groups (OG)	(OG-1) Create online learning group	The educator should understand different social media available and be able to create an online learning group.	1 (1)	2 (2, 4)	1 (3)	
	(OG-2) Use device as blogging tool	The educator should be able to use a mobile device as a blogging tool.		2 (2, 4)		2(1, 3)
Sharing and storing of information – cloud computing (CC)	(CC-1) Share content	The educator should be able to share content and thoughts with learners and fellow colleagues e.g. drop box.	2 (1, 4)	1 (2)	1 (3)	
	(CC-2) Blogs to create content	The educator should be able to use blogs and wikis to create content online and receive feedback.		2 (2, 4)		2(1,3)
	(CC-3) Use wikis for knowledge generating and feedback	The educator should be able to partake in knowledge generating activities e.g. through wikis and Google Docs.	1 (1)	2 (2, 4)		1 (3)
Using social networks for professional growth and collaboration (SN)	(SN-1) Create digital e-portfolios	The educator should be able to create a digital e-portfolio for professional development e.g. LinkedIn and to use educational networks like EduBlogs, MindMeister and ePals.	1 (1)	2 (2, 4)		1 (3)
Communication (CO)	(CO-1) Communicate through emails	(CO-1) The educator should be able to communicate with learners and colleagues through e-mail, social networks, via phone and text messages.	3 (1, 2, 4)		1 (3)	

Table 7-6 is graphically illustrated in Figure 7-11.

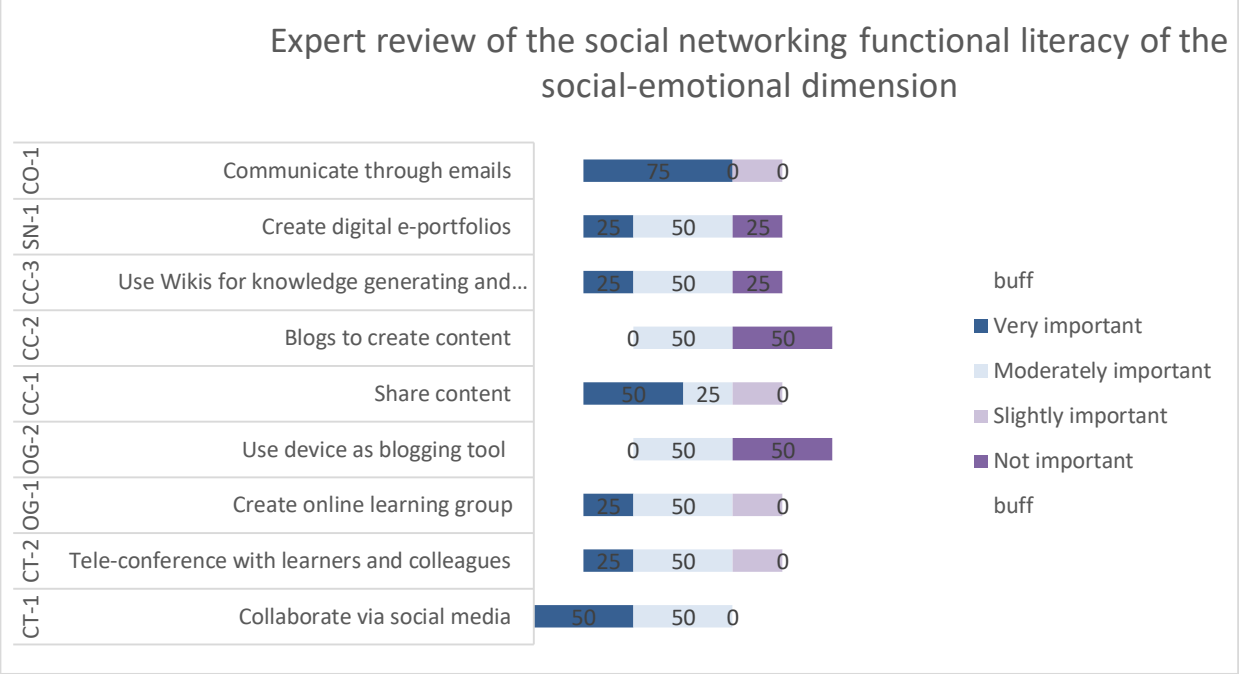


Figure 7-11: Diverging bar chart with Likert scale values for social networking functional literacy.

Average agreement values for social networking functional literacy are listed in Table 7-7.

Table 7-7: Average agreement value for operational literacy (experts).

Category of the social-emotional dimension: social networking functional literacy		
Skills	**Skill number and brief description**	**Average agreement value *(n=4)***
Use of social networks for collaborative learning and teamwork (CT)	(CT-1) Collaborate via social media	3,5
	(CT-2) Tele-conference with learners and colleagues	3
Being part of online groups (OG)	(OG-1) Create online learning group	3
	(OG-2) Use device as blogging tool	2
Sharing and storing of information – cloud computing (CC)	(CC-1) Share content	3,25
	(CC-2) Blogs to create content	2
	(CC-3) Use wikis for knowledge generating and feedback	2,75
Using social networks for professional growth and collaboration (SN)	(SN-1) Create digital e-portfolios	2,75
Communication (CO)	(CO-1) Communicate through emails	3,5

Table 7-7 is graphically represented in Figure 7-12.

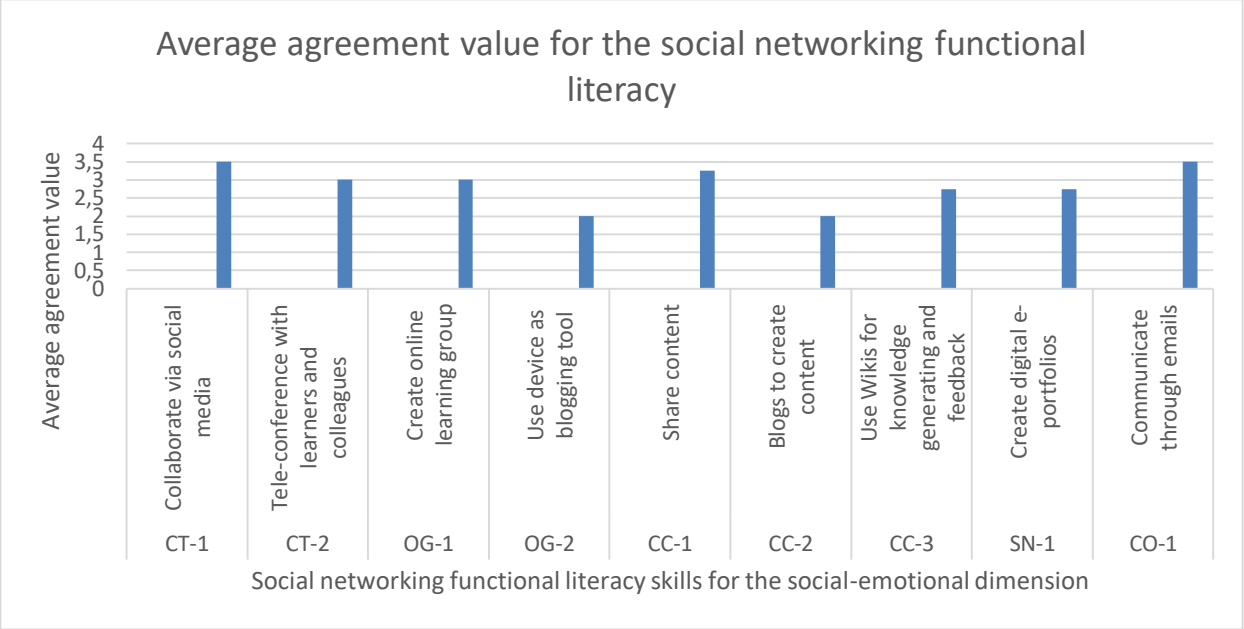


Figure 7-12: Average agreement value bar graph for social networking functional literacy (experts).

7.5.2.1 Social networking functional literacy summary

Figure 7-12 indicates that no skills in this dimension were categorised as 'must have' skills. This could be due to concerns expressed by the experts. Expert reviewer 4 noted the disruptive nature of social media and felt that a good balance needs to be achieved in order to benefit from social media. In literature, distraction was also one of the concerns suggested by Mathevula et al. (2014). Literature was thus in line with what the experts mentioned. The skills with the least average rating, as indicated in Figure 7-13, were OG-2 (use of device as a blogging tool) and CC-2 (blogging to create content). These skills fell in the category of 'could have'. A possible reason for this could be the lack of stable internet connectivity, as mentioned by Expert 4, and supported in literature (Dalvit et al., 2014).

7.5.3 **Online etiquette literacy**

This category of skills referred to one's conduct over the internet. Expert Likert ratings are indicated in Table 7-8.

Table 7-8: Findings from the expert review of the online etiquette literacy, social-emotional dimension.

Category of the social-emotional dimension: online etiquette literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Importance of each skill			
			Very important	Moderately important	Slightly important	Not important
Conduct and demeanour over the internet (CD)	(CD-1) Decent behaviour on the internet	The educator should behave in a decent manner over the internet and avoid vulgarity.	4 (1, 2, 3, 4)			
	(CD-2) Netiquette	The educator should be aware of netiquette.	4 (1, 2, 3, 4)			

Table 7-8 is represented in a diverging stacked bar chart in Figure 7-13.

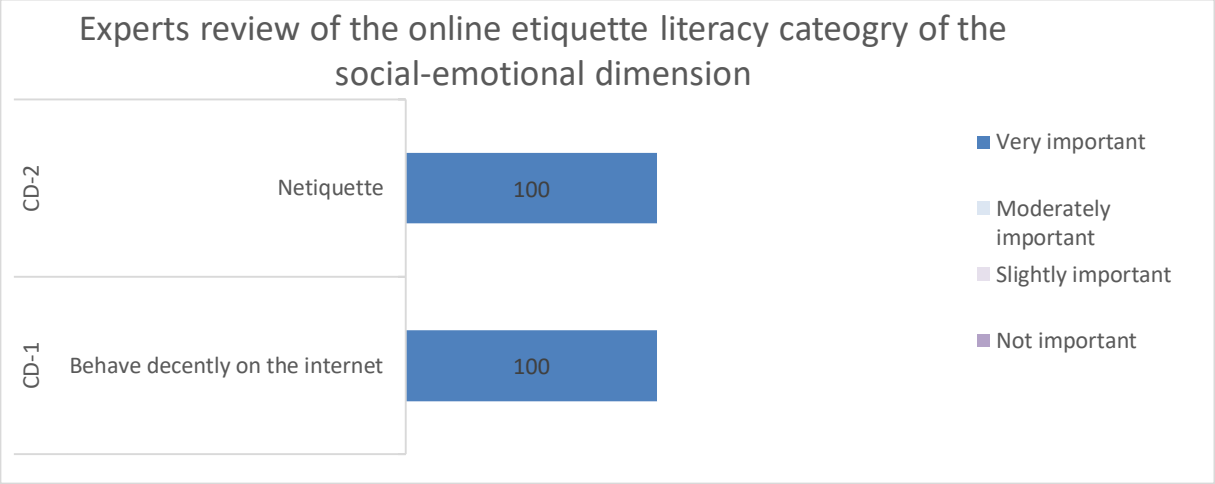


Figure 7-13: Diverging bar chart with Likert scale values for online etiquette literacy.

Table 7-9 represents the average agreement value for each skill.

Table 7-9: Average agreement value for online etiquette literacy (experts).

Skills	Skill number and brief description	Average agreement value *(n=4)*
Conduct and demeanor over the internet (CD)	(CD-1) Decent behaviour on the internet	4
	(CD-2) Netiquette	4

Table 7-9 is sketched into a bar graph in Figure 7-14.

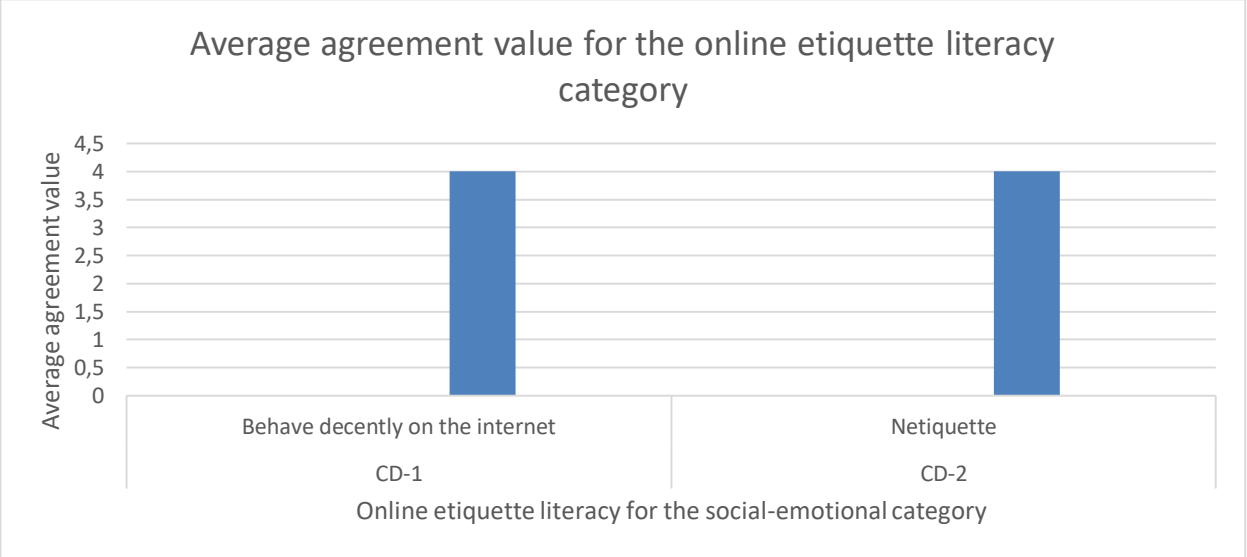


Figure 7-14: Average agreement value bar graph for online etiquette literacy (experts).

7.5.3.1 Online etiquette literacy summary

This category was made up of two skills and both have a 4-point rating as per Figure 7-14. This rating indicates how important these skills are and therefore classified as 'must have' skills. One expert advanced his/her agreement by mentioning the extreme importance of these skills, but only when a stable online environment can be created for educators in rural areas. This high rating is in support of literature as Sherwood (2017) strongly emphasises the skills depicted in Figure 7-14.

7.5.4 **Cyber safety literacy**

These skills dealt with the online safety aspect of using the internet (social-emotional literacy) and social media (social networking functional literacy). The feedback from experts is depicted in Table 7-10.

Table 7-10: Findings from the expert review of the cyber safety literacy, social-emotional dimension.

Category of the social-emotional dimension: cyber safety literacy						
Skills	**Skill number and brief description**	**Skills required by a rural educator**	**Importance of each skill**			
			Very important	**Moderately important**	**Slightly important**	**Not important**
Being safe in the online world (SW)	(SW-1) Beware of what to publish publicly	The educator should be aware of what to publish on social media as this leaves a digital footprint in the online world, therefore private information should not be disclosed.	4 (1, 2, 3, 4)			
	(SW-2) Keep learners safe online	The educator should ensure that learners are safe by educating them on e.g. cyberbullying.	4 (1, 2, 3, 4)			
	(SW-3) Dangers of unsafe networks	The educator should understand the dangers of unsafe networks.	4 (1, 2, 3, 4)			
	(SW-4) Identify online threats	The educator should be able to identify threats and know how to deal with such situations.	4 (1, 2, 3, 4)			
	(SW-5) Avoid copying published work	The educator should avoid copying published work.	4 (1, 2, 3, 4)			
	(SW-6) Legal rights when online	The educator should know about legal rights when using online services.	4 (1, 2, 3, 4)			

Table 7-10 indicated the ratings of the experts for cyber safety skills and these rating are depicted in Figure 7-15.

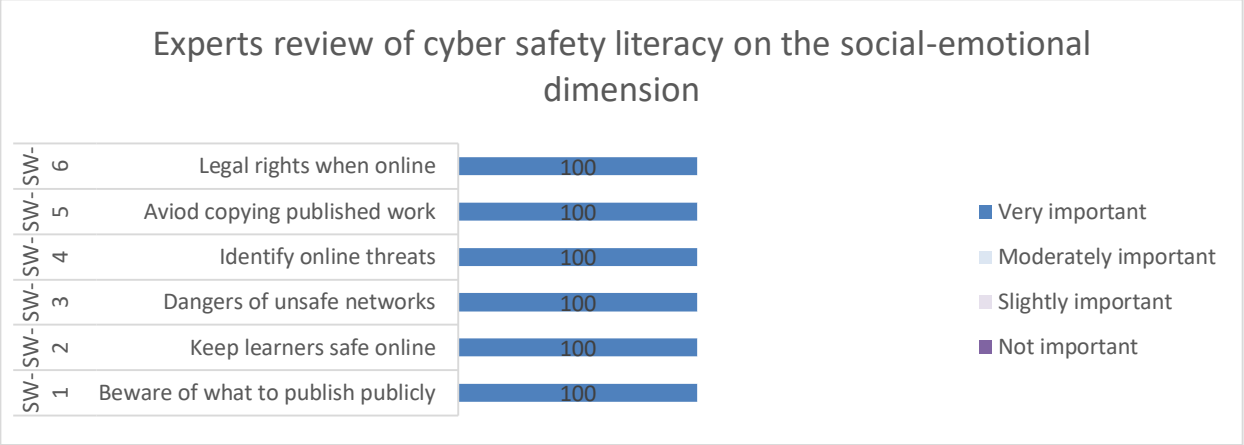


Figure 7-15: Diverging bar chart with Likert scale values for cyber safety literacy.

Table 7-11 indicates the average agreement values for the skills in the cyber safety category.

Table 7-11: Average agreement value for operational literacy (experts).

Category of the social-emotional dimension: cyber safety literacy		
Skills	Skill number and brief description	Average agreement value *(n=4)*
Being safe in the online world (SW)	(SW-1) Beware of what to publish publicly	4
	(SW-2 Keep learners safe online	4
	(SW-3) Dangers of unsafe networks	4
	(SW-4) Identify online threats	4
	(SW-5) Avoid copying published work	4
	(SW-6) Legal rights when online	4

The bar graph in Figure 7-16 indicates the average agreement values in Table 7-11.

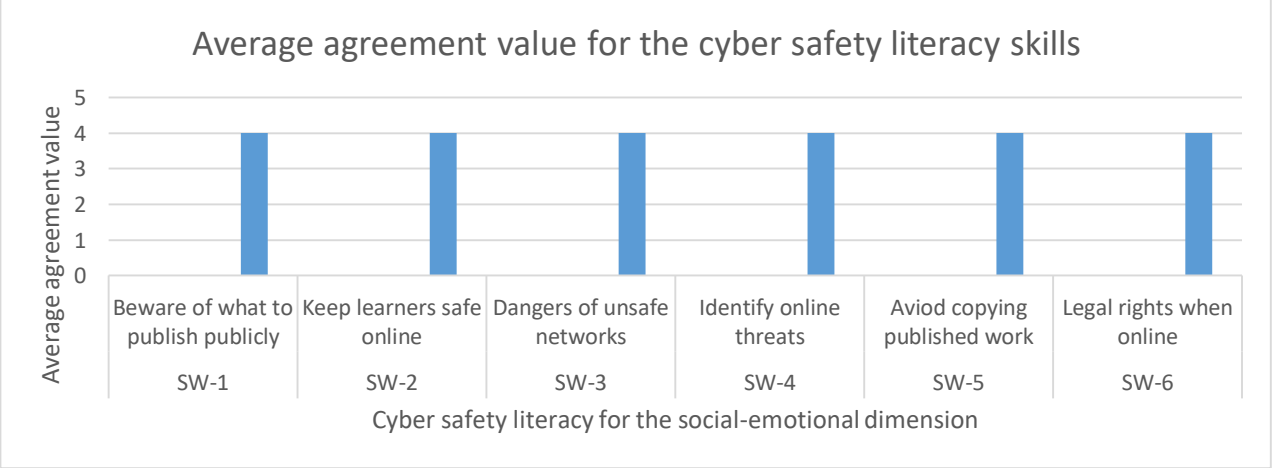


Figure 7-16: Average agreement value bar graph for operational literacy (experts).

7.5.4.1 Cyber safety literacy summary

Figure 7-16 indicated that all the experts found all six skills in the cyber safety category ‘very important’. All the skills had a 4-point value thus falling into the ‘must have’ skill category. These skills are vital as they ensure an educator’s safety in the online world (Kluzer, 2015). The point of safety was further emphasised by Expert 1, as he/she states that with these skills and educator can be protected from online abuse. Cyber safety skills were also classified as ‘very important’ in the digital literacy model. That is the reason that it is mentioned as a separate category (Ng, 2012).

7.5.5 **Social-emotional dimension summary**

This dimension was summarised in four categories. The main concern expressed by Expert reviewer 2 was the lack of stable internet connectivity in rural areas, as mentioned in literature as well (Dalvit et al., 2014). Expert reviewer 2 felt that the above-mentioned skills can only be put into practice once there is stable internet in the rural areas. Internet connection still remains a very big problem, as suggested in literature by Takavarasha et al. (2018). If internet issues could be resolved in rural areas, experts felt that the most crucial of the skills in this dimension fell within the cyber safety (Figure 7-16) and online etiquette category (Figure 7-15). The two skills with the least average agreement value resorted in the social networking functional dimension. These skills are OG-2 (using device as a blogging tool) and CC-2 (using blogs to create content). These both had a 2-point value respectively, thus forming part of the ‘could have’ category of skills.

7.6 COGNITIVE DIMENSION

This dimension dealt with skills which are necessary for critical thinking and the evaluation of information which is digitally available (Ng, 2012). The cognitive dimension is made up of reproduction literacy, branching literacy and information literacy, as illustrated in Figure 7-17.

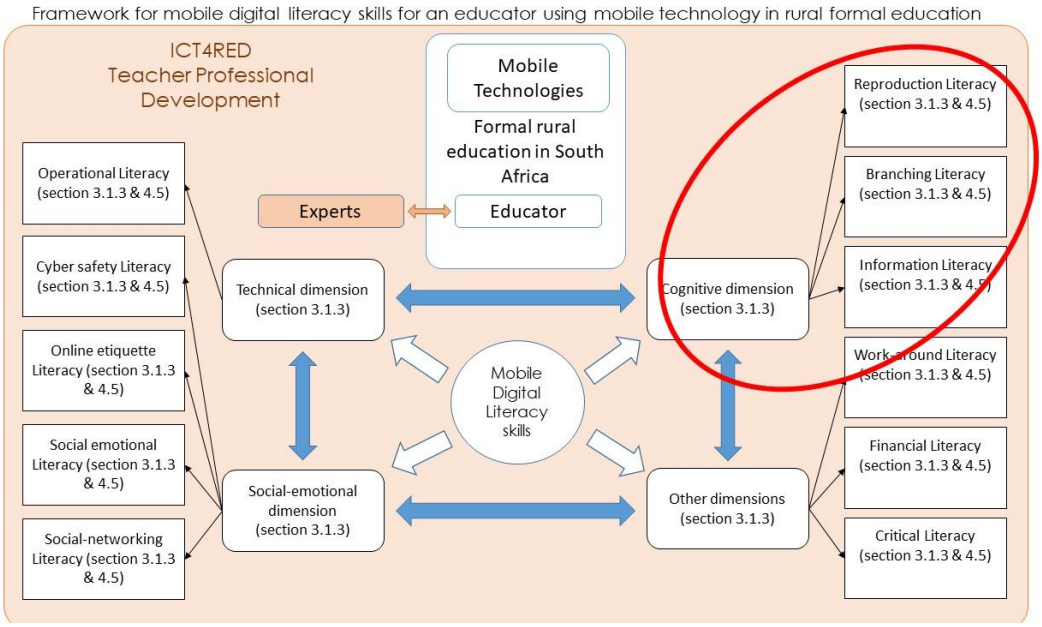


Figure 7-17: Findings of the highlighted section - the cognitive dimension (experts).

This will be presented as follows:

- Reproduction literacy (Section 7.6.1)
- Reproduction literacy summary (Section 7.6.1.1)
- Branching literacy (Section 7.6.2)
- Branching literacy summary (Section 7.6.2.1)
- Information literacy (Section 7.6.3)
- Information literacy summary (Section 7.6.3.1)
- Cognitive dimension summary (Section 7.6.4)

7.6.1 **Reproduction literacy**

Table 7-12 summarises the findings of experts' reviews regarding the reproduction literacy category.

Table 7-12: Findings from the expert reviews of the reproduction literacy, cognitive dimension.

Category of the cognitive dimension: reproduction literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Importance of each skill			
			Very important	Moderately important	Slightly important	Not important
Dealing with graphics, video and animation (GV)	(GV-1) Understanding file formats	The educator should know how to differentiate different file formats by understanding different file formats e.g. audio, video, text.	4 (1, 2, 3, 4)			
	(GV-2) Create a video	The educator should be able to create a YouTube video, a vodcast, or lesson video and online tutorials on their device.	2 (3, 4)	2 (1, 2)		
Content recreation (CR)	(CR-1) Integrate and create information	The educator should be able to integrate information and create meaningful information.	3 (2, 3, 4)	1 (1)		
	(CR-2) Find information in different formats	The educator should be able to find information and experiences across a number of means e.g. through photos, audio, videos, numerical representations and text.	4 (1, 2, 3, 4)			
	(CR-3) Adapt web content for the class	The educator should be able to adapt web content to the classroom.	4 (1, 2, 3, 4)			
Word processing and electronic spreadsheets (WS)	(WS-1) Edit in word processor	The educator should be able to edit in a word processor e.g. by copying and pasting.	3 (1, 2, 3)	1(4)		
	(WS-2) Use Excel and other apps	The educator should be able to use tools, such as Excel, to generate reports with statistical and graphical representation.	3 (1, 3, 4)	1 (2)		

Table 7-12 is represented in Figure 7-18 through a diverging stacked bar chart.

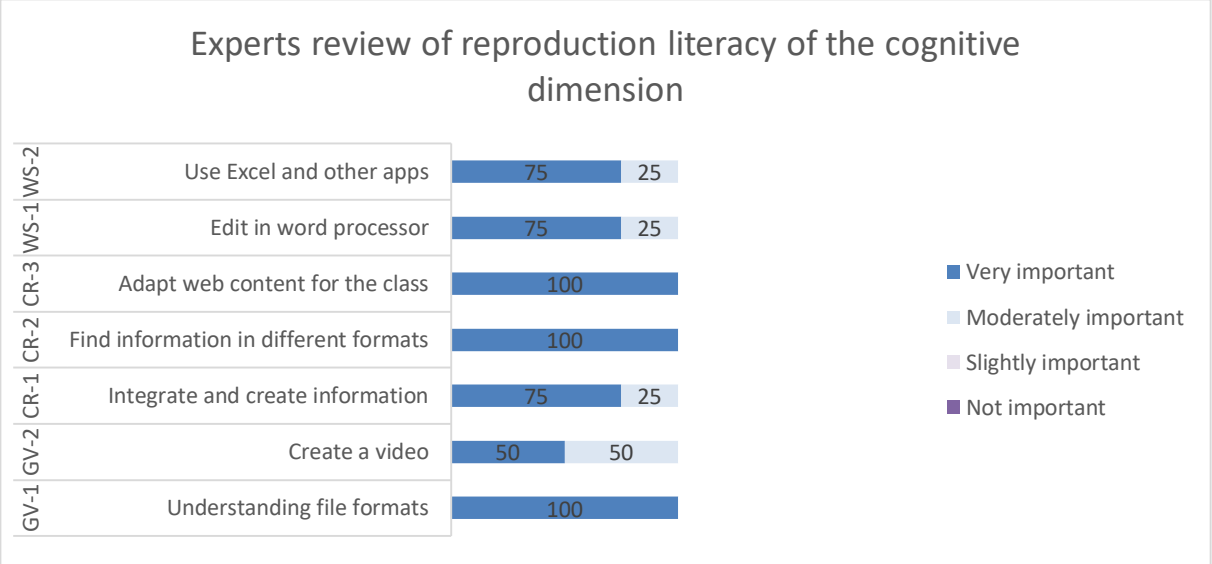


Figure 7-18: Diverging bar chart with Likert scale values for reproduction literacy.

Agreement values were calculated for the skills in Table 7-12 and the results are presented in Table 7-13.

Table 7-13: Average agreement value for reproduction literacy (experts).

Category of the cognitive dimension: reproduction literacy		
Skills	**Skill number and brief description**	**Average agreement value** *(n=4)*
Dealing with graphics, video and animation (GV)	(GV-1) Understanding file formats	4
	(GV-2) Create a video	3.5
Content recreation (CR)	(CR-1) Integrate and create information	3.75
	(CR-2) Find information in different formats	4
	(CR-3) Adapt web content for the class	4
Word processing and electronic spreadsheets (WS)	(WS-1) Edit in word processor	3.75
	(WS-2) Use Excel and other apps	3.75

The average values indicated in Table 7-13 are graphically represented in Figure 7-19.

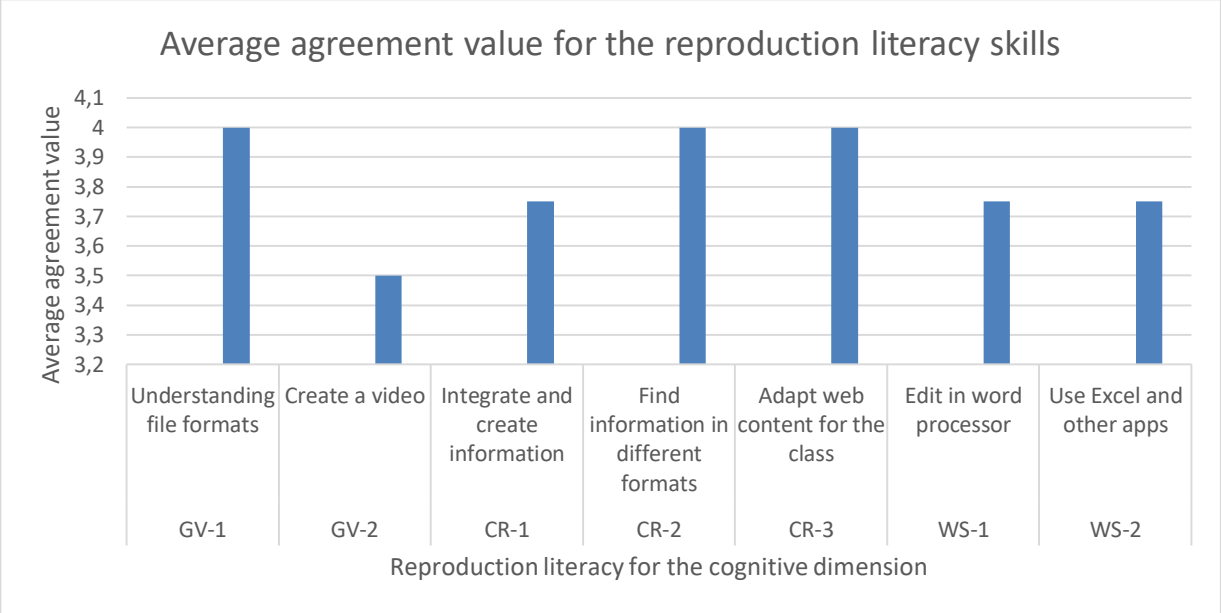


Figure 7-19: Average agreement value bar graph for reproduction literacy (experts).

7.6.1.1 Reproduction literacy summary

Figure 7-19 indicates that three of seven skills were 'most important'. The other four skills have a rating of between 3 and 3.9 points, therefore resorting under the 'should have' category. One expert mentioned that these skills are vital for content production and this importance was highlighted in literature as well by Frank et al. (2017). Another expert suggested that being able to recreate content is a vital skill for an educator whilst imparting knowledge to learners.

7.6.2 **Branching literacy**

Table 7-14 shows the expert ratings on skills needed to collate and understand information from many different sources.

Table 7-14: Findings from the expert reviews of the branching literacy, cognitive dimension.

Category of the cognitive dimension: branching literacy						
Skills	**Skill number and brief description**	**Skills required by a rural educator**	**Importance of each skill**			
			Very important	**Moderately important**	**Slightly important**	**Not important**
Multidimensional skills at sourcing information (MS)	(MS-1) Source answers online	The educator should know how to find an answer to a particular question and seek advice and to also find information sources that leads to other useful information.	3 (2, 3, 4)	1 (1)		
Developing a connection between information (DC)	(DC-1) Synthesise digital resources	The educator should know how to access, manage, integrate, evaluate and synthesise digital resources.	4 (1, 2, 3, 4)			
Having visual and media knowledge (VM)	(VM-1) Assign meaning to images and graphs	The educator should be able to assign a meaning to images and graphics.	4 (1, 2, 3, 4)			
	(VM-2) Express one's self through media	The educator should be able to express themselves through edited photos, videos, sketches, blogs, podcasts and other formats.	2 (2, 3)	2 (1, 4)		
	(VM-3) Listen to music and watch videos	The educator should be able to listen to music and watch videos.	3 (2, 3, 4)			1 (1)
	(VM-4) Understand text, video, audio and maps	The educator should be able to understand information in different forms like in text, video, audio, maps.	3 (2, 3, 4)	1 (1)		
	(VM-5) Understand media expressions	The educator should be able to understand media expressions.	2 (2, 3)	1 (4)		1 (1)
	(VM-6) Capture images	The educator should be able to capture images.	3 (2, 3, 4)			1 (1)

Table 7-14 is displayed graphically in Figure 7-20.

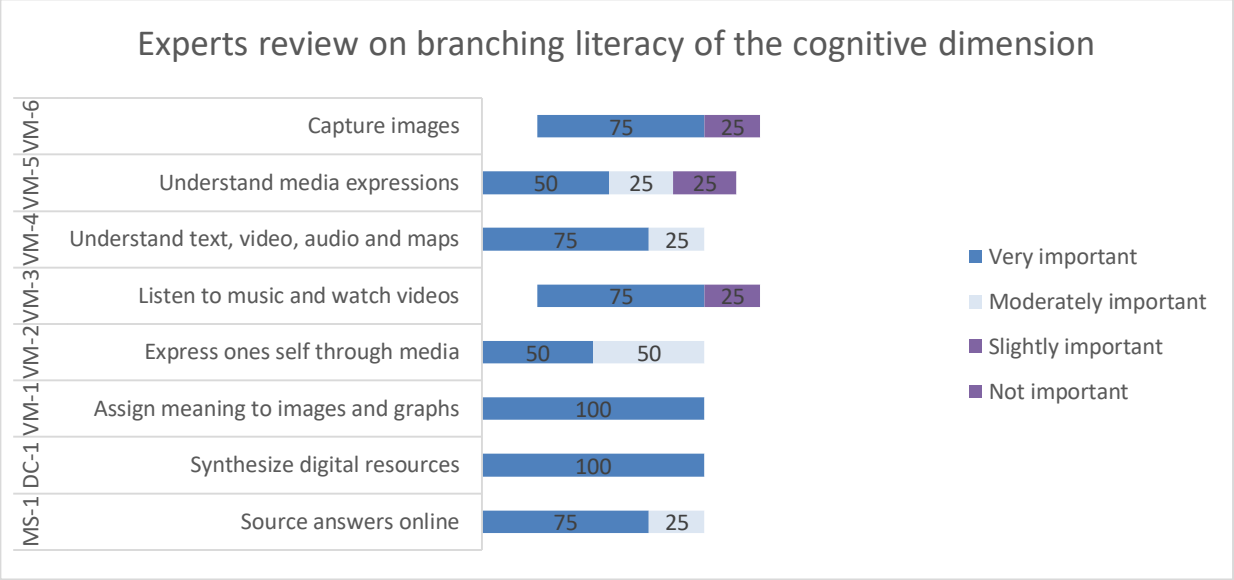


Figure 7-20: Diverging bar chart with Likert scale values for branching literacy.

To further analyse Table 7-14, average agreement values were calculated as per Table 7-15.

Table 7-15: Average agreement value for branching literacy (experts).

Category of the cognitive dimension: branching literacy		
Skills	Skill number and brief description	**Average agreement value *(n=4)***
Multidimensional skills at sourcing information (MS)	(MS-1) Source answers online	3,75
Developing a connection between information (DC)	(DC-1) Synthesise digital resources	4
Having visual and media knowledge (VM)	(VM-1) Assign meaning to images and graphs	4
	(VM-2) Express one's self through media	3,5
	(VM-3) Listen to music and watch videos	3,25
	(VM-4) Understand text, video, audio and maps	3,75
	(VM-5) Understand media expressions	3
	(VM-6) Capture images	3,25

Table 7-15 is further represented in a bar graph as per Figure 7-21.

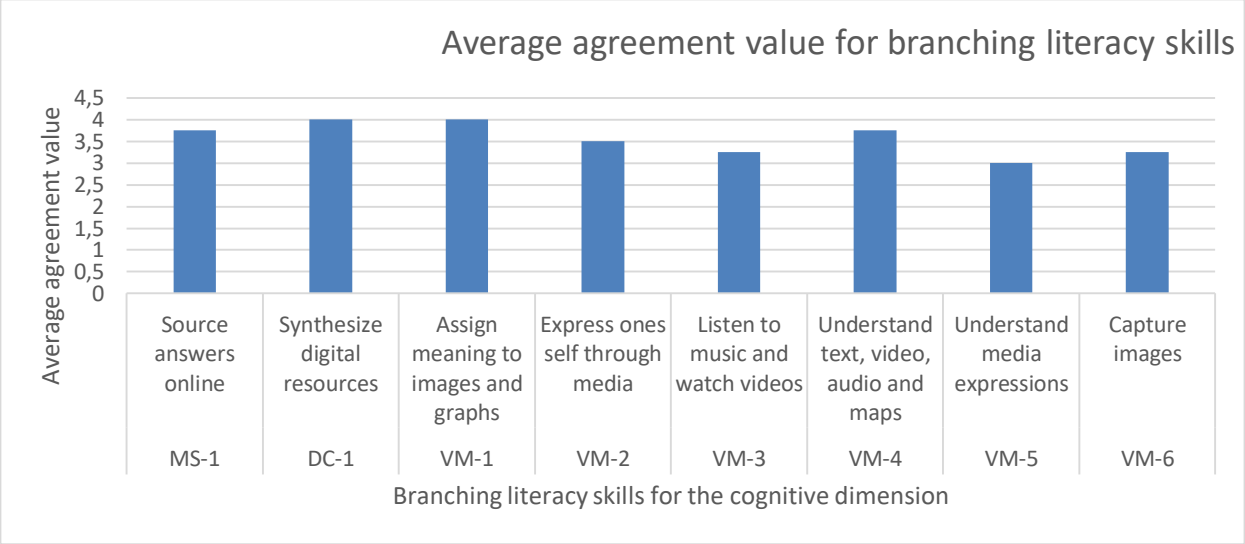


Figure 7-21: Average agreement value bar graph for branching literacy (experts).

7.6.2.1 Branching literacy summary

Figure 7-21 indicates that the two most rated skills were DC-1(synthesise digital resources) and VM-1 (assigning meaning to images and graphs), whilst the skill with the least average agreement rating was VM-5 (understand media expressions) with a rating of 3 points. Expert reviewer 1 mentioned that he/she did not find the relevance of being able to listen to music, videos and capture images in the classroom as significant. This opinion differed from that mentioned in literature by Ng (2012) and Zapata (2018). On the other hand, one expert felt that the above set of skills was very important when being equipped for 21st century learning (Finn-Stevenson, 2018).

7.6.3 **Information literacy**

This section dealt with skills relevant to basic assessing of information and contributing to the knowledge domain. The results for this section are depicted in Table 7-16.

Table 7-16: Findings from the expert review of the information literacy, cognitive dimension.

Category of the cognitive dimension: information literacy						
Skills	**Skill number and brief description**	**Skills required by a rural educator**	**Importance of each skill**			
			Very important	**Moderately important**	**Slightly important**	**Not important**
Background knowledge in acquiring information (BK)	(BK-1) Contribute to knowledge	The educator should be able to contribute, search and construct knowledge.	3 (2, 3, 4)	1 (1)		
Real-time thinking (RT)	(RT-1) Process large amount of information	The educator should be able to process and evaluate large amounts of information at the same time.	3 (2, 3, 4)		1 (1)	
	(RT-2) Assess quality and validity of information	The educator should be able to assess quality and validity and be able to create information through different domains.	3 (1, 2, 4)	1 (3)		
	(RT-3) Access e-publications and e-books	The educator should be able to access e-publications and e-books.	2 (2, 4)	2 (1, 3)		

Figure 7-22 is a graphical representation of the data presented in Table 7-16.

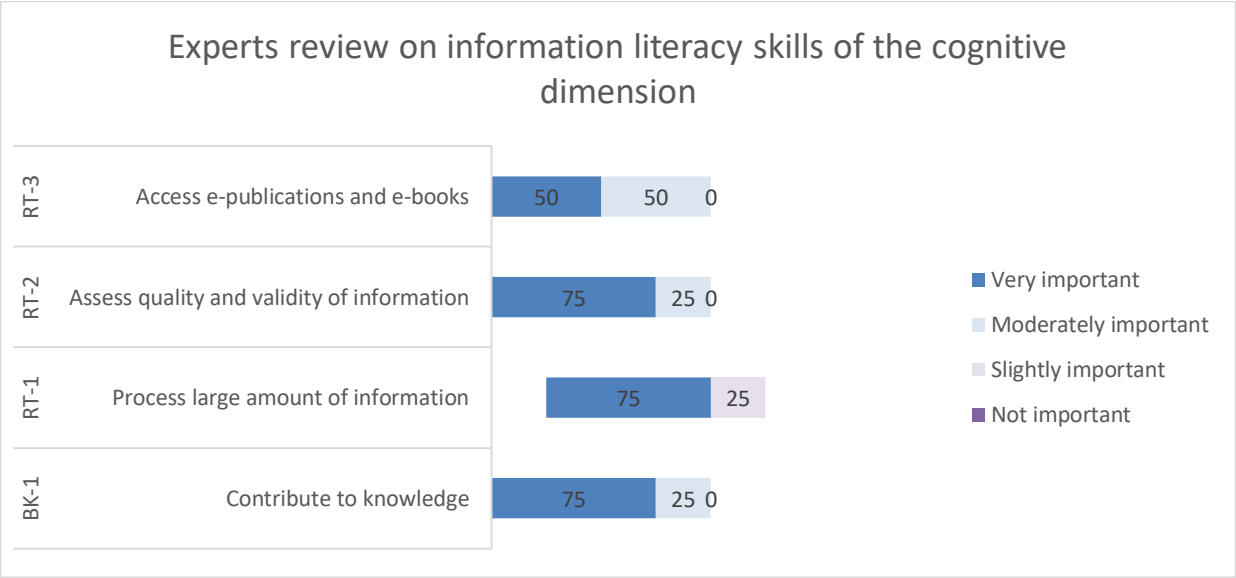


Figure 7-22: Diverging bar chart with Likert scale values for information literacy.

The data in Table 7-16 was assigned values to get an average rating as per Table 7-17.

Table 7-17: Average agreement value for operational literacy (experts).

Category of the cognitive dimension: information literacy		
Skills	Skill number and brief description	Average agreement value (n=4)
Background knowledge in acquiring information (BK)	(BK-1) Contribute to knowledge	3.75
Real-time thinking (RT)	(RT-1) Process large amount of information	3.5
	(RT-2) Assess quality and validity of information	3.75
	(RT-3) Access e-publications and e-books	3.5

The values from Table 7-17 are graphically presented in Figure 7-23.

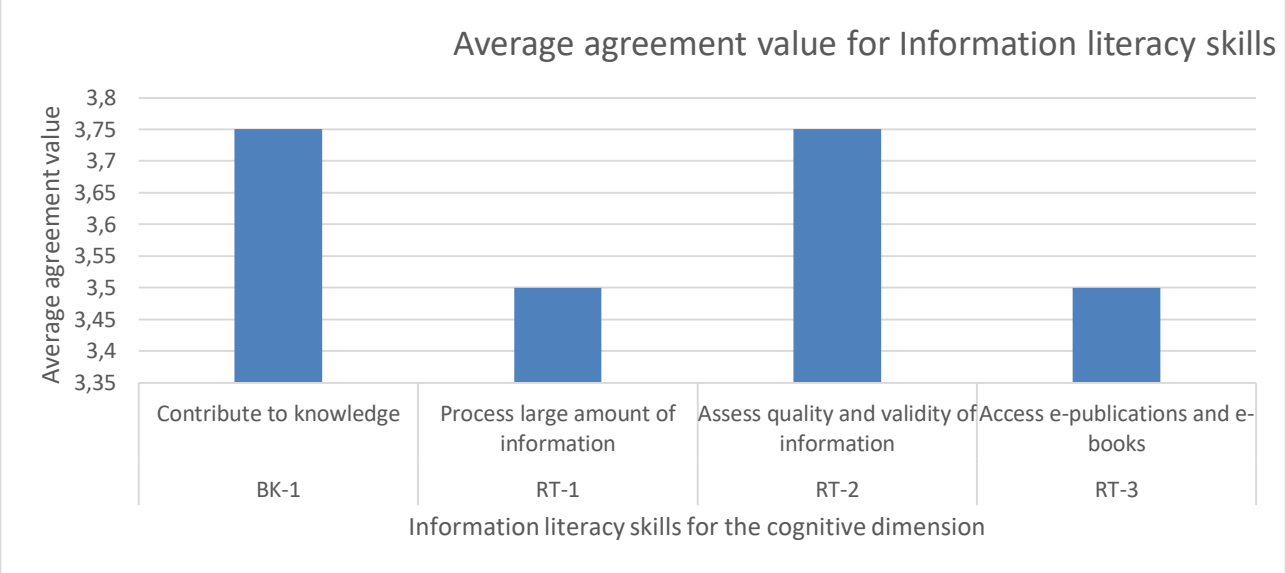


Figure 7-23: Average agreement value bar graph for information literacy (experts).

7.6.3.1 Information literacy summary

Figure 7-23 highlights that none of the four skills were assigned a 4-point rating and thus did not make the 'must have' category of skills. All the skills had a rating of between 3 - 3.9, thus categorisable as 'should have' skills. One of the experts mentioned that such skills are important to have and should be included as part of TPD programmes, such was the case in literature (Mabila et al., 2017).

7.6.4 Cognitive dimension summary

The skills that formed part of this dimension require an educator to be able to use information productively. Experts felt that skills in this dimension were imperative to 21st century learning (Longmore et al., 2018). Educators, by the very nature of their profession, should be able to recreate content for the learners in an understandable and simplified manner. The skill that received the lowest rating was, as per Figure 7-21, skill VM-5 (understanding media expressions). The average agreement value of this skill was 3. Despite having the lowest agreement value, it still fell in the 'should have' category of skills.

7.7 OTHER DIMENSIONS

The last dimension dealt with literacies applicable to all dimensions, as well as other literacies identified in literature, but not part of the digital literacy model adapted for this study (Ng, 2012). This literacy was made up of three categories as per Figure 7-24.

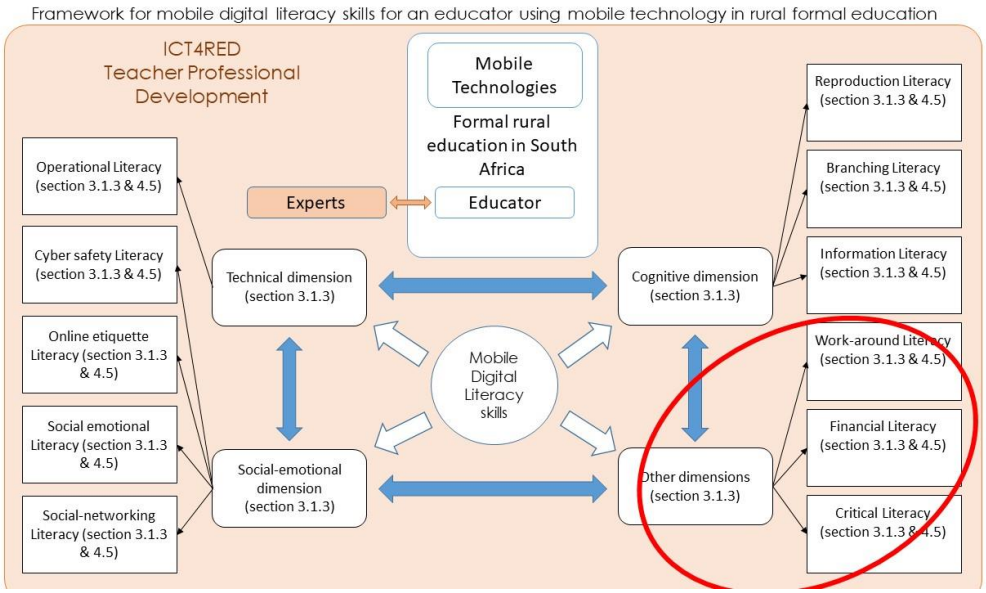


Figure 7-24: Findings of the highlighted section - the other dimensions (experts).

This section is presented as follows:

- Critical literacy (Section 7.7.1)
- Critical literacy summary (Section 7.7.1.1)

- Financial and workaround literacy (Section 7.7.2)
- Financial and workaround literacy (Section 7.7.2.1)

7.7.1 Critical literacy

Table 7-18 indicates the results of the experts' rating for critical literacy.

Table 7-18: Findings from the expert review of the critical literacy, other dimensions.

Category applicable to all dimension: critical literacy						
Skills	**Skill number and brief description**	**Skills required by a rural educator**	**Importance of each skill**			
			Very important	**Moderately important**	**Slightly important**	**Not important**
Being a data critique (DT)	(DT-1) Use information responsibly	The educator should be able to use information responsibly by sourcing information from credible sites and giving credit to respective authors. In addition, the educators should discourage learners from committing plagiarism by copying and pasting.	3 (2, 3, 4)	1 (1)		
	(DT-2) Teach learners to analyse information	The educator should be able to teach learners to analyse information to establish its authenticity, quality, usefulness and bias.	3 (2, 3, 4)	1 (1)		
	(DT-3) Evaluate web content	(DT-3) The educator should be able to evaluate web content for authenticity.	3 (2, 3, 4)	1 (1)		

Table 7-18 is illustrated in a diverging stacked bar graph in Figure 7-25.

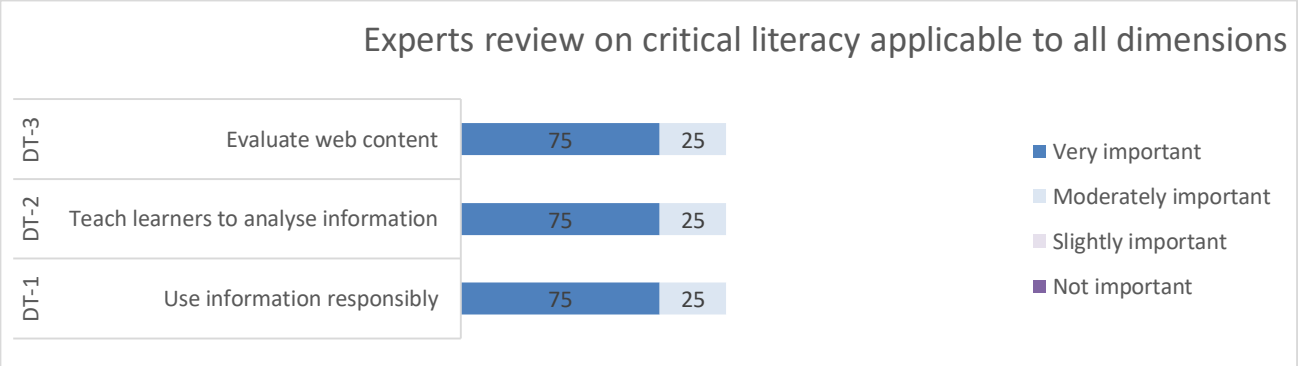


Figure 7-25: Diverging bar chart with Likert scale values for critical literacy.

To add meaning to the data in Table 7-18, average values were calculated and represented in Table 7-19.

Table 7-19: Average agreement value for critical literacy (experts).

Category applicable to all dimension: critical literacy		
Skills	Skill number and brief description	Average agreement value *(n=4)*
Being a data critique (DT)	(DT-1) Use information responsibly	3.75
	(DT-2) Teach learners to analyse information	3.75
	(DT-3) Evaluate web content	3.75

Figure 7-26 is a graphical representation of Table 7-19.

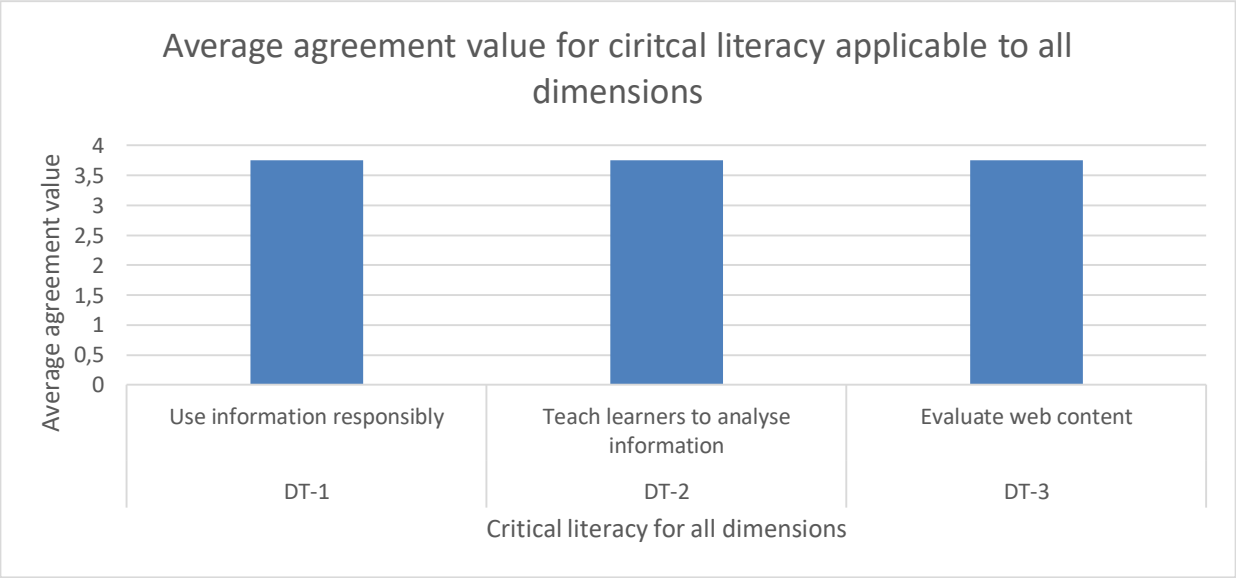


Figure 7-26: Average agreement value bar graph for critical literacy (experts).

7.7.1.1 Critical literacy summary

Figure 7-26 indicates that the three skills in this category had the same ratings of 3.75. These skills form part of the 'should have' category of skills and were all important and relevant as per the feedback of one expert. Another expert expressed his/her agreement with the mentioned skills by affirming the importance of information, especially when one is an educator. These ratings support literature where Ng (2013) mentions the importance of sourcing information from credible sites and Russell et al. (2018) note the importance of authenticating information and using information in an unbiased manner.

7.7.2 **Financial and workaround literacy**

The results for these skills are presented in Table 7-20.

Table 7-20: Expert review findings of the financial and workaround literacy, other dimensions.

Category applicable to all dimension: financial and workaround literacy						
Skills	Skill number and brief description	Skills required by a rural educator	Importance of each skill			
			Very important	Moderately important	Slightly important	Not important
Understanding data cost implications (DI)	(DI-1) Understand data cost	The educator should have an idea as to data costs implications whilst using a device in the classroom.	3 (1, 2, 3)			1 (4)
Adapting to the rural context (AR)	(AR-1) Workaround skills for resource constraints	(AR-1) An educator should have workaround skills to deal with challenges of a rural nature, like lack of electricity.	3 (1, 2, 3)			1 (4)

Table 7-20 is represented in Figure 7-27.

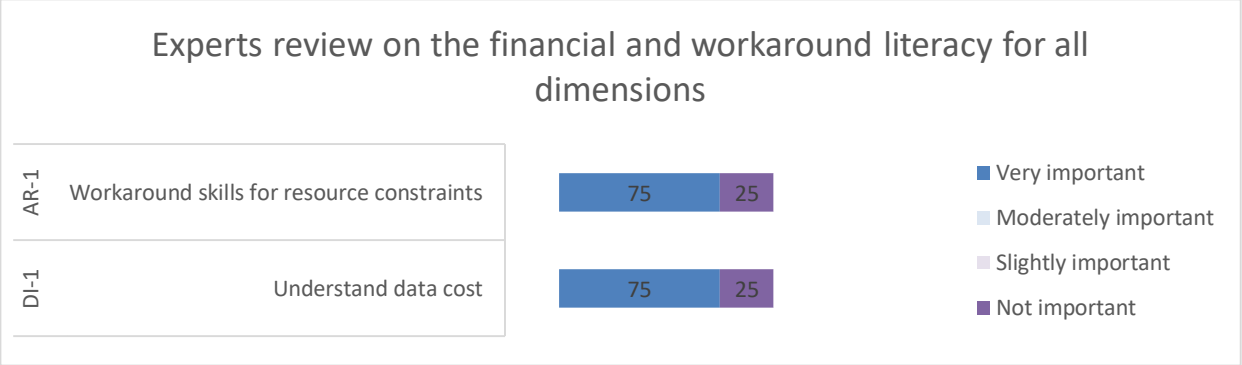


Figure 7-27: Diverging bar chart with Likert scale values for financial and workaround literacy.

Table 7-21 assigns average agreement values to each skill.

Table 7-21: Average agreement value for financial and workaround literacy (experts).

Category applicable to all dimension: financial and workaround literacy		
Skills	Skill number and brief description	Average agreement value *(n=4)*
Understanding data cost implications (DI)	(DI-1) Understand data cost	3.25
Adapting to the rural context (AR)	(AR-1) Workaround skills for resource constraints	3.25

Table 7-21 is indicated graphically in Figure 7-28.

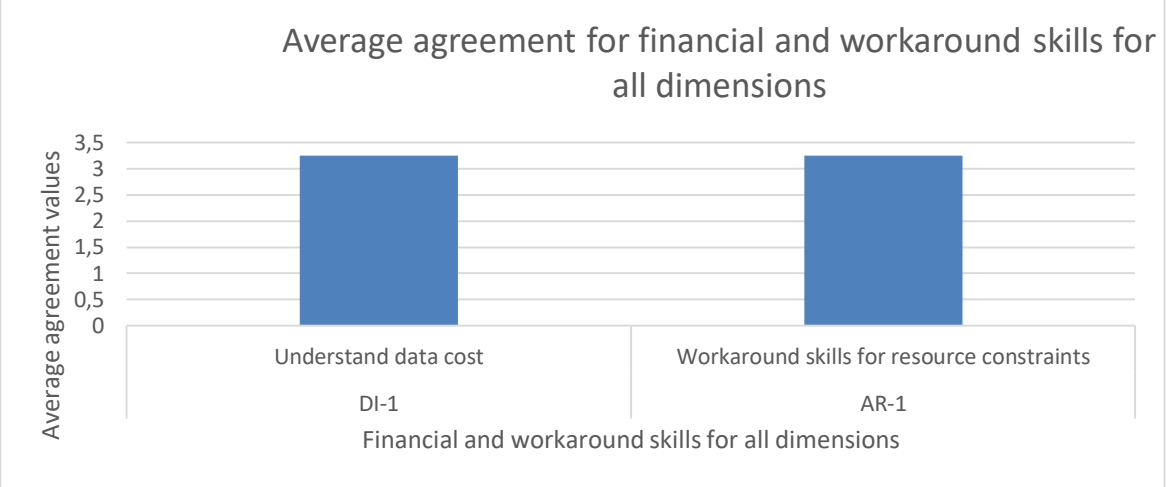


Figure 7-28: Average agreement value bar graph for financial and workaround literacy (experts).

7.7.2.1 Financial and workaround literacy summary

Both skills in this category had ratings of 3.25, as shown in Figure 7-28. One expert said that an educator should not be laden with financial and workaround skills, but these skills should be the responsibility of the school or Department (Zoo, Lee, & Yoon, 2017). Despite the concern, these skills resorted under a 'should have' skill.

7.8 PART B: UNIT OF ANALYSIS: THE EDUCATOR

The questionnaire was piloted with 1 educator and then administered to 20 educators from the ICT4RED project. These educators formed part of the ICT4RED training and were awarded with tablets for classroom use. The questionnaire aimed at exploring the importance of different mobile digital literacy skills for educators using mobile technologies in rural formal education. The questionnaire had two Sections: Section A and Section B. Section A focused on biographical details and Section B explored the different sections of the framework, as perceived by the participants.

This section: Part B is interrogated as follows:

- Section A: Biographical details (Section 7.8.1)
- Section B: Analysis of the Theoretical framework by educators (Section 7.8.2)

7.8.1 Section A: Biographical details

Biographical questions aimed to attain background data on the participants in respect of the following:

- Schooling sector
- Subject being taught
- Gender
- Age
- Use of mobile technology in the classroom
- Expertise level rated from novice to experienced expert

Schooling Sector

Figure 7-29 indicates the schooling sector of the respondents. There were no tertiary educators due to the fact that educators from the ICT4RED project were used and this project aimed mainly at primary and high schools in the Nciba circuit of the Cofimvaba district in the Eastern Cape Province (Botha et al., 2015; Mabila et al., 2017).

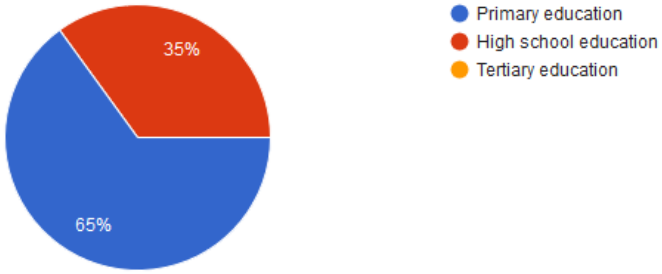


Figure 7-29: Schooling sector of the participants.

Subject taught

Table 7-22 indicates the different subjects taught.

Table 7-22: Subjects taught by educators.

Subject taught	Number of educators
Accounts	2
English	2
Life skills	4
Mathematics	3
Science	3
Technology	2
Xhosa	1

Gender and Age

Five participants were male and fifteen were females. Most of the participants resorted in the age group 31 to 40, as per Figure 7-30.

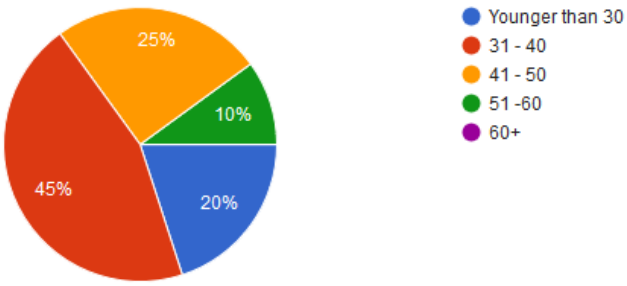


Figure 7-30: Age distribution of educator participants.

Use of mobile technology in the classroom and level of expertise

All educators were using mobile technology in the classroom, but each educator rated his/her expertise level differently, ranging from 1 being a 'novice' to 5 being an 'experienced expert'. Figure 7-31 indicates the summary of expertise.

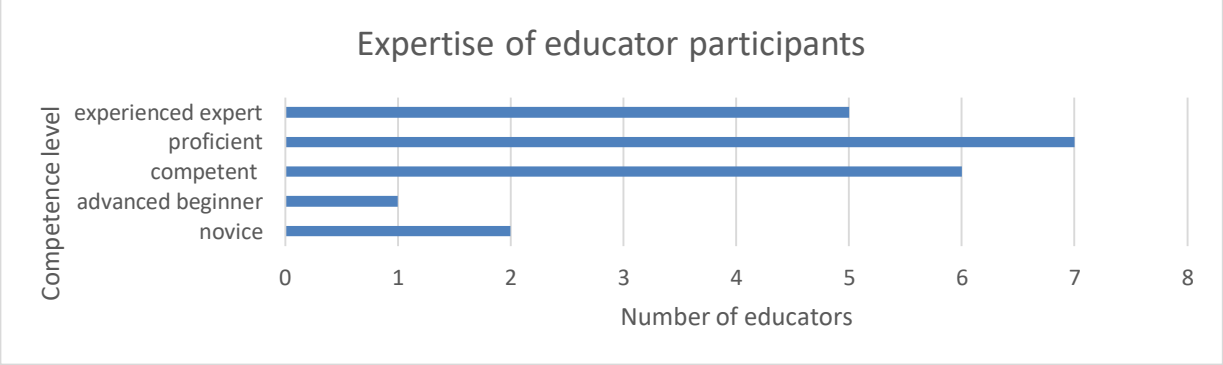


Figure 7-31: Expertise level of educators.

7.8.2 Section B: Exploring the different categories of the framework

Section B was divided into 10 sections focusing on specific categories of the framework. Section B will be analysed per category of the dimension in the framework.

The Likert ratings for the participant educators will be analysed in the same manner as that of the experts (Section 7.2).

The following categories are outlined:

- Technical Dimension (Section 7.9)
- Social-Emotional Dimension (Section 7.10)
- Cognitive Dimension (Section 7.11)
- Other dimensions (Section 7.12)

7.9 TECHNICAL DIMENSION

The technical dimension consisted of only one section. That is operational literacy.

The following categories are discussed:

- Operational literacy (Section 7.9.1)
- Operational literacy and technical dimension summary (Section 7.9.1.1)

7.9.1 Operational literacy

This section elaborates on the operational literacy skills of the technical dimension from an educators' point of view. Table 7-23 indicates the findings for the educators for operational literacy.

Table 7-23: Findings for operational literacy, technical dimension (educators).

Category of the technical dimension: operational literacy					
Skill no.	**Skills**	**1 = very important**	**2 = moderately important**	**3 = slightly important**	**4 = not important**
GS-1	Operate multiple devices in class	10	6	3	1
GS-2	Charge multiple devices	10	8	1	1
GS-3	Support subject material	13	5	1	1
GS-4	Promote mobile technologies	14	4	1	1
GS-5	Standard practice across devices	12	7	1	0
GS-6	Connect device to Wi-Fi	8	11	1	0
GS-7	Data usage and financial cost	8	9	3	0
GS-8	Use Bluetooth in class for file sharing	12	7	0	1
GS-9	Connect to peripheral devices in class	12	7	0	1
GS-10	Basic problem solving through troubleshoot guide	8	8	3	1
GS-11	Use mobile device affordances to enhance learning	7	7	4	2
GS-12	Know available device specifications	6	10	3	1
BF-1	Use of time management apps in planning	10	7	1	2
BF-2	Create worksheets	11	6	2	1
BF-3	Use device to record data	7	11	1	1
AD-1	Create videos in local language	14	4	1	1

Category of the technical dimension: operational literacy					
Skill no.	**Skills**	**1 = very important**	**2 = moderately important**	**3 = slightly important**	**4 = not important**
AD-2	Scan textbooks to create e-textbooks	10	7	2	1
AD-3	Enable transition to mobile devices for learners	7	7	4	2
AD-4	Educate learners of functionalities on device to adapt to rural areas	6	10	3	1
AD-5	Enable shared computing	10	7	1	2
AD-6	Enable device sharing amongst learners	11	6	2	1
AD-7	Charge devices always	7	11	1	1
AD-8	Use different power supplies	14	4	1	1
AD-9	Save content for offline use	10	7	2	1
AD-10	Use of cache memory	11	7	2	0
AD-11	Access digital textbooks	10	7	2	1
AD-12	Encourage file sharing via Bluetooth	8	7	4	1
AD-13	Learn to use mobile technology through online tutorials	5	9	4	2
NV-1	Use of touch screens and navigate between screens	6	6	5	3
NV-2	Multi task on device whilst teaching	7	2	6	5
NV-3	Navigate between educator and learner device	5	5	4	6
AM-1	Use different phone interfaces	7	9	2	2
AM-2	Disable automatic app updates	11	6	2	1
AM-3	Use educational games in class	7	11	1	1
AM-4	Use subject specific applications	14	4	1	1
AM-5	Use online quizzes and electronic polls	10	7	2	1
SO-1	Educate learners on device safe-keeping	11	7	2	0
SO-2	Deal with power surges	10	7	2	1
SO-3	Lock away devices for safety	8	7	4	1

Table 7-23 is represented graphically in Figure 7-32.

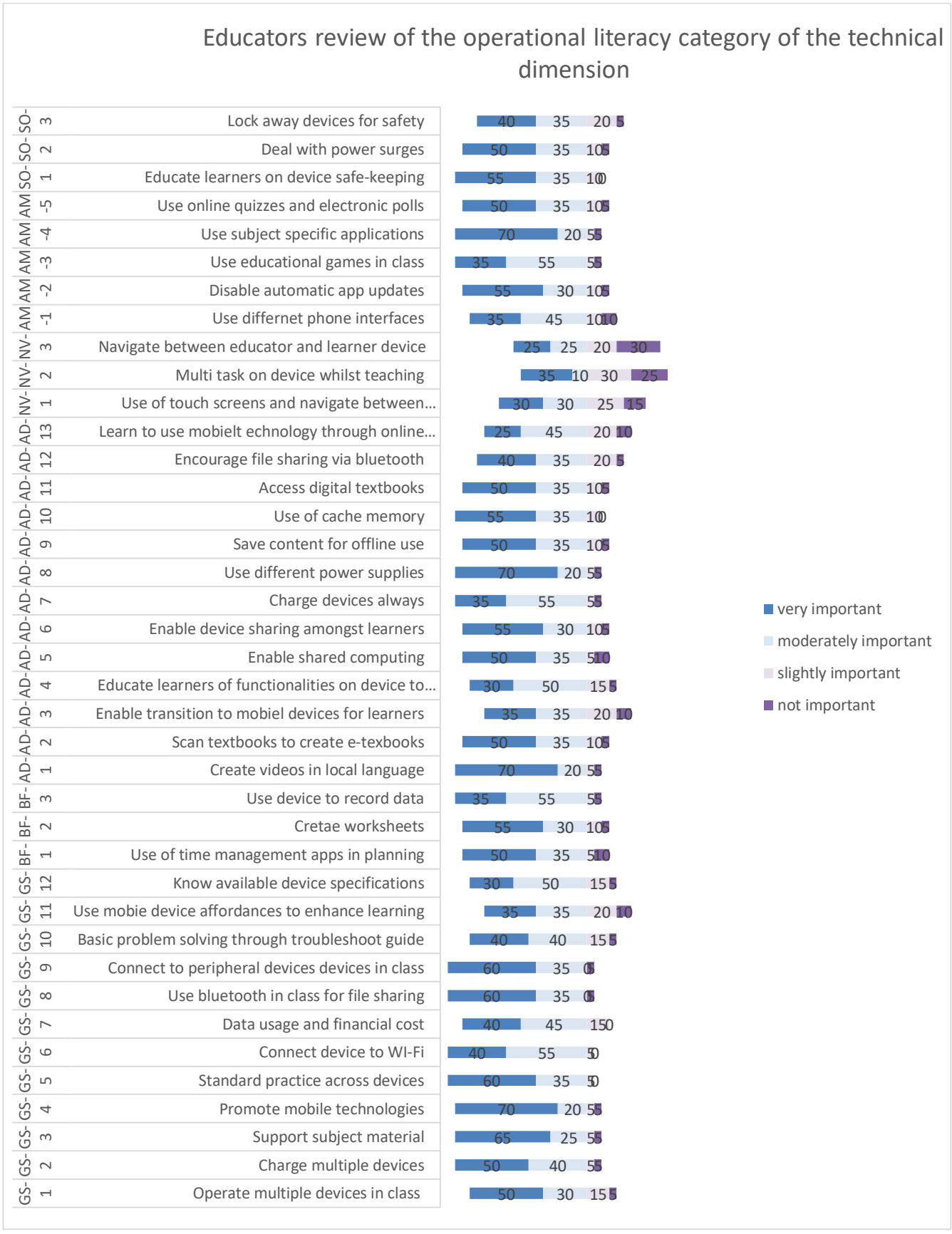


Figure 7-32: Diverging bar chart with Likert scale values for operational literacy (educators).

The Likert values in Table 7-23 are converted to numerical values as per the calculation in Figure 7-33.

Skill GS-1 – Operating multiple devices in a classroom, the ratings were
10 very important * 4 points = 40
6 moderately important * 3 points = 18
3 slightly important * 2 points = 6
1 not important * 1 point = 1
65 points / 20 educators that answered the questionnaire =
3.25 average for Skill GS-1.

Figure 7-33: Average agreement value calculation for educators.

The calculation in Figure 7-33, is applied through the rest of the educator's analysis perspective (Section B). The values generated for the technical dimension are represented in Table 7-24.

Table 7-24: Average agreement value for operational literacy (educators).

Skill no.	Skills	Average agreement value (n=20)
GS-1	Operate multiple devices in class	3.25
GS-2	Charge multiple devices	3.35
GS-3	Support subject material	3.5
GS-4	Promote mobile technologies	3.55
GS-5	Standard practice across devices	3.55
GS-6	Connect device to Wi-Fi	3.35
GS-7	Data usage and financial cost	3.25
GS-8	Use Bluetooth in class for file sharing	3.5
GS-9	Connect to peripheral devices in class	3.5
GS-10	Basic problem solving through troubleshooting guide	3.15
GS-11	Use mobile device affordances to enhance learning	2.95
GS-12	Know available device specifications	3.05
BF-1	Use of time management apps in planning	3.25
BF-2	Create worksheets	3.35
BF-3	Use device to record data	3.2
AD-1	Create videos in local language	3.55
AD-2	Scan textbooks to create e-textbooks	3.3
AD-3	Enable transition to mobile devices for learners	2.95
AD-4	Train learner functionalities of device to adapt to rural areas	3.05
AD-5	Enable shared computing	3.25
AD-6	Enable device sharing amongst learners	3.35
AD-7	Charge devices always	3.2
AD-8	Use different power supplies	3.55
AD-9	Save content for offline use	3.3
AD-10	Use of cache memory	3.45
AD-11	Access digital textbooks	3.3
AD-12	Encourage file sharing via Bluetooth	3.1
AD-13	Learn to use mobile technology through online tutorials	2.85
NV-1	Use of touch screens and navigate between screens	2.75
NV-2	Multi task on device whilst teaching	2.55
NV-3	Navigate between educator and learner device	2.45
AM-1	Use different phone interfaces	3.05
AM-2	Disable automatic app updates	3.35
AM-3	Use educational games in class	3.2
AM-4	Use subject specific applications	3.55
AM-5	Use online quizzes and electronic polls	3.3
SO-1	Educate learners on device safe-keeping	3.45
SO-2	Deal with power surges	3.3
SO-3	Lock away devices for safety	3.1

Table 7-24 is presented in a bar graph format as per Figure 7-34.

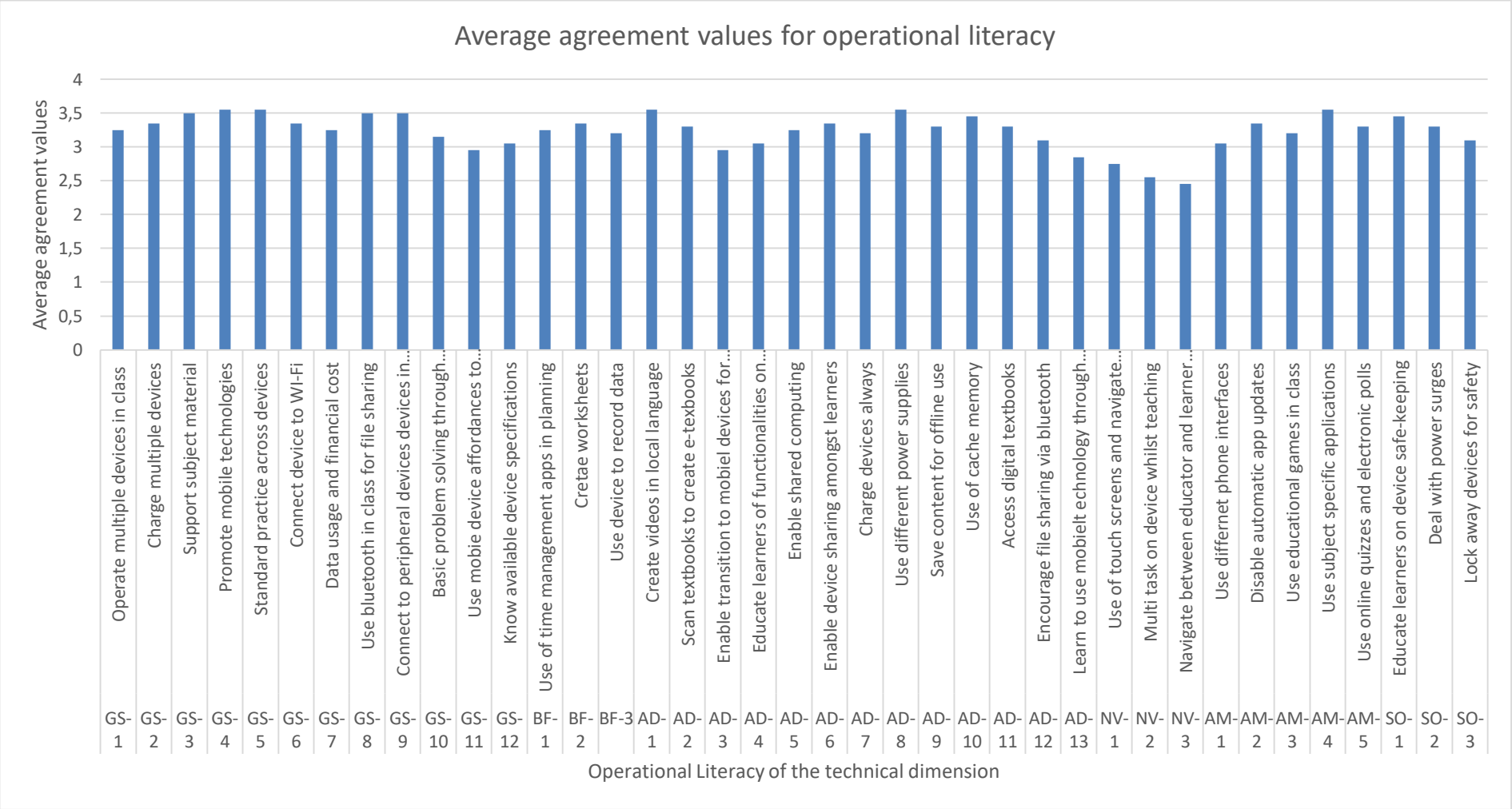


Figure 7-34: Average agreement value bar graph for operational literacy (educators).

7.9.1.1 Operational literacy and technical dimension summary

The skill with the lowest average agreement in Figure 7-34 is NV-3 (navigate between educator and learner device), with a rating of just under 2.5. From the 39 skills, none of them had an average rating of 4, thus none of the skills could be categorised as 'must have' skills. Thirty-three of the 39 skills, illustrated in Figure 7-34, had a rating of between 3 and 3.9, thus categorised as a 'should have' skill.

7.10 SOCIAL-EMOTIONAL DIMENSION

This dimension consisted of four parts in the questionnaire: social-emotional literacy, social networking functional literacy, online etiquette literacy and cyber safety literacy.

The outline is presented through the following categories:

- Social-emotional Literacy (Section 7.10.1)
- Social-emotional literacy summary (Section 7.10.1.1)
- Social-networking functional literacy (Section 7.10.2)
- Social-networking functional literacy summary (Section 7.10.2.1)
- Online etiquette literacy (Section 7.10.3)
- Online etiquette literacy summary (Section 7.10.3.1)
- Cyber safety literacy (Section 7.10.4)
- Cyber safety literacy summary (Section 7.10.4.1)

7.10.1 **Social-emotional literacy**

Table 7-25 depicts the Likert values of the educator ratings for the social-emotional category of skills.

Table 7-25: Findings for social-emotional literacy, social-emotional dimension (educators).

Category of the social-emotional dimension: social-emotional literacy					
Skill No.	**Skill brief description**	**Very important**	Moderately important	Slightly important	Not important
UI-1	General understanding of internet	15	5	0	0
UI-2	Manage slow connection efficiently	12	6	2	0
UI-3	Use online browser and cache memory	12	7	1	0
SI-1	Find relevant information	16	4	0	0
SI-2	Share information via web links	10	5	3	2

The above ratings are diagrammatically represented in Figure 7-35.

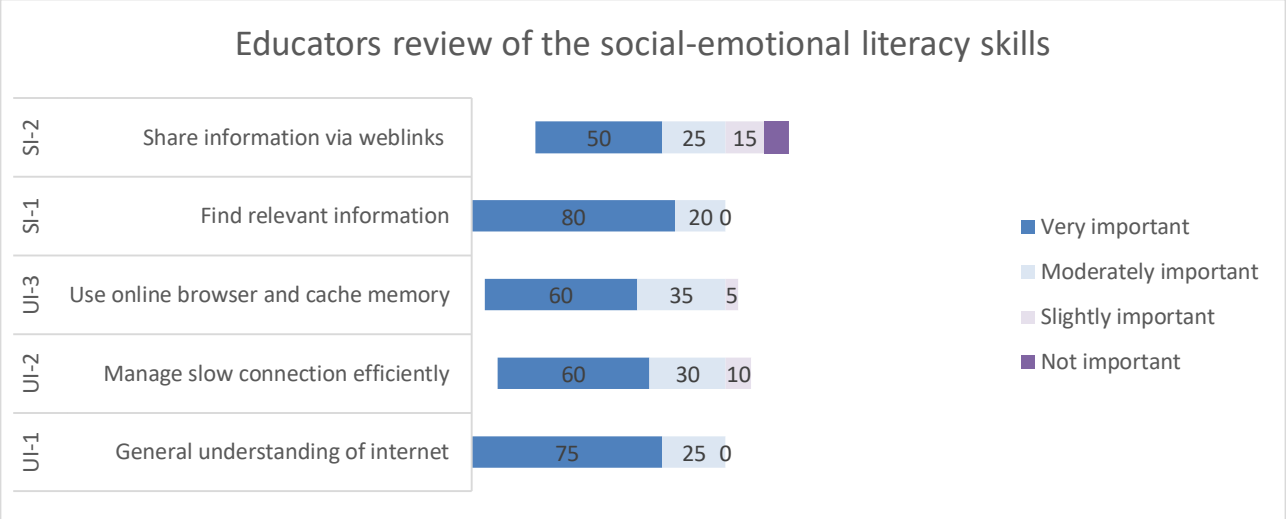


Figure 7-35: Diverging bar chart with Likert scale values for social-emotional literacy (educators).

To add more value to the ratings in Table 7-25, numerical values were assigned as per Table 7-26.

Table 7-26: Average agreement value for social-emotional literacy (educators).

Category of the social-emotional dimension: social-emotional literacy		
Skill No.	**Skill brief description**	**Average agreement (n=20)**
UI-1	General understanding of internet	3,75
UI-2	Manage slow connection efficiently	3,5
UI-3	Use online browser and cache memory	3,55
SI-1	Find relevant information	3,8
SI-2	Share information via web links	3,15

The graphical representation in Figure 7-36 represents the average agreement values in Table 7-26.

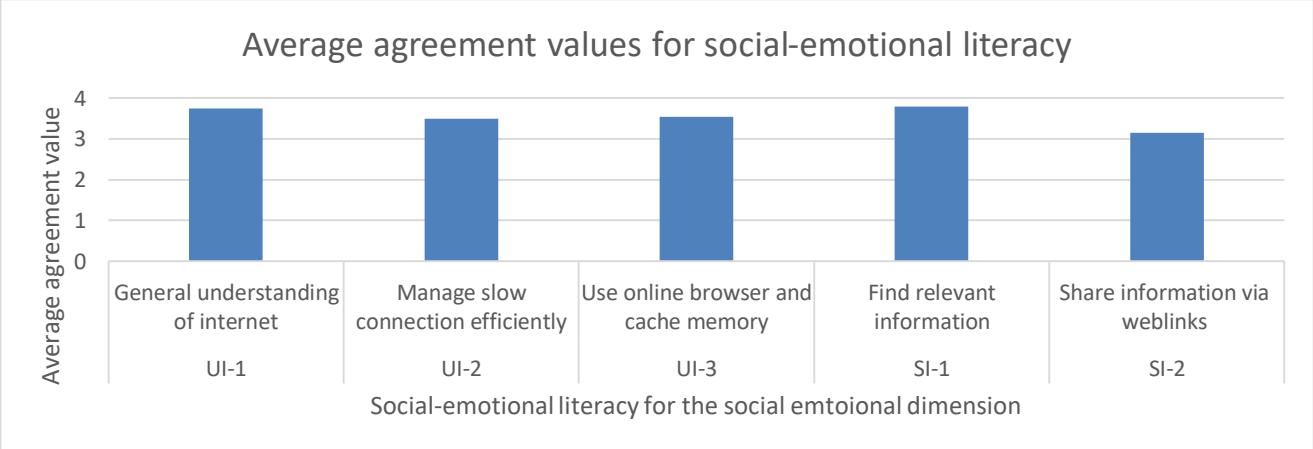


Figure 7-36:Average agreement value bar graph for social-emotional literacy (educators).

7.10.1.1 Social-emotional literacy summary

Figure 7-36 indicates that the skill with the lowest rating is SI-2 9 (share information via web links). This could be due to the concerns expressed by experts concerning the lack of internet. The most important skill in this category for educators was that of finding relevant information. This could be due to the very nature of the educator's task in terms of always sourcing and disseminating information (Anzai, 2018).

7.10.2 **Social networking functional literacy**

Table 7-27 indicates the importance scores assigned to the various skills by educators.

Table 7-27: Findings for social networking functional literacy, social-emotional dimension (educators).

Category of the social-emotional dimension: social networking functional literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	**Not important**
CT-1	Collaborate via social media	12	6	1	1
CT-2	Tele-conference with learners and colleagues	8	9	3	0
OG-1	Create online learning group	11	6	2	1
OG-2	Use device as blogging tool	11	7	2	0
CC-1	Share content	11	6	2	1
CC-2	Blogs to create content	1	8	6	5
CC-3	Use Wikis for knowledge generating and feedback	1	8	5	6
SN-1	Create digital e-portfolios	7	8	3	2
CO-1	Communicate through emails	6	9	4	1

The above results are represented in Figure 7-37.

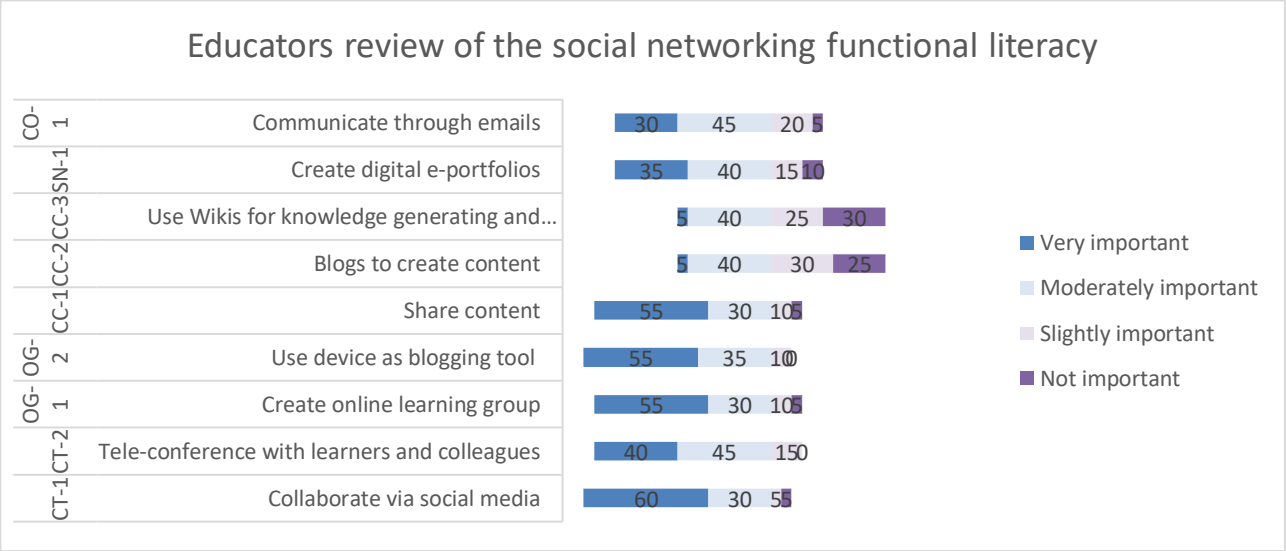


Figure 7-37: Diverging bar chart with Likert scale values for social networking literacy (educators).

Table 7-27 was further analysed to a numeric rendition as per Table 7-28.

Table 7-28: Average agreement value for social networking functional literacy (educators).

Category of the social-emotional dimension: social networking functional literacy		
Skill No.	**Skills**	**Agreement value (n=20)**
CT-1	Collaborate via social media	3.45
CT-2	Tele-conference with learners and colleagues	3.25
OG-1	Create online learning group	3.35
OG-2	Use device as blogging tool	3.45
CC-1	Share content	3.35
CC-2	Blogs to create content	2.25
CC-3	Use wikis for knowledge generating and feedback	2.2
SN-1	Create digital e-portfolios	3
CO-1	Communicate through emails	3

The values derived in Table 7-28 are depicted in a bar graph in Figure 7-38.

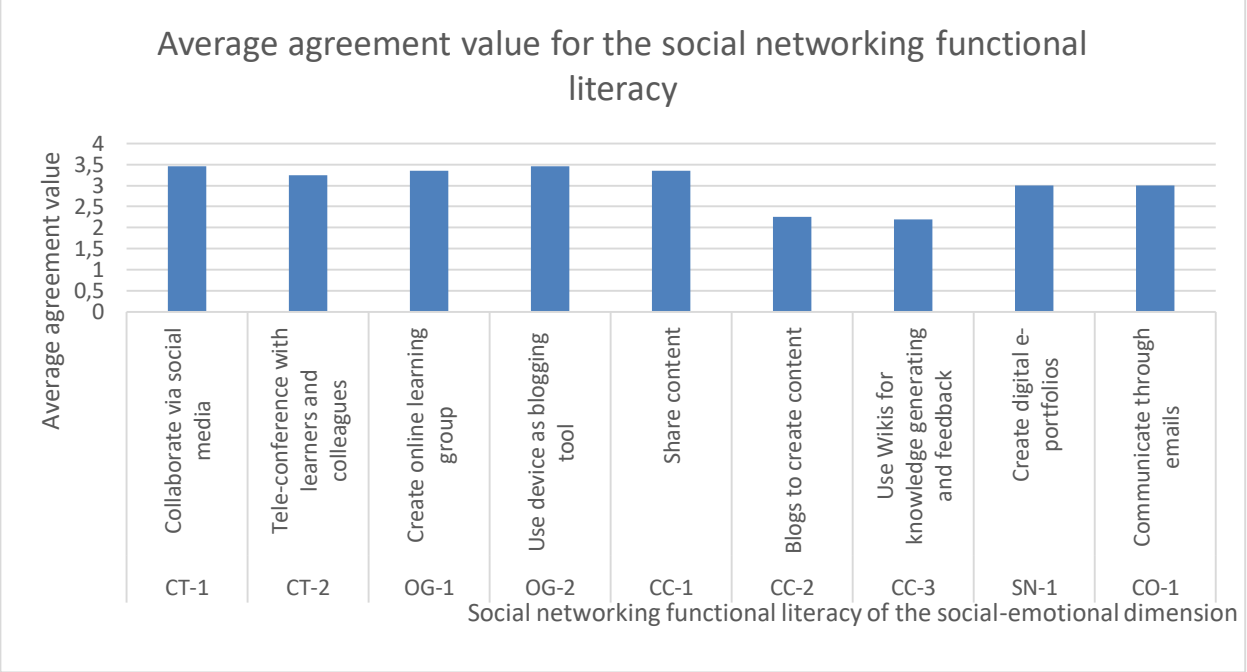


Figure 7-38: Average agreement value bar graph for social networking literacy (educators).

7.10.2.1 Social networking functional literacy summary

Figure 7-38 shows that the skills with the lowest rating were CC-2 (blogs to create content) and CC-3 (use wikis for knowledge generating and feedback). Educators did not seem to view these skills as important due to the lack of resources and internet connectivity (Masonta et al., 2017). Despite educators rating blogging for content

creation as less important, they seem to prioritise the use of mobile devices as a blogging tool.

7.10.3 **Online etiquette literacy**

Table 7-29 represents the Likert scale rating of educators' opinion of online etiquette skills.

Table 7-29: Findings for online etiquette literacy, social-emotional dimension (educators).

Category of the social-emotional dimension: online etiquette literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	**Not important**
CD-1	Behave decently on the internet	15	5	0	0
CD-2	Netiquette	12	7	1	0

Table 7-29 is graphically represented in Figure 7-39.

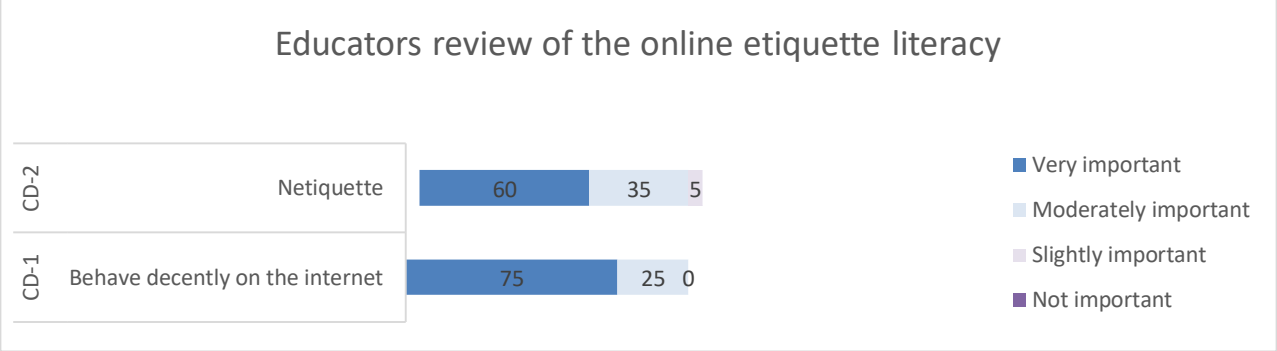


Figure 7-39: Diverging bar chart with Likert scale values for online etiquette literacy (educators).

Ratings from the assessment in Table 7-29 were assigned numerical values as presented in Table 7-30.

Table 7-30: Average agreement value for online etiquette literacy (educators).

Category of the social-emotional dimension: online etiquette literacy		
Skills no.	Skills	**Agreement value** *(n=20)*
CD-1	Behave decently on the internet	3.75
CD-2	Netiquette	3.55

The graphical representation of the values derived in Table 7-30 are presented in Figure 7-40.

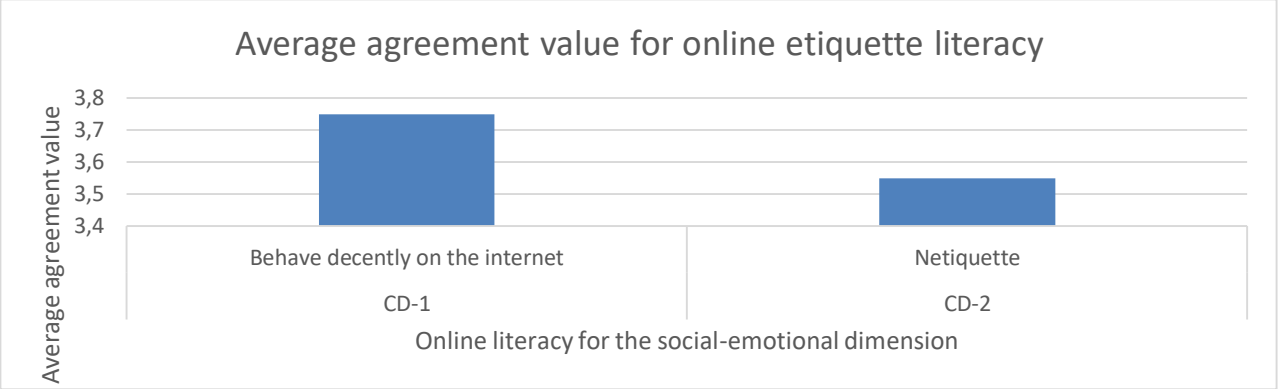


Figure 7-40: Average agreement value bar graph for online etiquette literacy (educators).

7.10.3.1 Online etiquette literacy summary

This category comprised two skills. Figure 7-40 indicates that both skills had a high average rating, thus showing educators' acknowledgement of the importance of this set of skills. This could be due to netiquette and being part of the ICT4RED TPD course (Botha et al., 2015; Mabila et al., 2017).

7.10.4 **Cyber safety literacy**

Table 7-31 indicated the results from the educators' perspective on cyber safety literacy.

Table 7-31: Findings for cyber safety literacy, social-emotional dimension (educators).

Category of the social-emotional dimension: cyber safety literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	**Not important**
SW-1	Beware of what to publish publicly	15	5	0	0
SW-2	Keep learners safe online	12	7	1	0
SW-3	Dangers of unsafe networks	14	6	0	0
SW-4	Identify online threats	12	7	1	0
SW-5	Avoid copying published work	12	7	1	0
SW-6	Legal rights when online	12	7	1	0

Table 7-31 is represented in Figure 7-41.

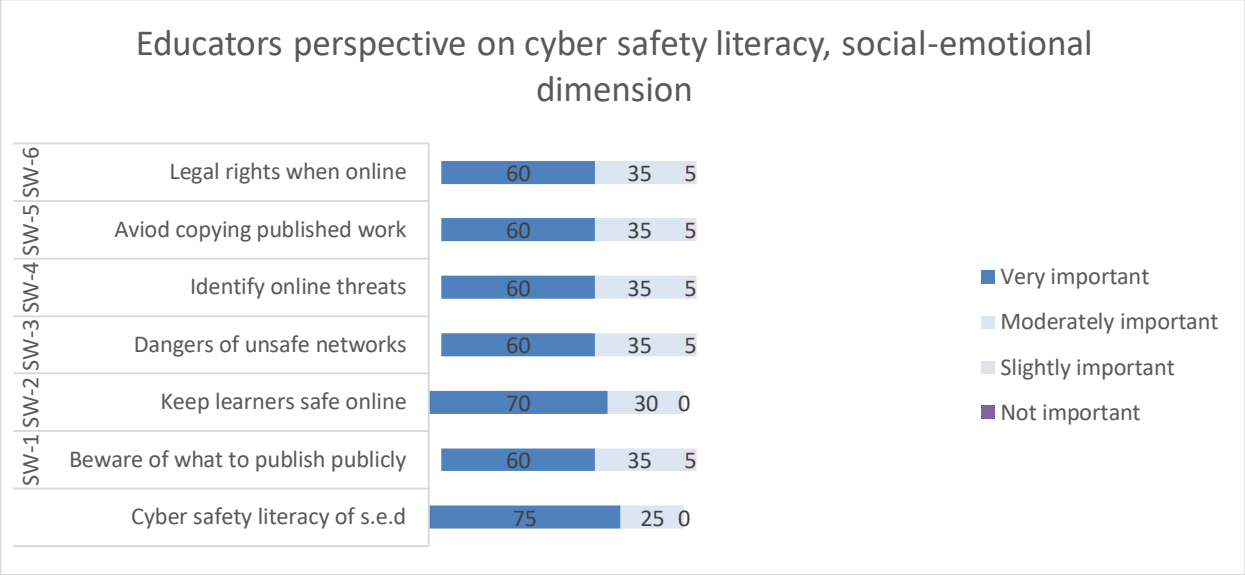


Figure 7-41: Diverging bar chart with Likert scale values for cyber safety literacy (educators).

Table 7-32 indicates the average agreement values for each skill in the cyber safety category.

Table 7-32:Average agreement value for cyber safety literacy (educators).

Category of the social-emotional dimension: cyber safety literacy		
Skill No.	Skills	Agreement value (n=20)
SW-1	Beware of what to publish publicly	3.75
SW-2	Keep learners safe online	3.55
SW-3	Dangers of unsafe networks	3.7
SW-4	Identify online threats	3.55
SW-5	Avoid copying published work	3.55
SW-6	Legal rights when online	3.55

Figure 7-42 is a graphical representation of Table7-32.

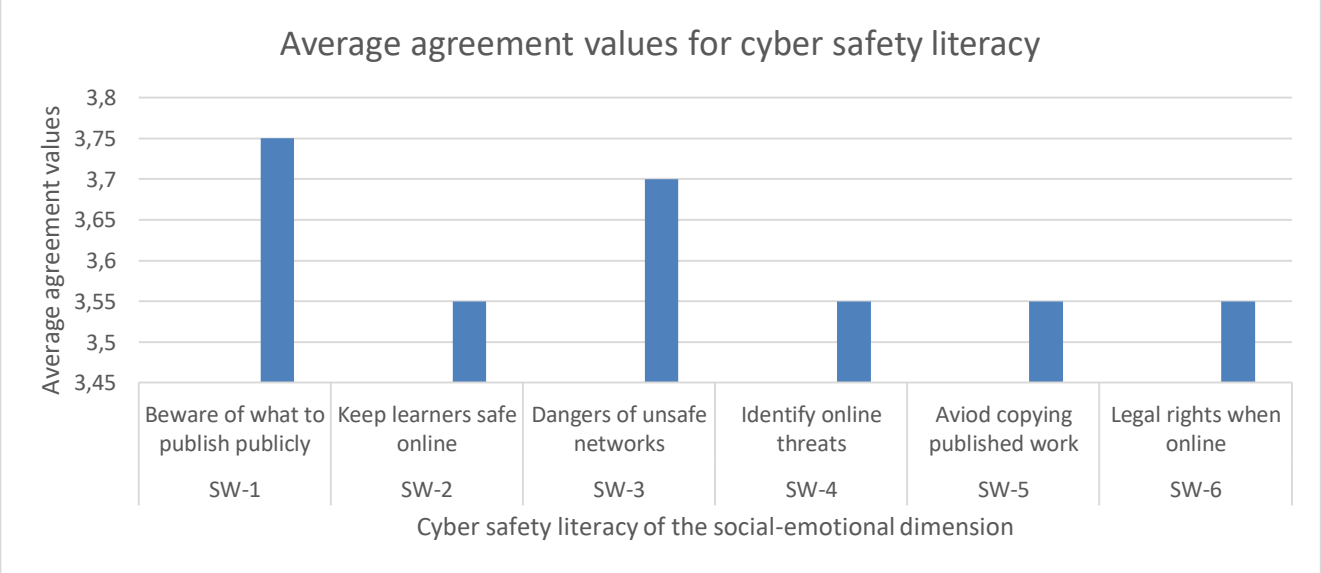


Figure 7-42: Average agreement value bar graph for cyber safety literacy (educators).

7.10.4.1 Cyber safety literacy summary

Figure 7-42 indicates that all skills fell into the 'should have' category with average agreement values ranging between 3 and 3.9. None of the skills were considered as 'must have' skills whereas the experts felt that these skills were 'must have' skills. This could be due to the lack of internet connectivity (Takavarasha et al., 2018) and consequent lack of exposure to the online world.

7.11 COGNITIVE DIMENSION

This section was covered over three sections in the questionnaire and addressed reproduction literacy, branching literacy and information literacy. These different literacies are summarised in the following sections:

- Reproduction literacy (Section 7.11.1)
- Reproduction literacy summary (Section 7.11.1.1)
- Branching literacy (Section 7.11.2)
- Branching literacy summary (Section 7.11.2.1)
- Information literacy (Section 7.11.3)
- Information literacy summary (Section 7.11.3.1)

7.11.1 **Reproduction literacy**

Table 7-33 indicates the ratings for the first category of the cognitive dimension: reproduction literacy.

Table 7-33: Findings for reproduction literacy, cognitive dimension (educators).

Category of the cognitive dimension: reproduction literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	**Not important**
GV-1	Understanding file formats	9	9	1	1
GV-2	Create a video	4	13	3	0
CR-1	Integrate and create information	8	10	2	0
CR-2	Find information in different formats	10	9	0	1
CR-3	Adapt web content for the class	9	8	2	0
WS-1	Edit in word processor	8	10	2	0
WS-2	Use Excel and other apps	10	10	0	0

Figure 7-43 depicts the Likert scale ratings.

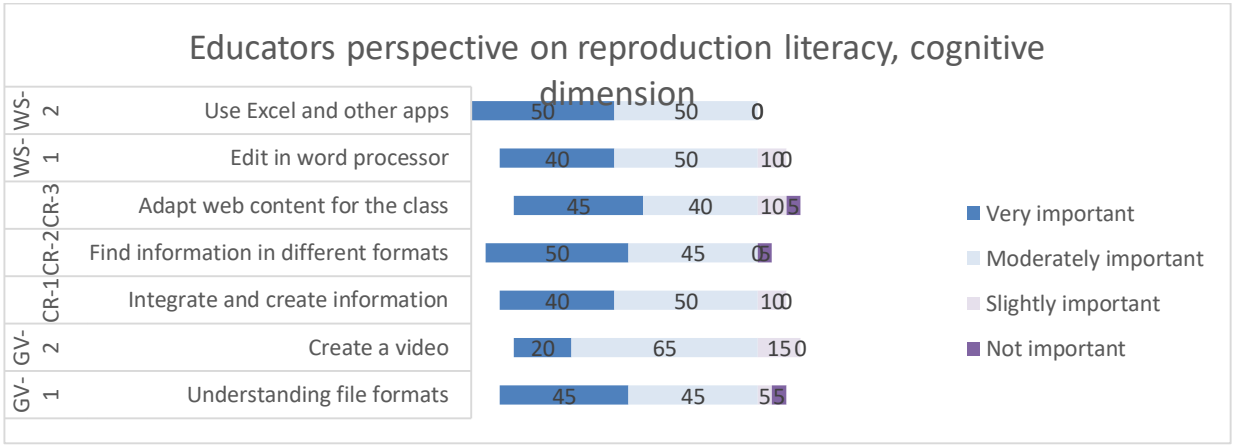


Figure 7-43: Diverging bar chart with Likert scale values for reproduction literacy (educators).

Table 7-34 shows the numerical values calculated for reproduction literacy category.

Table 7-34: Average agreement value for reproduction literacy (educators).

Category of the cognitive dimension: reproduction literacy		
Skill No.	**Skills**	**Agreement value (n=20)**
GV-1	Understanding file formats	3.3
GV-2	Create a video	3.05
CR-1	Integrate and create information	3.3
CR-2	Find information in different formats	3.4
CR-3	Adapt web content for the class	3.25
WS-1	Edit in word processor	3.3
WS-2	Use Excel and other apps	3.5

Figure 7-44 represents the average agreement values from Table 7-34.

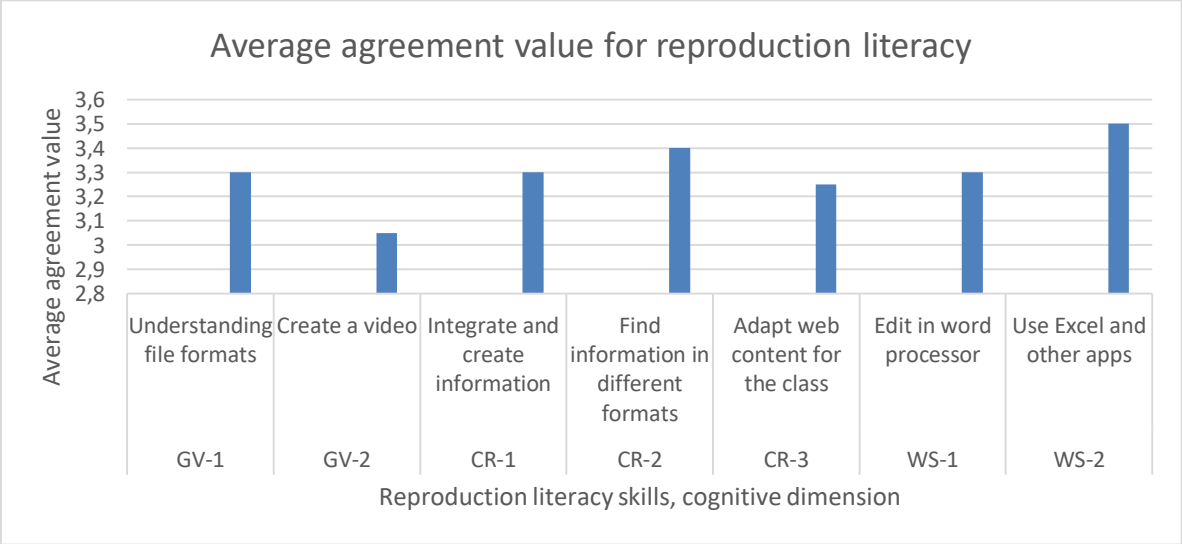


Figure 7-44: Average agreement value bar graph for reproduction literacy (educators).

7.11.1.1 Reproduction literacy

Skill GV-2 (creating a video) had the lowest rating, as shown in Figure 7-45. Educators did not feel the importance of creating a video in this category of skills. WS-2 (using Excel and other applications) scored the highest importance rating of 3.5. Educators seemed to value the use and functionality of basic applications such as Excel in classroom use, thus validating the importance of obtaining skills to use these applications (Schreuers et al., 2017).

7.11.2 **Branching literacy**

Table 7-35 shows the values of importance assigned to each skill by the educators.

Table 7-35: Findings for branching literacy, cognitive dimension (educators).

Category of the cognitive dimension: branching literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	Not important
MS-1	Source answers online	6	11	2	0
DC-1	Synthesise digital resources	10	8	2	0
VM-1	Assign meaning to images and graphs	9	9	2	0
VM-2	Express one's self through media	8	8	3	0
VM-3	Listen to music and watch videos	6	11	2	1
VM-4	Understand text, video, audio and maps	7	10	2	1
VM-5	Understand media expressions	6	11	2	1
VM-6	Capture images	7	10	2	1

Figure 7-45 depicts a diverging bar chart with the Likert scale values for the branching literacy category.

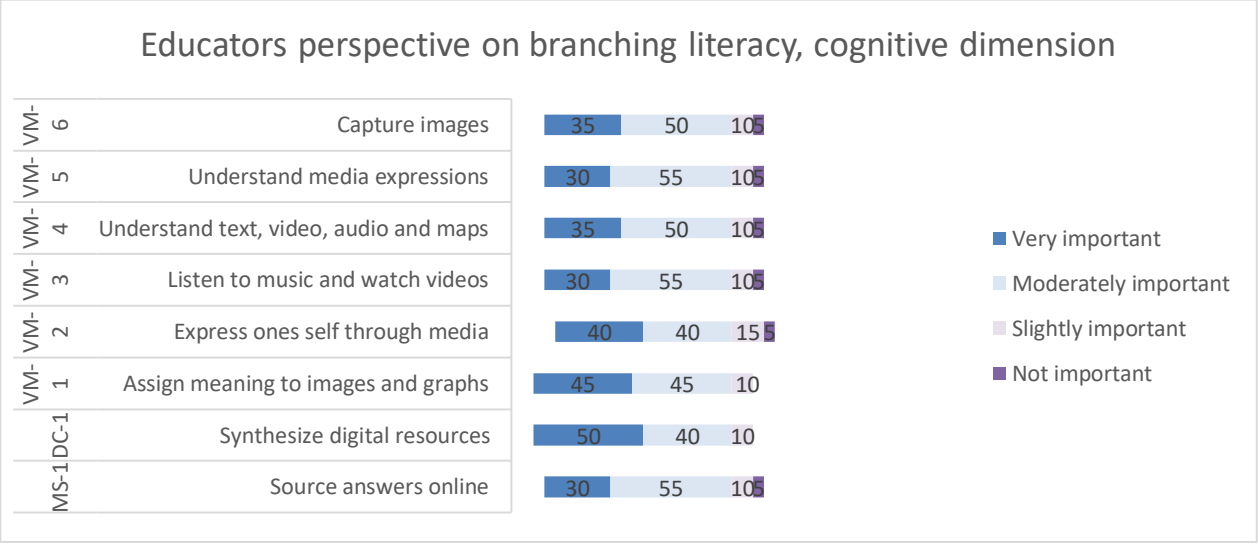


Figure 7-45: Diverging bar chart with Likert scale values for branching literacy (educators).

Table 7-36 indicates the average agreement values for the branching literacy category.

Table 7-36: Average agreement value for branching literacy (educators).

Category of the cognitive dimension: branching literacy		
Skill No.	Skills	Agreement value (n=20)
MS-1	Source answers online	3.1
DC-1	Synthesise digital resources	3.4
VM-1	Assign meaning to images and graphs	3.35
VM-2	Express one's self through media	3.15
VM-3	Listen to music and watch videos	3.1
VM-4	Understand text, video, audio and maps	3.15
VM-5	Understand media expressions	3.1
VM-6	Capture images	3.15

Table 7-36 is graphically represented in Figure 7-46.

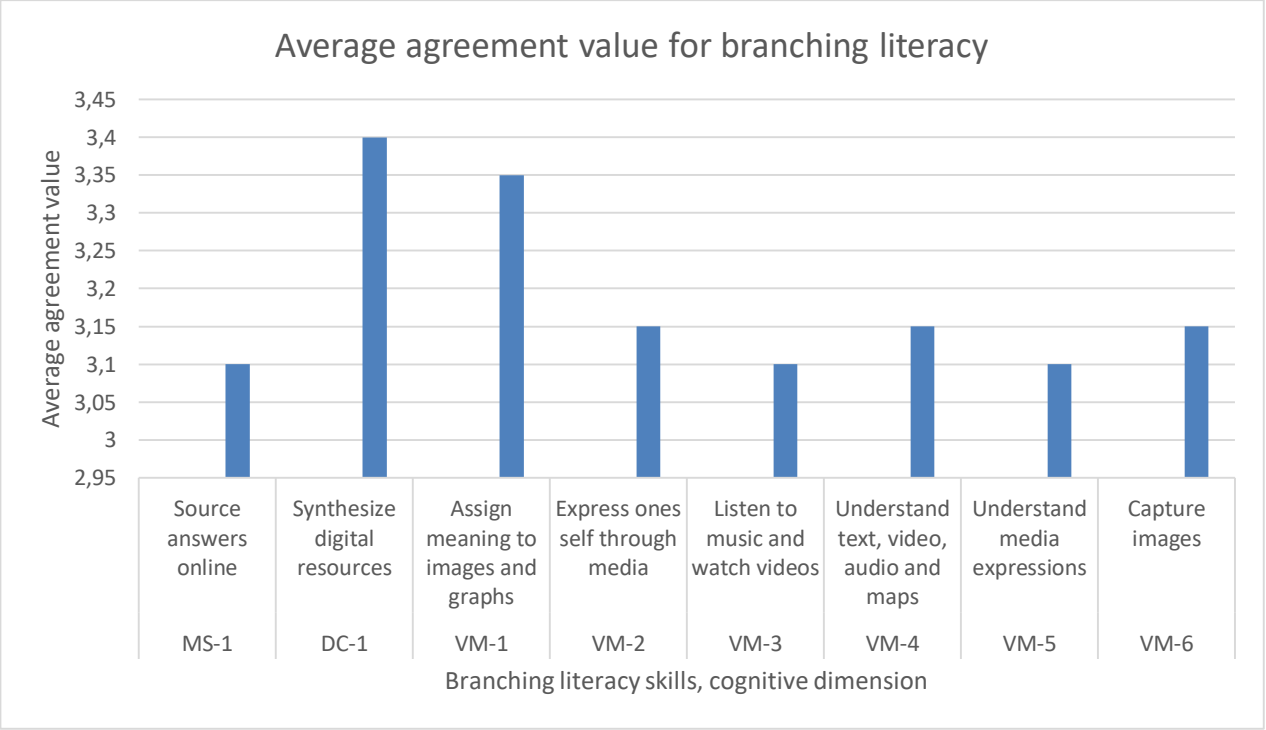


Figure 7-46: Average agreement value bar graph for branching literacy (educators).

7.11.2.1 Branching literacy summary

Figure 7-46 indicated that the highest rated skill is DC-1 (synthesise digital resources). This skill is of importance for an educator and forms part of the 21st century skills for learning (Koopman, 2014). The second highest rated skill is VM-1 (assigning meaning to images and graphs) with a rating of 3.35. Development and evolution of technology over time has facilitated media to be presented in different forms (Zheng et al., 2018).

7.11.3 Information literacy

Table 7-37 indicates the value of importance assigned by each of the 20 educators to skills in the information literacy category.

Table 7-37: Findings for information literacy, cognitive dimension (educators).

Category of the cognitive dimension: information literacy					
Skill No.	**Skills**	**Very important**	Moderately important	**Slightly important**	**Not important**
BK-1	Contribute to knowledge	14	6	0	0
RT-1	Process large amount of information	11	6	2	0
RT-2	Assess quality and validity of information	14	5	1	0
RT-3	Access e-publications and e-books	15	3	2	0

The findings from Table 7-37 are represented in Figure 7-47.

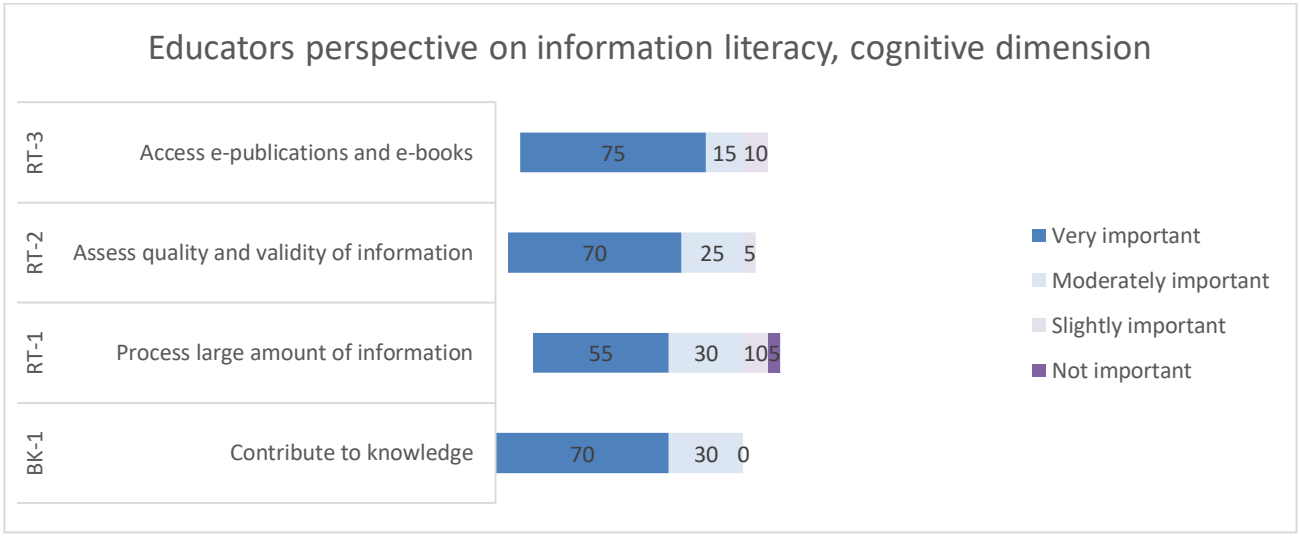


Figure 7-47: Diverging bar chart with Likert scale values for information literacy (educators).

Table 7-38 comprised the numerical values of the skills in the information literacy category.

Table 7-38: Average agreement value for information literacy (educators).

Category of the cognitive dimension: information literacy		
Skill No.	**Skills**	**Agreement value (n=20)**
BK-1	Contribute to knowledge	3.7
RT-1	Process large amount of information	3.35
RT-2	Assess quality and validity of information	3.65
RT-3	Access e-publications and e-books	3.65

Table 7-38 is graphically represented in Figure 7-48.

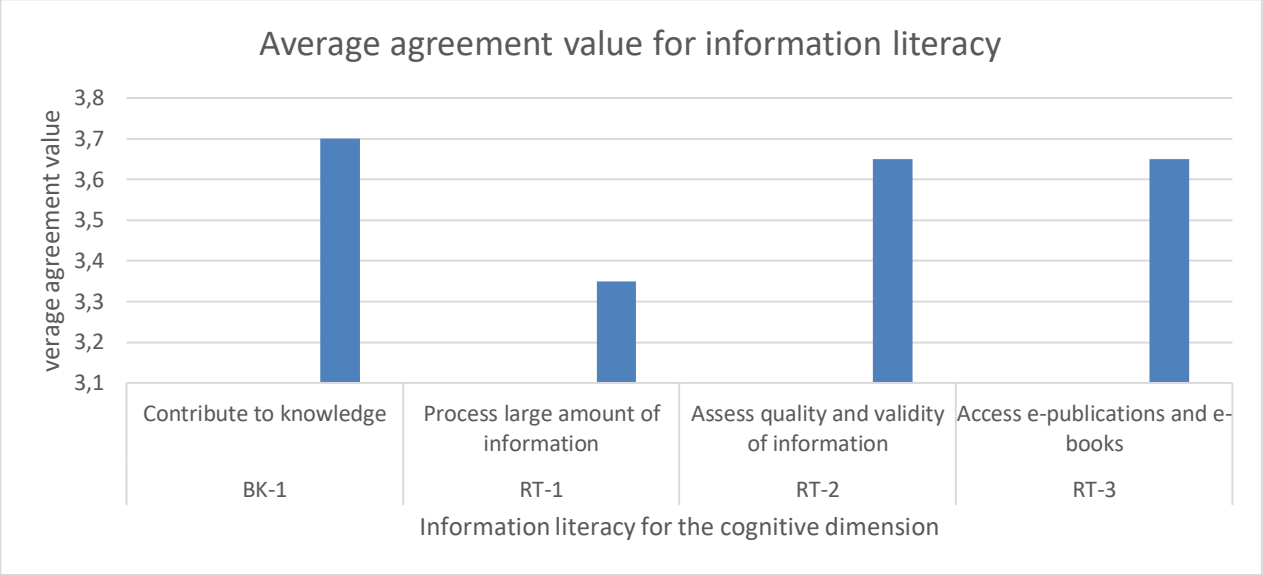


Figure 7-48: Average agreement value bar graph for information literacy (educators).

7.11.3.1 Information literacy summary

Figure 7-48 comprised four skills that were rated as important and had a point value of between 3 and 3.9. The least important one, despite a high rating, was RT-1 (processing large amounts of information), which seems contradictory to literature as Russell et al. (2018) mention processing large amounts of information as an imperative skill.

7.12 OTHER DIMENSIONS

The literacies in this dimension were applicable to all dimensions and consisted of two sections in the questionnaire: critical literacy and financial and workaround literacy. These literacies are presented in the following sections:

- Critical literacy (7.12.1)
- Critical literacy summary (7.12.1.1)
- Financial and workaround literacy (7.12.2)
- Financial and workaround literacy summary (7.12.2.1)
- Other dimensions summary (7.12.3)

7.12.1 **Critical literacy**

Table 7-39 indicates results from the findings of the critical literacy category.

Table 7-39: Findings for critical literacy, other dimensions (educators).

Category applicable to all dimension: critical literacy					
Skill No.	**Skills**	**Very important**	**Moderately important**	**Slightly important**	**Not important**
DT-1	Use information responsibly	8	10	2	0
DT-2	Teach learners to analyse information	8	10	2	0
DT-3	Evaluate web content	5	10	5	0

Table 7-39 is presented in Figure 7-49 in the form of a diverging bar chart.

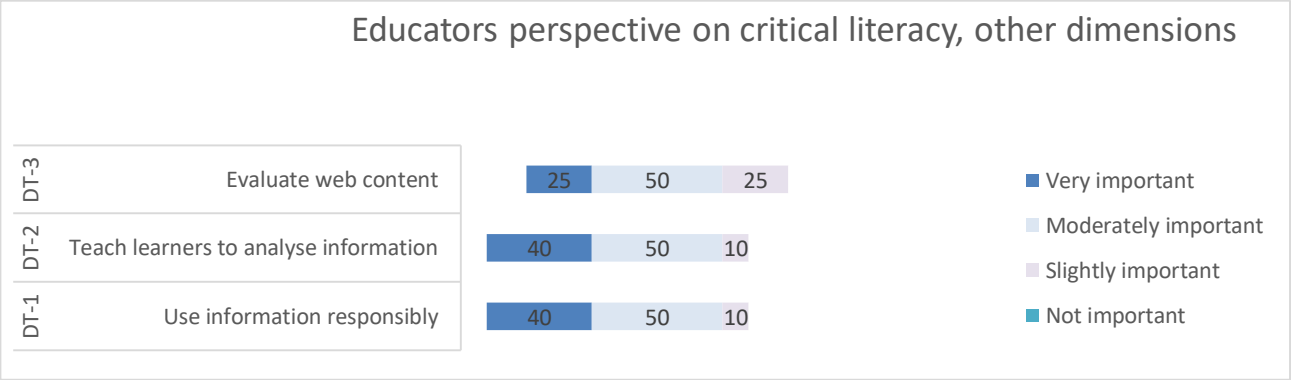


Figure 7-49: Diverging bar chart with Likert scale values for critical literacy (educators).

Average agreement values for the critical literacy category is indicated in Table 7-40.

Table 7-40: Average agreement value for critical literacy (educators).

Category applicable to all dimension: critical literacy		
Skill No.	**Skills**	**Agreement value (n=20)**
DT-1	Use information responsibly	3.3
DT-2	Teach learners to analyse information	3.3
DT-3	Evaluate web content	3

The values indicated in Table 7-40 are graphically presented in Figure 7-50.

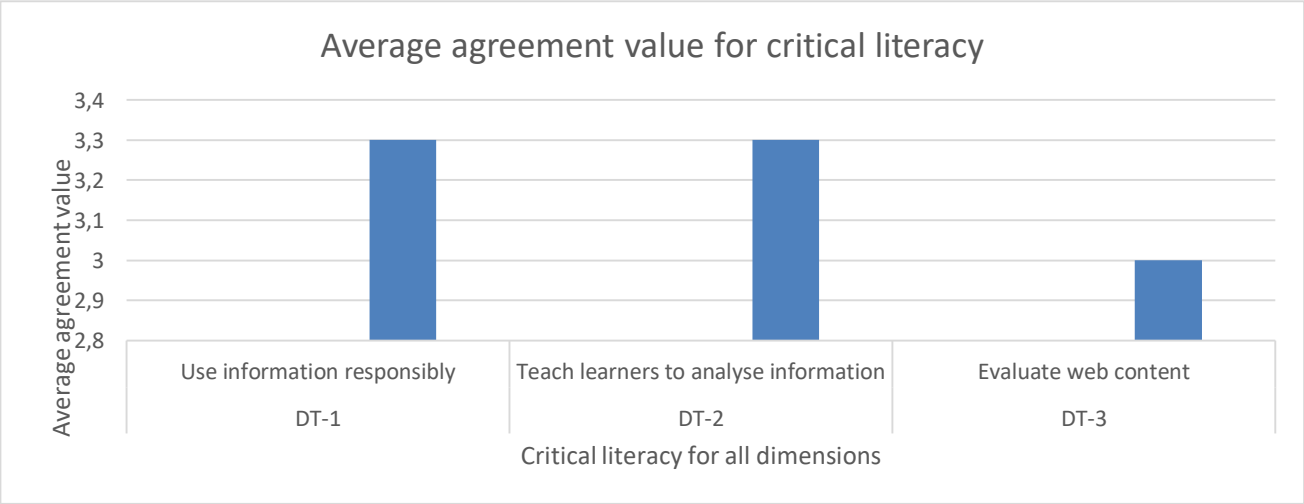


Figure 7-50: Average agreement value bar graph for critical literacy (educators).

7.12.1.1 Critical literacy summary

The least important skill in Figure 7-50 is DT-3 (evaluating web content). This skill had a 3-point average. The reason for this skill being least rated could possibly be the lack of internet in rural areas, therefore less exposure to using the web (Meyer & Neethling, 2017).

7.12.2 **Financial and workaround literacy**

Table 7-41 represents the values of the educators' opinions regarding financial and workaround skills.

Table 7-41: Findings for financial and workaround literacy, other dimensions (educators).

Category applicable to all dimension: financial and workaround literacy					
Skill No.	**Skills**	Very important	Moderately important	Slightly important	Not important
DI-1	Understand data cost	16	3	0	0
AR-1	Workaround skills for resource constraints	16	3	0	0

The graphical representation of Table 7-41 is indicated in Figure 7-51.

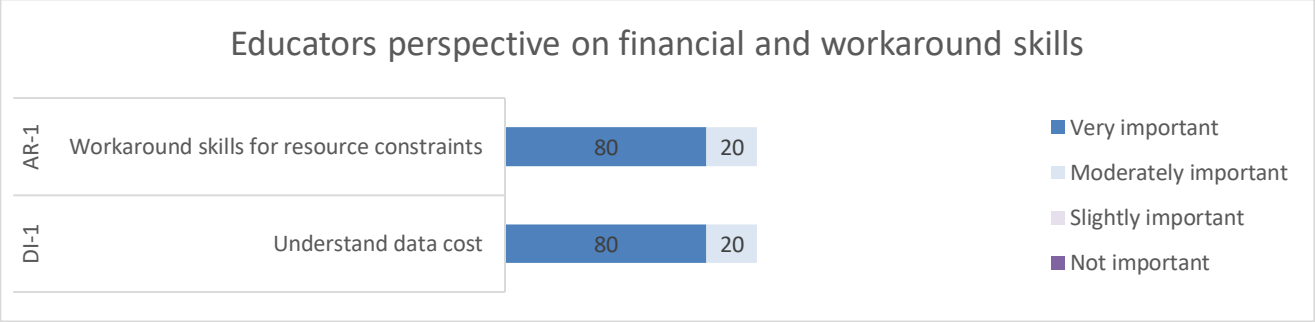


Figure 7-51: Diverging bar chart with Likert scale values for financial and workaround literacy (educators).

Table 7-42 presents the average agreement values for financial and workaround literacy skills.

Table 7-42: Average agreement value for financial and workaround literacy (educators).

Category applicable to all dimension: financial and workaround literacy		
Skill No.	**Skills**	**Agreement value (n=20)**
DI-1	Understand data cost	3.65
AR-1	Workaround skills for resource constraints	3.65

Table 7-42 is graphically represented in Figure 7-52.

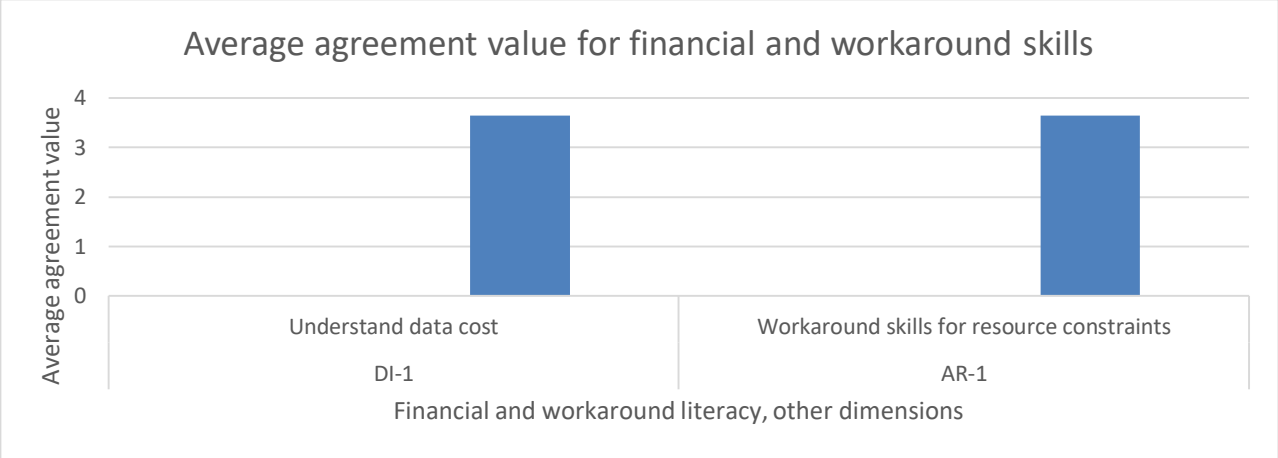


Figure 7-52: Average value bar graph for financial and workaround literacy (educators).

7.12.2.1 Financial and workaround literacy summary

Figure 7-52 shows that the financial and workaround literacy consisted of two skills and the educators rated them as equally important. Both the skills had a value of 3.65, thus falling into the 'should have' category.

7.12.3 **Other dimensions summary**

The skills in this category rated from 3 to 3.9, thus falling into the 'should have' skills. The skills with the lowest rating was DT-3 (evaluating web content). As mentioned, the most likely cause of this rating being the lowest is the fact that rural areas are disadvantaged in terms of access to stable internet (Takavarasha et al., 2018).

7.13 FINAL FRAMEWORK

This final framework answers the main research question: *How can a framework for educators' mobile digital literacy skills support educators' use of mobile technology in formal rural education?*

Chapter 5 presented a *Theoretical framework for mobile digital literacy skills of educators using mobile technology in rural formal education* (Section 5.6 and Figure 5-6). The conceptualisation of the mobile digital literacy skills for this study, was built on the digital literacy model by Ng (2012). The resulting Theoretical framework was developed from a literature review (Chapters 3, 4 and 5) and operationalised through a single case study. Thus, the final framework integrates the findings from the experts and educators, as illustrated in a scatter graph in Figure 7-53 and tabulated in Table 7-43.

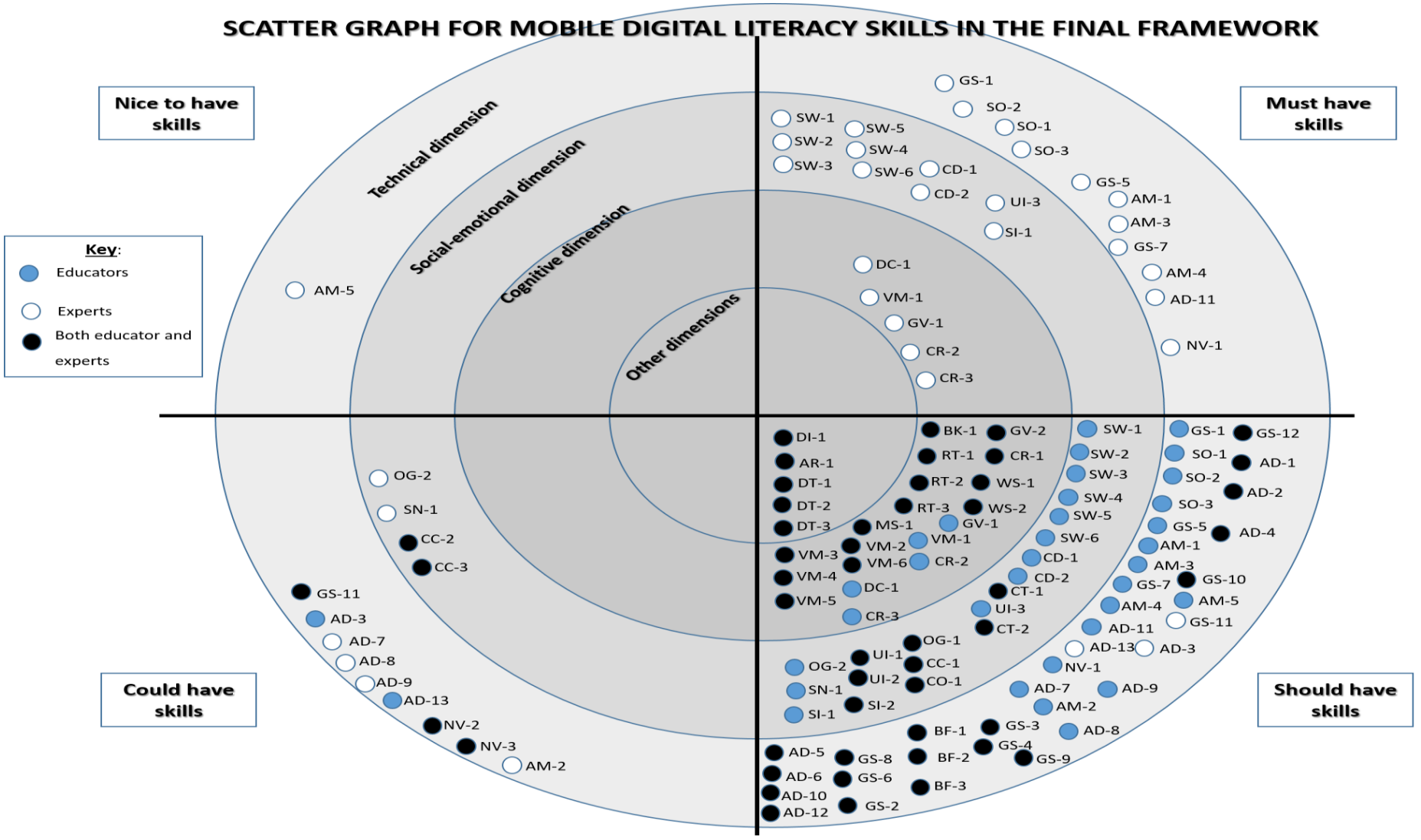


Figure 7-53: Final framework for mobile digital literacy skills for an educator using mobile technology in rural formal education.

The key to the skills coding in Figure 7-53 is presented in Table 7-43.

Table 7-43: Skill coding key and Final framework for mobile digital literacy skills for educators using mobile technology in rural formal education.

Technical dimension	Social-emotional dimension	Cognitive dimension	Other dimensions
Must have skills: (GS-1) Mobile device operation (SO-1) Educate learners on device safe-keeping (SO-2) Deal with power surges (GS-5) Maintain common settings across devices (GS-7) Data usage and financial cost (AM-1) Use different phone interfaces (AM-3) Use educational games in class (AM-4) Use subject specific applications (AD-11) Access digital textbooks (NV-1) Use of touch screens and navigate between screens	**Must have skills:** (SW-1) Beware of what to publish publicly (SW-2 Keep learners safe online (SW-3) Dangers of unsafe networks (SW-4) Identify online threats (SW-5) Avoid copying published work (SW-6) Legal rights when online (CD-1) Decent behaviour on the internet (CD-2) Netiquette (UI-3) Use online browser and cache memory (SI-1) Find relevant information	**Must have skills:** (CR-2) Find information in different formats (CR-3) Adapt web content for the class (GV-1) Understanding file formats (DC-1) Synthesise digital resources (VM-1) Assign meaning to images and graphs	**Must have skills:**
Should have skills: (GS-2) Charge multiple devices (GS-3) Support subject material (GS-4) Encourage mobile technologies (GS-6) Connect device to Wi-Fi (GS-8) Use Bluetooth in class for file sharing (GS-9) Connect to peripheral devices in class (GS-10) Basic problem solving through troubleshoot guide (GS-12) Understand device specifications (BF-1) Use time management apps in planning (BF-2) Create worksheets (BF-3) Use device to record data (AD-1) Create videos (AD-2) Scan textbooks (AD-4) Educate learners for device functionality to adapt to rural areas	**Should have skills:** (UI-1) General understanding of internet (UI-2) Manage slow connection efficiently (SI-2) Share information via web links (CT-1) Collaborate via social media (CT-2) Tele-conference with learners and colleagues (OG-1) Create online learning group (CC-1) Share content (CO-1) Communicate through emails	**Should have skills:** (GV-2) Create a video (CR-1) Integrate and create information (WS-1) Edit in word processor (WS-2) Use Excel and other apps (MS-1) Source answers online (VM-2) Express one's self through media (VM-3) Listen to music and watch videos (VM-4) Understand text, video, audio and maps (VM-5) Understand media expressions (VM-6) Capture images (BK-1) Contribute to knowledge	**Should have skills:** (DT-1) Use information responsibly (DT-2) Teach learners to analyse information (DT-3) Evaluate web content (DI-1) Understand data cost (AR-1) Workaround skills for resource constraints

(AD-5) Enable shared computing (AD-6) Enable device sharing amongst learners (AD-10) Use cache memory (AD-12) Encourage file sharing via Bluetooth		(RT-1) Process large amount of information (RT-2) Assess quality and validity of information (RT-3) Access e-publications and e-books	
Could have skills: (GS-11) Use mobile device affordances to enhance learning (AD-3) Enable transition to mobile devices for learners (AD-7) Charge devices always (AD-8) Use different power supplies (AD-9) Save content for offline use (AD-13) Use online tutorials (NV-2) Multi task on device whilst teaching (NV-3) Navigate between educator and learner device (AM-2) Disable automatic app updates	**Could have skills:** (CC-2) Blogs to create content (CC-3) Use wikis for knowledge generating and feedback (OG-2) Use device as blogging tool (SN-1) Create digital e-portfolios	**Could have skills:**	**Could have skills:**
Nice to have skills: (AM-5) Use online quizzes and electronic polls	**Nice to have skills:**	**Nice to have skills:**	**Nice to have skills:**

Figure 7-53 represents the four sets of skills, as per the MoSCoW rating: must have skills, should have skills, could have skills and nice to have skills. Each circle represents a dimension from the framework and in each dimension each skill is rated according to the category of importance. The skills are also indicated in the different groupings of importance according to an educator alone, an expert alone or both an educator and expert.

Table 7-43 enables the identification of the skill according to the codes used in Figure 7-53. The researcher created codes for each skill to prevent the final framework from being cumbersome, thus enhancing understanding and interpretation of Figure 7-53.

Table 7-43 does not only serve as a key to the skill codes, but as a *final framework for mobile digital literacy skills for an educator using mobile technology in rural formal education*. as can be seen due to the repetition of skills in the scatter graph in Figure 7-53, the researcher rounded down the skills to either of the four categories. After having rounded down the skills, consensus was used to determine the final category as indicated in Table 7-43.

7.14 SUMMARY

This chapter presented and discussed opinions and perspectives of experts and educators with the aim of answering the main research question: *How can a framework for mobile digital literacy skills support educators using mobile technology in formal rural education?* presented in Chapter 1. This section used the Theoretical framework (Section 5.6.3) to gain insight from a practical aspect. Each skill in the framework was assessed by four experts and 20 educators using a four-point Likert scale. The ratings on the Likert scales were assigned a numerical value to derive an average agreement rating. Based on this rating the skills were classified as: must have skills, should have skills, could have skills and, lastly, nice to have skills. These skills were then summarised into the final framework presented in Section 7-13.

CHAPTER 8: CONCLUSION

Chapter 7 presented the final framework (Section 7.13) derived from the findings presented in the said chapter and consolidated with the Theoretical framework (Section 5.6) from literature.

In this final chapter the research outcomes are briefly summarised with reference to the research questions. A summary of the thesis chapters is presented in Section 8.1. The outline of the study, along with a discussion as to the success of the research in answering the research questions, is offered in Section 8.2. Section 8.3 reviews the study contributions and Section 8.4 provides an overview of the limitations of this research work. Section 8.5 highlights possibilities for future research, 8.6 reflects on the study and Section 8.7 presents concluding remarks.

8.1 SUMMARY OF CHAPTERS

Section 1.7 presented the organisation of this dissertation as well as the focus of each chapter. This section provides a brief summary highlighting the main points of Chapters 1 to 8.

- *Chapter 1: Introduction* defined this study. The research questions in Section 1.2.2 and 1.2.3 enabled explanation of the research rationale and placed the study in context.
- *Chapter 2: Literature review* facilitated the conceptualisation of the literature review that was made up of three different chapters.
- *Chapter 3: Educators technological pedagogical skills.* This chapter helped to construct a deep understanding of the broad term *digital literacy*. The different components and literacies were combined to derive one model.
- *Chapter 4: Mobile information and communication technology.* This chapter discussed the different types of mobile technologies along with mobile connectivity. The chapter further mentioned the use of mobile technology along with the digital skills required specifically for mobile technology.
- *Chapter 5: ICT in education – a rural South African perspective.* This chapter described what rural areas are and the challenges to using ICT in rural education. The chapter then elaborated on the specific skill set an educator

needs to facilitate the use of mobile technology in rural education. The chapter concluded with a draft Theoretical framework and an overall mind map.

- *Chapter 6: Research methodology* depicted the research methodology adapted for this study. The research methodology was illustrated in the research onion (Figure 6-11). The research design explicitly accommodated the needs of this study to facilitate the collection of the required data and validate for reliability.
- *Chapter 7: Finding and analysis* presented results of the qualitative research study. Four expert reviews and 20 participant questionnaires led to a refined and validated framework for mobile digital literacy skills for an educator using mobile technology in rural formal education.

8.2 OVERVIEW OF THE STUDY

This section provides an overview of this study. Section 8.2.1 discusses the research process whereas Section 8.2.2 provides a reflection of the key findings of the research.

8.2.1 Research process

This dissertation documents the exploration of the research problem explained in Chapter 1 of this study. The research was contextualised through a framework in the rural formal education sector of South Africa. Mobile digital literacy skills in the rural formal education sector were explored in literature, verified through qualitative questionnaires and analysed according to the data collected from educators currently using mobile technologies in the rural classroom. The *main research question* that directed and outlined this exploration were:

How can a framework for mobile digital literacy skills support educators using mobile technology in rural formal education?

The following sub-research questions were formulated to support the exploration:

- *How can mobile digital literacy skills, from literature, support educators when using mobile technology in formal education? and*
- *How do the identified mobile digital literacy skills influence educators' practice in rural formal education?*

The exploration followed a qualitative approach towards answering the research question. The research process comprised three phases, as depicted in Figure 8-1.

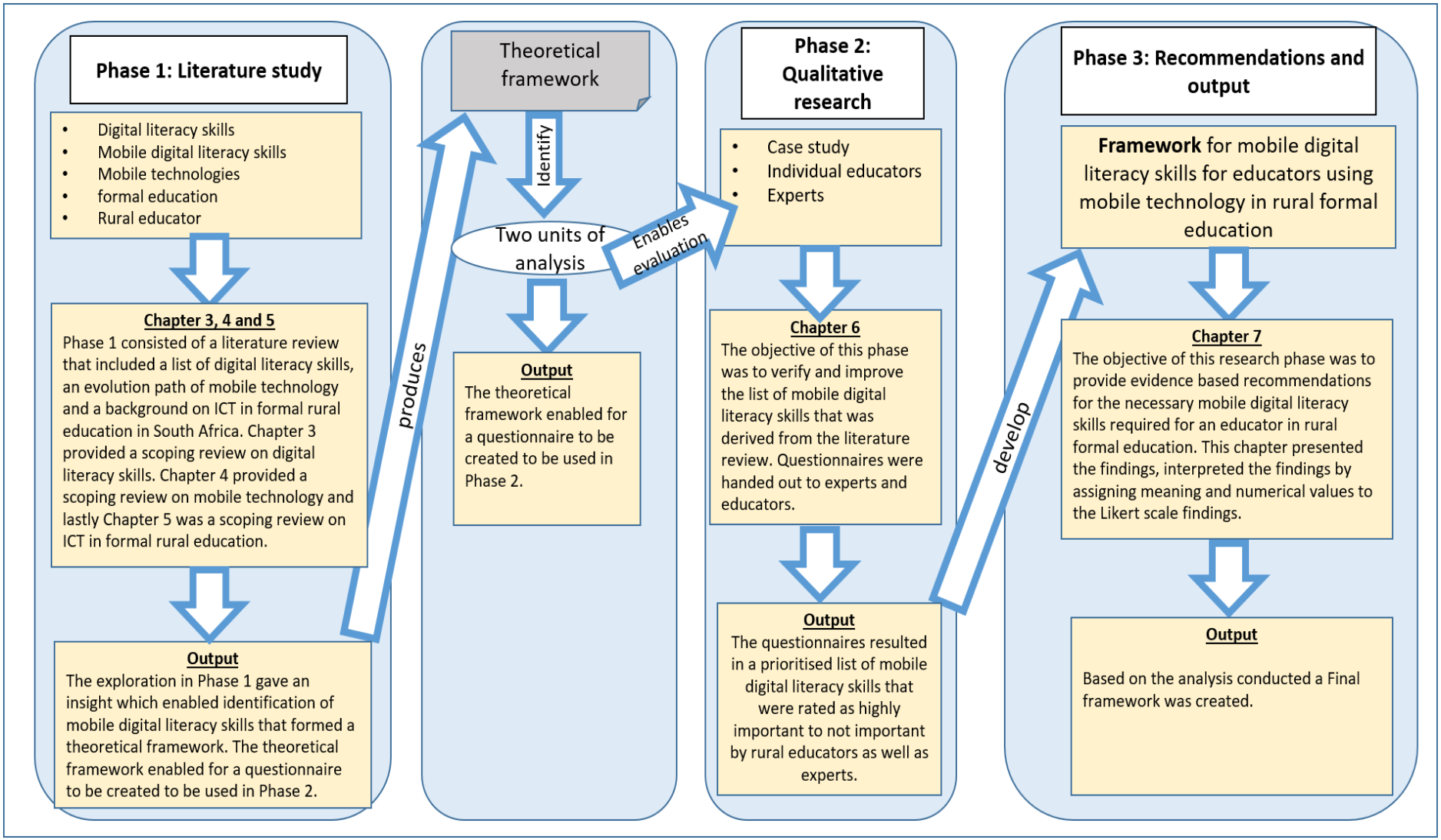


Figure 8-1: Research process applied in this study.

8.2.2 **Reflection on key findings**

The findings were derived from the literature and from the questionnaires which were completed by both experts and educators.

8.2.2.1 Sub-research question 1

How can mobile digital literacy skills, from literature, support educators when using mobile technology in formal education?

Sub-research question 1 was addressed in Chapters 3, 4 and 5. Chapter 3 provided an overview of digital literacy skills. Chapter 4 provided the background to mobile technology and, lastly, Chapter 5 provided literature on the current situation with regards to ICT in formal rural education. Much research was available on the definition of digital literacy skills as well as components of digital literacy. The definition of digital literacy, along with its components, was collated to create a digital literacy model. A few researchers have investigated mobile technologies in rural formal education. Amongst other challenges, lack of mobile digital literacy skills was a prevailing hindrance to the successful implementation of mobile technologies in formal rural education. Not much research has been conducted to identify a set of specific mobile digital literacy skills needed by a rural formal educator to successfully implement mobile technology in the classroom. Chapters 3, 4 and 5 of this dissertation alongside an evaluation by two domain experts resulted in the identification of possible mobile digital literacy skills for a Theoretical framework which then served as a foundation for the qualitative research phase.

8.2.2.2 Sub-research question 2

How do the identified mobile digital literacy skills influence educators' practice in rural formal education?

Sub-research question 2 was answered in Chapters 6 and 7 of the dissertation. Questionnaires were handed out to four experts in the field of education, specifically involved in the development of the ICT4RED project. Questionnaires were also handed out to 20 educators which formed part of the ICT4RED project. The results of the questionnaires led to the compilation of a *final framework* (Section 7.13). The list of skills in the final framework were compiled by asking the experts and educators to rank the importance of each skill identified in the literature.

8.2.2.3 Main research question

How can a framework for mobile digital literacy skills support educators using mobile technology in rural formal education?

The main research question addressed in this dissertation relates to mobile digital literacy skills that an educator needs to be able to implement mobile technologies in rural formal education. The two sub-research question enabled the realisation of the main research question. Mobile digital literacy skills were identified through a literature review, evaluated by domain experts, then verified and prioritised through expert reviews and questionnaires.

A total of 80 mobile digital literacy skills were considered as 'must have' and 'should have' skills. Therefore, these skills were considered important. This list of skills, according to categories, is presented in Table 8-1.

Table 8-1: Prioritised mobile digital literacy skill list for educators using mobile technology in rural formal education.

Technical dimension	Social-emotional dimension	Cognitive dimension	Other dimensions
(GS-1) Mobile device operation (GS-2) Charge multiple devices (GS-3) Support subject material (GS-4) Encourage mobile technologies (GS-5) Maintain common settings across devices (GS-6) Connect device to Wi-Fi (GS-7) Data usage and financial cost (GS-8) Use Bluetooth in class for file sharing (GS-9) Connect to peripheral devices in class (GS-10) Basic problem solving through troubleshooting guide (GS-11) Use mobile device affordances to enhance learning (GS-12) Understand device specifications (BF-1) Use time management apps in planning (BF-2) Create worksheets (BF-3) Use device to record data (AD-1) Create videos (AD-2) Scan textbooks (AD-3) Enable transition to mobile devices for learners (AD-4) Educate learners for device functionality to adapt to rural areas (AD-5) Enable shared computing	(UI-1) General understanding of internet (UI-2) Manage slow connection efficiently (UI-3) Use online browser and cache memory (SI-1) Find relevant information (SI-2) Share information via web links (CT-1) Collaborate via social media (CT-2) Tele-conference with learners and colleagues (OG-1) Create online learning group (OG-2) Use device as blogging tool (CC-1) Share content	(GV-1) Understanding file formats (GV-2) Create a video (CR-1) Integrate and create information (CR-2) Find information in different formats (CR-3) Adapt web content for the class (WS-1) Edit in word processor (WS-2) Use Excel and other apps (MS-1) Source answers online (DC-1) Synthesise digital resources (VM-1) Assign meaning to images and graphs (VM-2) Express one's self through media	(DT-1) Use information responsibly (DT-2) Teach learners to analyse information (DT-3) Evaluate web content (DI-1) Understand data cost (AR-1) Workaround skills for resource constraints

(AD-6) Enable device sharing amongst learners (AD-7) Charge devices always (AD-8) Use different power supplies (AD-9) Save content for offline use (AD-10) Use cache memory (AD-11) Access digital textbooks (AD-12) Encourage file sharing via Bluetooth (AD-13) Use online tutorials (NV-1) Use of touch screens and navigate between screens (AM-1) Use different phone interfaces (AM-2) Disable automatic app updates (AM-3) Use educational games in class (AM-4) Use subject specific applications (AM-5) Use online quizzes and electronic polls (SO-1) Educate learners on device safe-keeping (SO-2) Deal with power surges	(SN-1) Create digital e-portfolios (CO-1) Communicate through e-mails (CD-1) Decent behaviour on the internet (CD-2) Netiquette (SW-1) Beware of what to publish publicly (SW-2 Keep learners safe online (SW-3) Dangers of unsafe networks (SW-4) Identify online threats (SW-5) Avoid copying published work (SW-6) Legal rights when online	(VM-3) Listen to music and watch videos (VM-4) Understand text, video, audio and maps (VM-5) Understand media expressions (VM-6) Capture images (BK-1) Contribute to knowledge (RT-1) Process large amounts of information (RT-2) Assess quality and validity of information (RT-3) Access e-publications and e-books	

Table 8-1 summarised the “must have” and “should have” skills from the mobile digital literacy skills framework presented in Section 7.13.

It is recommended that educators and rural TPD developers, who wish to integrate mobile technologies in rural education in South Africa, should consider the list presented in Table 8-1.

The mobile digital literacy skills are divided into four dimensions, namely: technical dimension, social-emotional dimension, cognitive dimension and other dimensions. It is recommended that these dimensions be considered when mobile digital literacy skills training and training sessions are considered.

8.3 SIGNIFICANCE AND CONTRIBUTIONS OF THIS RESEARCH

Section 1.2.1 highlights the purpose of this research. The contribution and importance of this study was discussed. The results of this study highlight that the research findings are important and can contribute to the field of information systems research, specifically for researchers focusing on mobile technologies and mobile digital literacy skills within rural formal education.

The findings from this study are significant to the academic body of knowledge in that:

- The findings suggest exploratory insights into mobile digital literacy skills that are required by educators in rural formal education in South Africa.
- The findings offer a deeper understanding of mobile technologies and their benefits in education.
- Challenges associated with the implementation of mobile technologies in rural formal education.
- The findings offer ground research for further research initiatives with regard to mobile digital literacy skills in rural formal education.
- The framework serves as a guide for future training programmes designed for educators in a rural setting.

Educators and experts developing courses for ICT in schools may also benefit from this study, as they seek to enhance their skills to heighten the success of implementing mobile technologies in rural formal education. This study provides educators with a list of skills to assess themselves in terms of implementing mobile technology in the classroom.

The knowledge gained from this study resulted in a summarised list of mobile digital literacy skills presented in the form of a framework (Section 7-13). The list of skills in the framework could serve as a guide for future research.

8.4 LIMITATIONS OF RESEARCH

Every research study has limitations (Hofstee, 2006) and these should be clearly stated (Patton, 1990) thus clearly defining the restrictions of the scope of the study (Hofstee, 2006). The limitations experienced in this study are briefly defined.

Generalisability of results could be affected as research participants were purposefully chosen for this study. Only educators who formed part of the ICT4RED and DRDLR ICT4E projects were chosen. Other possible educators were excluded as they were not part of these projects in the rural areas under consideration. In accordance with the limitation mentioned, the study was thus restricted to:

- Rural educators,
- Currently using mobile technology in the classroom,
- The classroom being in a rural area,

- The classroom being part of a formal education system such as a school.

The framework developed in this study although functional, might not be repeatable. The researcher rounded the mobile digital literacy skills down as per consensus due to repetition, other researchers could identify other categories and other ways of classifying skills in the relevant categories. The limitations therefore, can be seen as possible opportunities for future research.

8.5 POSSIBLE FUTURE RESEARCH

This study could assist as groundwork for other research projects in the future. Possible research to be explored could include:

- List of mobile digital literacy skills from a learner's point of view.
- The study could be implemented in other schools, not only those in rural areas.
- The study could be further explored in other developing countries that face similar hurdles to the rural schools in South Africa.
- A similar study could be done with a greater sample of respondents to curb the limitation of generalisability.
- A comparative study can be conducted to see how the list of mobile digital literacy skills would differ in an urban school.

Mobile technologies are being significantly integrated into many, if not all, aspects of life. As indicated in literature, mobile digital literacy skills play a significant part in enhancing the successful integration of technology in rural formal education. This study covered only a small section of mobile technology integration in schools and therefore a lot more exploration can be done in order to fully revolutionise education.

8.6 REFLECTIONS

This section elaborates on a scientific, methodological and personal reflection of this study.

8.6.1 Scientific reflection

This study outlined mobile digital literacy skills for rural educators using mobile technologies within rural formal education in South Africa. The framework containing a list of mobile digital literacy skills can be considered as a foundation for future

research. Although mobile digital literacy skills are imperative in many aspects of life and different economic sectors, this study focused mainly on the educational aspect.

8.6.2 **Methodological reflection**

The research methodology followed a qualitative slant and supported the interpretivist approach. This study is another example of the use of case study.

The qualitative phases of research supported and enhanced the list of mobile digital literacy skills. A list of possible mobile digital literacy skills was identified and informed a Theoretical framework which served as a foundation for the qualitative research. Considering the opportunities and challenges of this study, the research methodology was a suitable choice.

The study included three samples:

- Domain experts used to evaluate the relevance and validity of the list of mobile digital literacy skills derived from literature.
- Experts used to evaluate the relevance, applicability, conciseness and comprehensiveness of the list of mobile digital literacy skills.
- Educators using mobile technology in the classroom, therefore validating the skills.

A sample of two domain experts and four experts were used for the qualitative research. As discussed in Section 6.8.3.2, a sample size of up to five experts is sufficient (Holbrook et al., 2007). A total of 20 educators, or respondents, were used for the qualitative questionnaire.

The qualitative research method is grounded on hermeneutical principles (Section 6.9), as suggest by Klein et al. (1999).

The data analysis technique conforms to some methodological principles, therefore making the data analysis techniques justifiable for use in this study.

8.6.3 **Personal reflections**

This research taught me to be disciplined, persevere against all odds and stay focused. Initially the net was cast too wide and I struggled to narrow down the research scope. It took much reading and narrowing down to arrive at the ultimate research question to guide this study. Another problem encountered involved contacting and

communicating with the educators from the rural areas. In future, I would look into hiring a translator.

When I reflect on this study, I experience a sense of satisfaction at the Theoretical contribution made, the research methodology used and the personal growth achieved.

8.7 CLOSING REMARKS

The focus of this dissertation was the development of a *framework for mobile digital literacy skills for educators using mobile technology in rural formal education*. The researcher followed an interpretivist approach to realise the purpose of this study. This qualitative study enabled the researcher to explore the case within a natural setting.

This study Theoretical has contributed to the academic body of knowledge in two fields: information systems and m-learning. The practical contribution of the study could be an enhanced learning system in South Africa, thus improving literacy in the country. The need for sufficient mobile digital literacy skills for educators using mobile technology in rural formal education cannot be overlooked. Mobile digital literacy skills are fundamental to successful mobile technology integration in the rural schooling sector of South Africa.

REFERENCES

Aabø, S. (2005). The role and value of public libraries in the age of digital technologies. *Journal of Librarianship and Information Science, 37*(4), 205-211. doi:10.1177/0961000605057855

Abend, G. (2013). "The Meaning of Theory." *Sociology, 26*, 173-199.

Adom, D., Hussein, E. K., & Agyem, J. A. (2018). Theoretical and conceptual Framework: Mandatory ingredients of a quality research. *INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH, 7*(1).

Aker, J. C., & Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives, 24*(3), 207-232. doi:10.1257/jep.24.3.207

Alazam, A.-O., Bakar, A., Hamzah, R., & Asmiran, S. (2012). Teachers' ICT skills and ICT integration in the classroom: the case of vocational and technical teachers in Malaysia. *Creative Education, 3*, 70.

Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality progress, 40*(7), 64-65.

Andreea-Diana, S. (2014). The importance of involving pupils from the rural area in using ICT skills and tools–a milestone. *Procedia-Social and Behavioral Sciences, 128*, 36-43.

Anzai, D. (2018). Early literacy skills: Finding the right pathway for each child.

Armstrong, R., Hall, B. J., Doyle, J., & Waters, E. (2011). 'Scoping the scope'of a cochrane review. *Journal of Public Health, 33*(1), 147-150.

Astill, J. (2017). Beefing up mobile-phone and internet penetration in Africa. *The Economist*.

Aventurier, P. (2014). *Academic social networks: challenges and opportunities.* Paper presented at the 7th UNICA Scholarly Communication Seminar.

Bagot, K., Matthews, S., Mason, M., Squeglia, L., Fowler, J., Gray, K., . . . Godino, J. (2018). Current, Future and Potential Use of Mobile and Wearable Technologies and Social Media Data in the ABCD Study to Increase Understanding of Contributors to Child Health. *Developmental cognitive neuroscience*.

Bair, R., & Stafford, T. (2012). Digital literacy. *Training & Development*(June), 4-4.

Bansal, T., & Joshi, D. (2014). A study of students experiences of WhatsApp mobile learning. *Global Journal of Human-Social Science Research*.

Bartikowski, B., Laroche, M., Jamal, A., & Yang, Z. (2018). The type-of-internet-access digital divide and the well-being of ethnic minority and majority consumers: A multi-country investigation. *Journal of Business Research, 82*, 373-380.

Batchelor, J., & Botha, A. (2007). Design Criteria for Mobile Phones : A Teenagers Perspective.

Batchelor, J., Ford, M., & Botha, A. (2009). Once upon a time in a mobile world … Activity Theory as an Analysis Tool. *2*.

Beauchamp, T. L., & Childress, J. F. (2001). *Principles of biomedical ethics*: Oxford University Press, USA.

Bekhet, A. K., & Zauszniewski, J. A. (2012). Methodological triangulation: An approach to understanding data. *Nurse researcher*.

Bhatnagar, S. (2000). *Information and Communication Technology in Rural Development*.

Bhavnani, A., Chiu, R. W.-W., Janakiram, S., & Silarszky. (2009). the Role of Mobile Phones in sustainable rural poverty reduction.

Bingimlas, K. A. (2009). Barriers to the succesful ontegration of ICT in teaching and learning environments: A review of literature. *Eurasia Journal of Mathematics, Science & Technology Education*, 235-245.

Blanche, M. T., Durrheim, K., & Painter, D. (2006). *Research in practice: Applied methods for the social sciences*: Juta and Company Ltd.

Blodgett, J. (2017). Taking the class out of the classroom: Libraries, literacy, and service learning *The Experiential Library* (pp. 43-52): Elsevier.

Bocconi, S., Kampylis, P. G., & Punie, Y. (2012). Innovating learning: Key elements for developing creative classrooms in Europe. *Luxembourg: JRC-Scientific and Policy Reports*.

Boileau, T. (2014). *Modeling Digital Literacy Skills Living in the Information Age*. Retrieved from http://www.academia.edu/6555011/Methods_for_Teaching_Digital_Literacy:

Botha, A., Berg, M. V. D., Batchelor, J., & Sedano, C. A. I. (2008). Ability through Mobility.

Botha, A., & Herselman, M. (2015). ICTs in Rural Education. 105-113. doi:10.1145/2830629.2830646

Bouma, G. D., & Ling, R. (2004). *The research process*: Oxford University Press, USA.

Bradshaw, H. M., & Park, C. (2011). Economic and Social Benefits of Digital Inclusion for Individuals and Wider Society Evidence Review Recommendations on how to develop a robust framework for exploring costs and benefits of digital inclusion in Wales Case Studies–Carmarthenshire 50+ Forum Social Research Division.

Brewer, J., & Hunter, A. (2006). *Foundations of multimethod research: Synthesizing styles*: Sage.

Bronfenbrenner, U. (1977). Toward an Experimental Ecology of Human Development. (JULY), 513-531.

Brown, H., & Mbati, L. S. (2015). Mobile Learning: Moving Past the Myths and Embracing the Opportunities. *16*(2), 115-115.

Buabeng-Andoh, C. (2012). An Exploration of Teachers' Skills, Perceptions and Practices of ICT in Teaching and Learning in the Ghanaian Second-Cycle Schools. *Contemporary Educational Technology, 3*(1).

Buabeng-Andoh, C. (2012). Factors influencing teachers ' adoption and integration of information and communication technology into teaching : A review of the literature Charles Buabeng-Andoh. *international journal of education and Development using Information and Communication Technology, 8*(1), 136-155.

Buzzetto, H. N., Elobaid, M., & Elobeid, M. (2018). Addressing Information Literacy and the Digital Divide in Higher Education. *Interdisciplinary Journal of E-Learning and Learning Objects, 14*(1), 77-93.

Cachia, R., Ferrari, A., Ala-Mutka, K., & Punie, Y. (2010). Creative learning and innovative teaching. *Final report on the study on creativity and innovation in education in the EU member states*.

Cachia, R., Ferrari, A., Ala-mutka, K., & Punie, Y. (2010). *Creative Learning and Innovative Teaching Final Report on the Study on Creativity and Innovation in Education in the EU Member States*.

Cambridge. (2015). Digital technologies in the classroom. *Review of Educational Research*, 4-4.

Casey, M., & Babu, A. (2016). *Game of Phones: Deloitte's Mobile Consumer Survey. The Africa cut 2015/2016.* . Retrieved from https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/ZA_Deloitte-Mobile-consumer-survey-Africa-300816.pdf

Caudill, J. G. (2007). The Growth of m-Learning and the Growth of Mobile Computing: Parallel developments. *International Review of Research in Open and Distance Learning, 8*(2).

Cavus, N., & Ibrahim, D. (2009). m-Learning: An experiment in using SMS to support learning new English language words. *British Journal of Educational Technology, 40*(1), 78-91.

Cellular News. (2009). “South Africa Mobile Penetration Level Breaks the 100% Mark”. *20th Jan 2009*. Retrieved from http://www.cellular-news.com/story/35620.php.

Cerda-Diaz, L. (2017). Assessment in TIC Skills in Pedagogy Students of the Catholic University of Maule (Chile). *Procedia-Social and Behavioral Sciences, 237*, 893-899.

Chan, W. M. (2014). Video podcasting as a supplementary language learning tool–A study of its use, student access and perceptions. *Electronic Journal of Foreign Language Teaching, 11*(1), 183-206.

Chang, C.-Y., & Hwang, G.-J. (2018). Trends of mobile technology-enhanced medical education: a review of journal publications from 1998 to 2016. *Int. J. Mobile Learning and Organisation, 12*(4), 373.

Cheung, A., & Slavin, R. E. (2011). [The effectiveness of education technology for enhancing reading achievement: A meta-analysis].

Chew, S. W., Cheng, I.-L., & Chen, N.-S. (2018). Exploring challenges faced by different stakeholders while implementing educational technology in classrooms through expert interviews. *Journal of Computers in Education, 5*(2), 175-197.

Chigona, A., Chigona, W., & Davids, Z. (2014). Educators' motivation on integration of ICTs into pedagogy: case of disadvantaged areas. *South African Journal of Education, 34*(3), 01-08.

Chipangura, B. (2016). A Framework for providing mobile centric services to students at higher education institutions: The case of open distance learning.

Choudrie, J., Islam, M. S., Wahid, F., Bass, J. M., & Priyatma, J. E. (2017). *Information and Communication Technologies for Development: 14th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2017, Yogyakarta, Indonesia, May 22-24, 2017, Proceedings* (Vol. 504): Springer.

Clark, M., Coward, C., Rothschild, C., Reynal, l. d., & Richter, B. (2017, 2017). *Towards a Mobile Information Literacy framework: Rethinking Information Literacy in a Mobile Era*.

Clark, M., Coward, C., Rothschild, C., Reynal, L. d., & Richter, B. (2017). Towards a mobile information literacy framework: Rethinking information literacy in a mobile era. *iConference 2017 Proceedings*.

Cochrane, T. D. (2010). Exploring mobile learning success factors. *ALT-J, 18*(2), 133-148. doi:10.1080/09687769.2010.494718

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America*: Teachers College Press.
Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., . . . Moher, D. (2014). Scoping reviews: time for clarity in definition, methods, and reporting. *Journal of clinical epidemiology, 67*(12), 1291-1294.
Craig, B., Price, E., & Howley, A. (1995). The Power of Babble : Technology and Rural Education. 19-19.
Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.
Creswell, J. W. (2007). *Qualitative inquiry and research design* (Second ed.): SAGE.
Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.
Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: a step-by-step approach. *British journal of nursing, 17*(1), 38-43.
D'Alessio, S., Donnelly, V., & Watkins, A. (2010). Inclusive education across Europe: the move in thinking form integration for inclusive. *Revista de Psicología y Educación, 1*(5), 109-126.
Daccord, T. (2012). 5 critical mistakes schools make with iPads (and How to Correct Them). *Edudemic. Retreived from http://www. edudemic. com/2012/09/5-critical-mistakes-schools-iPads-and-correct-them*.
Daccord, T. (2012). 5 Critical Mistakes Schools Make With iPads (And How To Correct Them). Retrieved from http://www.edudemic.com/2012/09/5-critical-mistakes-schools-ipads-and-correct-them/
Dahlstrom, E., Walker, J., & Dziuban, C. (2013). *ECAR study of undergraduate students and information technology*. Retrieved from www.educause.edu/ecar:
Dalvit, L., Kromberg, S., & Miya, M. (2014). *The data divide in a South African rural community: a survey of mobile phone use in Keiskammahoek.* Paper presented at the Proceedings of the e-Skills for knowledge production and innovation conference.
Darab, B., & Montazer, G. A. (2011). An eclectic model for assessing e-learning readiness in the Iranian universities. *Computers & Education, 56*(3), 900-910.
David, M., & Sutton, C. D. (2011). *Social research: An introduction*: Sage.
Davis, K., Drey, N., & Gould, D. (2009). What are scoping studies? A review of the nursing literature. *International journal of nursing studies, 46*(10), 1386-1400.
Deaney, R., Ruthven, K., & Hennessy, S. (2006). Teachers' developing 'practical theories' of the contribution of information and communication technologies to subject teaching and learning: an analysis of cases from English secondary schools. *British Educational Research Journal, 32*(3), 459-480.
DeKeseredy, W., & Schwartz, M. (2009). *Dangerous exits: Escaping abusive relationships in rural America*: Rutgers University Press.
Delony, D. (2017). LAN WAN PAN MAN: Learn the Differences Between These Network Types.
Denzin, N. (1970). Strategies of multiple triangulation. *The research act in sociology: A theoretical introduction to sociological method, 297*, 313.
Dhir, A., Kaur, P., Jere, N., & Albidewi, I. A. (2012). *Understanding mobile phone battery-human interaction for developing world a perspective of feature phone users in africa.* Paper presented at the Future Internet Communications (BCFIC), 2012 2nd Baltic Congress on.

Dinkelman, T. (2008). The Effects of Rural Electrification on Employment : New Evidence from South Africa.

Dlamini, S., Meyer, I., Marais, M., & Ford, M. (2017). *An implementation readiness framework for education systems: Integrating ICT into teaching and learning.* Paper presented at the IST-Africa Week Conference (IST-Africa), 2017.

Dlodlo, N. (2009). Access to ICT Education for girls and women in rural South Africa: A case study. *Technology in society*, 1-12.

Doyle, A. (2017). [What is a skill set?].

EdTech Team. (2015). The 20 Digital Skills Every 21st Century Teacher should have.

Eisner, E. W. (2017). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*: Teachers College Press.

Engelbrecht, E. (2003). A look at e-learning models: investigating their value for developing an e-learning strategy. *Progressio, 25*(2), 38-47.

Ertzberger, J., & Martin, F. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education, 68*, 76-85. doi:10.1016/j.compedu.2013.04.021

eSchoolMedia. (2011). *Education's Guide to Mobile Devices: Everything You Need to Know About Mobile Tech and Your Schools*. Retrieved from

Eshet-Alkalai, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia, 13*(1), 93-106.

Eshet-alkalai, Y., & Chajut, E. (2009). Changes Over Time in Digital Literacy. *12*(6).

Farrel, G., & Isaacs, S. (2007). Survey of ICT and Education in Africa.

Ferrari, A. (2008). *Digital Competence in Practice : An Analysis of Frameworks*. Retrieved from www.jrc.ec.europa.eu:

Fin24. (2014). Via Afrika CEO on global innovators list. *News24*. Retrieved from http://m.news24.com/fin24/Tech/Companies/Via-Afrika-CEO-on-globalinnovator-%0Alist-20141119

Fink, A. (2005). *Conducting Research Literature Reviews* (2nd ed.): SAGE Publications.

Finn-Stevenson, M. (2018). *Schools of the 21st century: Linking child care and education*: Routledge.

Fisher, I., & Ziviani, J. (2004). Explanatory case studies: Implications and applications for clinical research.

Floricel, S., Piperca, S., & Tee, R. (2018). Representation and flexibility strategies for managing the dynamic and structural consequences of project complexity. *Complexity*.

Ford, M., Botha, A., & Herselman, M. (2014). ICT4RED 12—Component implementation framework: A conceptual framework for integrating mobile technology into resource-constrained rural schools. *IST-Africa Conference …*, 1-11. doi:10.1109/ISTAFRICA.2014.6880597

Frank, T. H., & Castek, J. (2017). From digital literacies to digital problem solving: Expanding technology-rich learning opportunities for adults. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 6*(2), 66.

Fu, Q.-K., & Hwang, G.-J. (2018). Trends in mobile technology-supported collaborative learning: A systematic review of journal publications from 2007 to 2016. *Computers & Education, 119*, 129-143.

Gazette, G. (2004). White Paper. *470*(26734).

Gill, J., & Johnson, P. (2010). *Research methods for managers*: Sage.
Gilster, P. (1997). Digital literacy. The thinking and survival skills new users need to make the internet personally and professionally meaningful.
Glaser, R., & Chi, M. T. (1988). Overview. The nature of expertise *The nature of expertise*, 15-18.
Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *8*(4), 597-606.
Gopalan, A., Karavanis, S., Payne, T., & Sloman, M. (2011, 2011). *Smartphone based E-learning*, Noordwijkerhout, Netherlands.
Gracia-Penalvo, F., Hernandez-Gracia, A., Conde, M., Fidalgo-Blanco, A., Alier, M., Sein_Echaluce, M., . . . Iglesias-Pradas, S. (2015, 2015). *Learning services-based technological ecosystems*.
Granger, C., Morbey, M. L., Lotherington, H., Owston, R., & Wideman, H. (2002). Canada : Factors contributing to teachers' successful implementation of information technology. *Annual meeting of AERA*(June 2015), 1-40. doi:10.1046/j.0266-4909.2002.00259.doc.x
Guba, E., & Lincoln, Y. (1994). Competing Paradigms in Qualitative Research (pp. 105-117).
Gustafsson, J. (2017). Single case studies vs. multiple case studies: A comparative study.
Haddad, G., Trucano, M., & Wacholz, C. (2007). ICT–in-Education Toolkit for policymakers, planners, and practitioners: Paris: UNESCO and World Bank-InfoDev. http://www. ictinedtoolkit. org/usere/login. php.
Hadjerrouit, S. (2010). A Theoretical Framework to Foster Digital Literacy: The Case of Digital Learning Resources *Key Competencies in the Knowledge Society* (pp. 144-154): Springer.
Hansen, J. J. (2018). Digital literacy–cognitive strategies, genre skills and situated practice *Designing for Learning in a Networked World* (pp. 138-157): Routledge.
Harper, V. (2003). The digital divide (DD): A reconceptualization. *Association for the Advancement of Computing in Education (AACE), 11*(1), 96-103.
Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). *Case study research: foundations and methodological orientations.* Paper presented at the Forum Qualitative Sozialforschung/Forum: Qualitative Social Research.
Hart, C. (1998). Doing a Literature Review. *SAGE publications*, 239-239.
Hassan, M. M., Albakr, H. S., & Al-Dossari, H. (2014). *A cloud-assisted internet of things framework for pervasive healthcare in smart city environment.* Paper presented at the Proceedings of the 1st International Workshop on Emerging Multimedia Applications and Services for Smart Cities.
Hausknecht, S., & Kaufman, D. (2018). *Increasing digital literacy skills of older adults through a digital storytelling project-based course.* Paper presented at the EdMedia+ Innovate Learning.
Heeks, R. (2006). Health information systems: Failure, success and improvisation. *International journal of medical informatics, 75*(2), 125-137.
Herrington, a. (2009). Using a smartphone to create digital teching episodes as resouces in adult education. *New technologies, new pedagogies: Mobile learning in higher education*, 28-35.
Herselman, M. (2003). ICT in Rural Areas in South Africa : Various Case Studies Drawbacks Encountered in Uplifting Rural Schools. *informing Science*(June).

Herselman, M., & Botha, A. (2013). Supporting rural teachers 21stcentury skills development through mobile technology use: A case in Cofimvaba, Eastern Cape, South Africa. *Adaptive Science and Technology (…*. doi:10.1109/ICASTech.2013.6707490

Herselman, M., & Botha, A. (2015). A Teacher Tablet Toolkit to meet the challenges posed by 21st century rural teaching and learning environments. *South African Journal of Education, 35*(4), 19-19.

Herselman, M., Ford, M., & Botha, A. (2014). ICT4RED 12—Component implementation framework: A conceptual framework for integrating mobile technology into resource-constrained rural schools. *IST-Africa Conference …*, 1-11. doi:10.1109/ISTAFRICA.2014.6880597

Herzon, R. M. J., & Pittman, R. B. (1995). *Home, Family and Community: ingredients in the rural education equation*. Retrieved from

Hevner, A., & Chatterjee, S. (2010). Design science research in information systems *Design research in information systems* (pp. 9-22): Springer.

Hicks, T., & Turner, K. H. (2013). No longer a luxury: Digital literacy can't wait. *English Journal, 6*, 58-65.

Hofstee, E. (2006). Constructing a good dissertation. *Johannesburg: EPE*.

Hoinville, G., & Jowell, R. (1978). Survey research practice.

Holbrook, A. L., Krosnick, J. A., Moore, D., & Tourangeau, R. (2007). Response order effects in dichotomous categorical questions presented orally: The impact of question and respondent attributes. *Public Opinion Quarterly, 71*(3), 325-348.

Hoskins, B., & Fredriksson, U. (2008). *Learning to Learn: What is it and can it be measured?* : European Commission JRC.

Houghton, C., Casey, D., & Smyth, S. (2017). Selection, collection and analysis as sources of evidence in case study research. *Nurse Researcher (2014+), 24*(4), 36.

Howley, A., & Hough, B. (2011). Rural Elementary School Teachers ' Technology Integration. *26*(9).

Huang, I., Guo, R., Xie, H., & Wu, Z. (2012). The convergence of information and communication technologies gains momentum. *The global information technology report*, 35-45.

Hussein, A. (2009). The use of Triangulation in Social Sciences Research : Can qualitative and quantitative methods be combined ? *Comparative social work, 1*, 1-12.

Hutchison, A., Beschorner, B., & Schmidt-Crawford, D. (2012). Exploring the Use of the iPad for Literacy Learning. *The Reading Teacher, 66*(1), 15-23. doi:10.1002/trtr.01090

Hutchison, A., & Reinking, D. (2011). Teachers' perceptions of integrating information and communication technologies into literacy instruction: A national survey in the United States. *Reading Research Quarterly, 46*(4), 312-333.

IGI Global. (2015). What is a domain expert.

Introna, L., Kavanagh, D., Kelly, S., Orlikowski, W., & Scott, S. (2016). *Beyond Interpretivism? New Encounters with Technology and Organization: IFIP WG 8.2 Working Conference on Information Systems and Organizations, IS&O 2016, Dublin, Ireland, December 9-10, 2016, Proceedings*: Springer International Publishing.

ITU. (2009). *Measuring the Information Society* Retrieved from https://www.itu.int/ITU-D/ict/publications/idi/material/2009/MIS2009_w5.pdf:

ITU. (2014). *ITU release 2014 ICT figures*. Retrieved from http://www.itu.int/net/pressoffice/press_releases/2014/23.aspx#.W-Lr_OJoRQI:

ITU. (2018). *Achieving universal and affordable Internet in the least developed countries* (9789261254513). Retrieved from https://www.itu.int/en/ITU-D/LDCs/Pages/ICTs-for-SDGs-in-LDCs-Report.aspx:

Jahnke, I., Norqvist, L., & Olsson, A. (2014). Digital Didactical Designs of Learning Expeditions. (Iml), 165-178.

Jansen, H., & Hak, T. (2005). The productivity of the three-step test-interview (TSTI) compared to an expert review of a self-administered questionnaire on alcohol consumption. *Journal of Official Statistics, 21*(1), 103.

Jansen, W., & Ayers, R. (2007). Guidelines on cell phone forensics. *NIST Special Publication, 800*(101), 800-101.

Jarvenpaa, S. L., & Lang, K. R. (2005). Managing the paradoxes of mobile technology. *Information Systems Management, 22*(4), 7-23. doi:10.1201/1078.10580530/45520.22.4.20050901/90026.2

Jere, N. R., Thinyane, M., Boikhutso, T., & Ndlovu, N. (2013). *An assessment of ICT challenges in rural areas: ICT experts vs rural users views: a case of the Siyakhula Living Lab.* Paper presented at the Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference.

Jisc. (2015). *Digital students are different*. Retrieved from https://drive.google.com/file/d/%0A0B4y3qNoTbFdYd0ttdEx1STVyeDRFOGdvMVhkeWhMdjZYcVBR/view?pli¼1 (

Jones, B. R., & Flannigan, S. (2006). Connecting the Digital Dots : Literacy of the 21st Century. *Workforce, 29*(2), 8-10. doi:Article

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology, 7*(4), 396.

Kafle, N. P. (2011). Hermeneutic phenomenological research method simplified. 181-200.

Kasemsap, K. (2017). Digital storytelling and digital literacy: Advanced issues and prospects *Deconstructing the Education-Industrial Complex in the Digital Age* (pp. 151-171): IGI Global.

Kassim, H., Peterson, J., Bauer, M. W., Connolly, S., Dehousse, R., Hooghe, L., & Thompson, A. (2013). *The European Commission of the twenty-first century*: OUP Oxford.

Keegan, D. (2005). *Mobile learning: The next generation of learning*.

Kelly, T., & Minges, M. (2012). *Maximizing Mobile*.

Kende, M. (2015). *Global Internet Report 2015: Mobile Evolution and Development of the Internet*: Internet Society.

Kennedy, R., George, K., Vitalice, O., & Okello-Odongo, W. (2015). *TV white spaces in Africa: Trials and role in improving broadband access in Africa.* Paper presented at the AFRICON, 2015.

Khumalo, B., Molepo, G., & Mji, A. (2015). Perceptions of school principals on the challenges arising from unavailability of Information and Communication technologies (ICT) in Rural South African schools. *Rethinking Teaching and Learning in the 21st Century*.

Kimchi, J., Polivka, B., & Stevenson, J. S. (1991). Triangulation: operational definitions. *Nursing research, 40*(6), 364-366.

Klein, H., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly, 23*(1), 67-93.

Kluzer, S. (2015). Guidelines on the adoption. 1-28.

Koehler, M. J., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70. doi:10.1016/j.compedu.2010.07.009

Kong, S. C. (2014). Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy. *Computers & Education, 78*, 160-173. doi:10.1016/j.compedu.2014.05.009

Koopman, M. (2014). *Step-by-step approach: The integration of ICT in the classroom in rural African schools.* Paper presented at the eChallenges e-2014, 2014 Conference.

Koranteng, K. (2012). *Access and use of Information and Communication Technology for Teaching and Learning amongst schools in under reseourced communities in the Western Cape, South Africa.*

Krish, P., & Salman, Q. (2018). POLITENESS IN EMAIL COMMUNICATION AMONG ARAB POSTGRADUATE STUDENTS IN A MALAYSIAN PUBLIC UNIVERSITY. *e-Bangi, 11*(2).

Kukhnavets, P. (2016). MoSCow Method: the Most Successful Prioritization Technique For Any Project.

Kuo, Y.-F., & Yen, S.-N. (2009). Towards an understanding of the behavioral intention to use 3G mobile value-added services. *Computers in Human Behavior, 25*(1), 103-110.

Lan, Y.-F., & Sie, Y.-S. (2010). Using RSS to support mobile learning based on media richness theory. *Computers & Education, 55*(2), 723-732.

Langenhoven, C. (2015). User experience of learners in a technology-facilitated learning in a resource deprived context. (August).

Lankshear, C., & Knobel, M. (2008). Concepts, Policies and Practices (Vol. 30, pp. 29-29): Peter Lang.

Larson, L. C. (2010). Digital readers: The next chapter in e-book reading and response. *The Reading Teacher, 64*(1), 15-22.

Lazar, J., Feng, J. H., & Hochheiser, H. (2010). Research methods in Humancomputer interaction. *Wiley*, 53.

Leech, N. L., & Onwuegbuzie, A. J. (2007). An array of qualitative data analysis tools: A call for data analysis triangulation. *School Psychology Quarterly, 22*(4), 557-584. doi:10.1037/1045-3830.22.4.557

Leedy, P., & Ormrod, J. E. (2012). *Practical Research: Planning and Design (10th Edition)*: Boston: Pearson.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research*: Pearson Custom.

Leedy, P. D., & Ormrod, J. E. (2010). *Practical Research* (9th ed.): Pearson.

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. *American Psychologist, 73*(1), 26.

Lewis, S. (2015). Qualitative inquiry and research design: Choosing among five approaches. *Health promotion practice, 16*(4), 473-475.

Li, Y., & Oliveira, H. (2015). Research on Classroom Practice. 489-496. doi:10.1007/978-3-319-12688-3_46

Likert, R. (1932). A technique for the measurement of attitudes. In R. S. Woodworth (Ed.), *A technique for the measurement of attitudes* (Vol. 22, pp. 5-55). New York.

Longmore, A.-L., Grant, G., & Golnaraghi, G. (2018). Closing the 21st-Century Knowledge Gap: Reconceptualizing Teaching and Learning to Transform Business Education. *Journal of Transformative Education, 16*(3), 197-219.

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: A research agenda. *British Journal of Educational Technology, 41*(2), 154-169. doi:10.1111/j.1467-8535.2008.00912.x

Ma, J., Zhang, H., Zhu, P., Fong, M.-H., Tong, W., & Jia, M. (2018). Methods and systems for wireless networks with relays: Google Patents.

Mabila, J., Biljon, J. V., & Herselman, M. (2017). A sustainability framework for mobile technology integration in schools : The case of resource- constrained environments in South Africa. *The Journal of Community Informatics, 13*(2), 59-86.

Maclellan, E., & Soden, R. (2003). Expertise, expert teaching and experienced teachers' knowledge of learning theory. *Scottish Educational Review, 35*(2), 110-120.

Macmillan, P. (2015). Tablets a cure in rural schools. *City Press*.

Madsen, S. (2017). How to Prioritize with the MoSCoW Technique.

Makoe, M. (2011). Academics going mobile : new roles for new technologies. *Progressio, 33*(2), 174-188.

Malgas, H. (2011). *Department of Basic Education: 2011 Strategic Plans and Budget review (Day 2): Specific programmes*. Retrieved from Parliamentary Monitoring Group:

Mamba, M. S. N., & Isabirye, N. (2015). A framework to guide development through ICTs in rural areas in South Africa. *Information Technology for Development, 21*(1), 135-150.

Maree, K. (2007). *First steps in research*: Van Schaik Publishers.

Markauskaite, L. (2007). Exploring the structure of trainee teachers' ICT literacy: the main components of, and relationships between, general cognitive and technical capabilities. *Educational Technology Research and Development, 55*(6), 547-572.

Marshall, C., & Rossman, G. (2006). The how of the study: Building the research design. *Designing qualitative research*, 55-101.

Martin, A. (2005). DigEuLit - a European framework for digital literacy: a progress report. *Journal of eLiteracy, 2*(2), 130-137.

Martin, J. P. (2018). *Skills for the 21st century: Findings and policy lessons from the OECD survey of adult skills*. Retrieved from

Martindale, R. (2015). *The Relationship between Pre-Service Teachers' Basic Technology Competence, Technology Self-Efficacy and Perceptions of Adopting Educational Applications on iPads for Classroom Use.* University of Arkansas.

Masonta, M. T., Kliks, A., & Mzyece, M. (2017). Unlocking the potential of unoccupied spectrum in developing countries: Southern African Development Community–case study. *Development Southern Africa, 34*(2), 224-244.

Masonta, M. T., Olwal, T., & Ntlatlapa, N. (2010). *An Energy Saving Scheme for Internet Provision in Rural Africa: LESS.* Paper presented at the IST-Africa, 2010.

Mathevula, M. D., & Uwizeyimana, D. E. (2014). The challenges facing the integration of ICT in teaching and learning activities in South African rural secondary schools. *Mediterranean Journal of Social Sciences, 5*(20), 1087.

Matusiak, K. K. (2010). *Use of Digital Resources in an Academic Environment: A Qualitative study of students' perceptions, experiences and digital literacy skills.* (I).

Mayisela, T. (2013). The potential use of mobile technology: enhancing accessibility and communication in a blended learning course. *South African Journal of Education, 33*(1), 1-18.

McShane, I., & Wilson, C. K. (2017). Beyond the School Fence: Rethinking Urban Schools in the Twenty-first Century. *Urban Policy and research, 35*(4), 472-485.

Melhuish, K., & Falloon, G. (2010). Looking to the future: M-learning with the iPad.

Mellow, P. (2005). The media generation: Maximise learning by getting mobile. *ascilite 2005: Balance, Fidelity, Mobility: maintaining the momentum?*, 469-476.

Meszaros, C. (2008). Interpretation and the Hermeneutic Turn (pp. 17-22): engage.

Meyer, D. F., & Neethling, J. R. (2017). MEASUREMENT OF THE ENABLING DEVELOPMENT ENVIRONMENT: A COMPARATIVE STUDY IN A DEVELOPING REGION. *Economics & Sociology, 10*(4), 67-82.

Meyer, I., Ford, M., Marais, M., & Dlamini, S. (2017). Systemic levers for change towards sustainable institutionalisation of ICT in schools. 1-11. doi:10.23919/istafrica.2017.8102323

Meyer, I., Marais, M., & Dlamini, S. (2016). Framework for assessing implementation readiness in ICT4E projects. *Unpublished framework document, CSIR Meraka Institute, Pretoria, South Africa*.

Ministry of Education. (2015). *Digital Technology: Safe and responsible use in schools*.

Mishra, P., & Koehler , M. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017-1054.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge : A Framework for Teacher Knowledge. *108*(6), 1017-1054.

Mitrovic, Z. (2017). *The impact of cloud computing on the role of an IT department: a case study of a higher education institution in the Western Cape.* Cape Peninsula University of Technology.

Mlitwa, N. B. W., & Nonyane, J. (2008). *The Status of ICT Access and use in South African Schools : Comparing the Rural and Urban Schools in the Mpumalanga Province.*

Mohammadyari, S., & Singh, H. (2015). Understanding the effect of e-learning on individual performance: The role of digital literacy. *Computers & Education, 82*, 11-25.

Moletsane, R. (1993). Repositioning educational research on rurality and rural education in South Africa : Beyond deficit paradigms. 1-8.

Morse, M. J., Michael, B., Maria, M., Karin, O., & Jude, S. (2002). Verification Strategies for Establishing Reliability and Validity in Qualitative Research. *International journal of qualitative methods, 1*(2), 1-19.

Mphahlele, S. (2014). *The content delivery on tablets in schools in rural Cofimvaba District.*

Muir-Herzig, R. G. (2004). Technology and its impact in the classroom. *Computers & Education, 42*(2), 111-131.

Mura, G., & Diamantini, D. (2014). The Use and Perception of ICT among Educators: the Italian Case. *Procedia-Social and Behavioral Sciences, 141*, 1228-1233.

Mushi, R., Jafari, S., & Ennis, A. (2018). Measuring Mobile Phone Technology Adoption in SMEs: Analysis of Metrics *Technology Adoption and Social Issues: Concepts, Methodologies, Tools, and Applications* (pp. 1546-1557): IGI Global.

Myers, J. (2016). Research: Qualitative vs. Quantitative.

Myers, M. D. (2013). *Qualitative research in business and management*: Sage.

Nagel, L., & Verster, M. (2012). *A student-grown Facebook group in an architecture class: Seed or weed*.

Naismith, L., & Corlett, D. (2006). Naismith, L. & Corlett, D. (2006). Reflections on Success: A retrospective of the mLearn conference series 2002- 2005. mLearn 2006 – Across generations and cultures, Banff, Canada. (Clic), 1-29.

Naismith, L., & Corlett, D. (2006). *Reflections on success: A retrospective of the mLearn conference series 2002-2005.* Paper presented at the mLearn 2006: Across generations and cultures.

Nash, L. (2017). Words of Wisdom: crafting digital texts creatively and collaboratively.

Ndlovu, N. S., & Lawrence, D. (2012). The quality of ICT use in South African classrooms.

Neumann, M. M. (2018). Maternal Scaffolding of Preschoolers' Writing Using Tablet and Paper-Pencil Tasks: Relations With Emergent Literacy Skills. *Journal of Research in Childhood Education, 32*(1), 67-80.

Neumann, M. M. (2018). Using tablets and apps to enhance emergent literacy skills in young children. *Early Childhood Research Quarterly, 42*, 239-246.

News24. (2015). Gauteng heads toward paperless education. *News24*.

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers and Education, 59*(3), 1065-1078. doi:10.1016/j.compedu.2012.04.016

Ng, W. (2013). Conceptualising mLearning Literacy. *International Journal of Mobile and Blended Learning, 5*(1), 1-20. doi:10.4018/jmbl.2013010101

Ng, W., & Nicholas, H. (2013). A framework for sustainable mobile learning in schools. *British Journal of Educational Technology, 44*(5), 695-715. doi:10.1111/j.1467-8535.2012.01359.x

Nielsen, J. (2000). Why you only need to test with 5 users: Useit. com Alertbox.

Nieuwenhuis, P. J. (2014). Qualitative Research Session 1: Taking stock of where we are.

Nieveen, N., & Plomp, T. (2018). Curricular and Implementation Challenges in Introducing Twenty-First Century Skills in Education *Assessment and Teaching of 21st Century Skills* (pp. 259-276): Springer.

Nkula, K., & Krauss, K. E. M. (2014). Proceedings of the 8th International Development Informatics Association Conference. *ICTs for inclusive communities in developing societies.*(8), 241-261.

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *18*(2), 2015-2017. doi:10.1136/eb-2015-102054

Oates, B. J. (2005). *Researching information systems and computing*: Sage.

Okoli, C., & Schabram, K. (2010). Working Papers on Information Systems A Guide to Conducting a Systematic Literature Review of Information Systems Research. *Working Papers on Information Systems, 10*(26), 1-51. doi:10.2139/ssrn.1954824

Olckers, C. (2011). *CHAPTER 3: Research design and methods.*

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information systems research, 2*(1), 1-28.

Ouma, G. O., Awuor, F. M., & Kyambo, B. (2013). E-learning readiness in public secondary schools in kenya. *European Journal of Open, Distance and E-learning, 16*(2).

Ozdamli, F. (2012). Pedagogical framework of m-learning. *Procedia - Social and Behavioral Sciences, 31*, 927-931. doi:10.1016/j.sbspro.2011.12.171

Ozdamli, F., & Cavus, N. (2011). Basic elements and characteristics of mobile learning. *Procedia - Social and Behavioral Sciences, 28*, 937-942. doi:10.1016/j.sbspro.2011.11.173

Paasch, C., & Duchene, F. (2012). Exploring Mobile / WiFi Handover with Multipath TCP Categories and Subject Descriptors. *Cellular Networks: Operations, Challenges, and Future Design (CellNet)*, 1-6. doi:10.1145/2342468.2342476

Paily, M. U. (2016). [Information and communication technology].

Pan, Y. (2012). Portable tablet computing device with a low power operation mode as a media player: Google Patents.

Pandey, A. (2011). What is MoSCoW Analysis?

Park, S. Y., Nam, M. W., & Cha, S. B. (2012). University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. *British Journal of Educational Technology, 43*(4), 592-605.

Park, Y. (2011). A Pedagogical Framework for Mobile Learning: Categorizing Educational Applications of Mobile Technologies into Four Types. *The International Review of Research in Open and Distance Learning, 12*(2).

Parry, R., Eikhof, D. R., Barnes, S.-A., & Kispeter, E. (2018). *Development, supply, deployment, demand: Balancing the museum digital skills ecosystem. First findings of the 'One by One'national digital literacy project*.

Patel, S., Chauhan, M., & Kapadiya, K. (2012). 5G: Future mobile technology-vision 2020. *International Journal of Computer Applications, 54*(17).

Patten, B., Arnedillo Sánchez, I., & Tangney, B. (2006). Designing collaborative, constructionist and contextual applications for handheld devices. *Computers & Education, 46*(3), 294-308. doi:10.1016/j.compedu.2005.11.011

Patterson, M. E., & Williams, D. R. (2002). Hermeneuti Principle, Methods and Case examples (pp. 127-127): Sagamore Publishing.

Patton, M. Q. (1990). Enhancing the Quality and Credibility of Qualitative Analysis. (Patton 1990), 1189-1208.

PC Magazine. (2011). Definition of: Smartphone.

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2006). *The design science research process: a model for producing and presenting information systems research.* Paper presented at the Proceedings of the first international conference on design science research in information systems and technology (DESRIST 2006).

Pheeraphan, N. (2013). Enhancement of the 21st century skills for Thai higher education by integration of ICT in classroom. *Procedia-Social and Behavioral Sciences, 103*, 365-373.

Pillay, B., & Dzinotyiweyi, C. (2014). *DRDLR ICT for Education Project*. Retrieved from Pretoria:

Platz, M., & Herselman, M. (2018). *Developing an accreditation system to recognize competence in mathematics education students in Germany.* Paper presented at the IST Africa 2018.

Poushter, J. (2016). *Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies*. Retrieved from

Prieto, J. C. S., Migueláñez, S. O., & García-Peñalvo, F. J. (2013). Understanding mobile learning: devices, pedagogical implications and research lines. *Education in the Knowledge Society (EKS), 15*(1), 20-42.

Prince, M. J. (2004). Does active learning work? A review of the research. *Journal of Engineer*(July), 223-231.

Pulli, K., Aarnio, T., Miettinen, V., Roimela, K., & Vaarala, J. (2008). *Mobile 3D Graphics With OpenGL ES and M3G (Morgan Kaufmann series in computer graphics)*: Morgan Kaufmann Publishers.

Qadir, J., Gordon, S., Tan, J., Chiaraviglio, L., Wu, J., & Zhang, W. (2018). *A Sustainable Connectivity Model of the Internet Access Technologies in Rural and Low-Income Areas.* Paper presented at the Smart Grid and Innovative Frontiers in Telecommunications: Third International Conference, SmartGIFT 2018, Auckland, New Zealand, April 23-24, 2018, Proceedings.

Qureshi, S., & Xiong, J. (2017). The Role of Mobile Phones in the Provision of Equitable Health Care for Human Development.

Qwerty. (2017). *the Digital Landscape in South Africa 2017*. Retrieved from http://qwertydigital.co.za/wp-content/uploads/2017/08/Digital-Statistics-in-South-Africa-2017-Report.pdf

Ramey, K. (2014). Use of Cell Phones at School – 25 Tips For Teachers and Students.

Rashevska, N., & Tkachuk, V. (2018). Technological conditions of mobile learning in high school. *arXiv preprint arXiv:1808.01989*.

Richey, R. C., & Klein, J. D. (2014). Design and development research *Handbook of research on educational communications and technology* (pp. 141-150): Springer.

Rivers, P. A., Rivers, J. K., & Hazell, V. (2015). Africa and technology in Higher Education: trends, challenges, and promise. *International Journal for Innovation Education and Research, 3*(5).

Rodriguez, -. d.-D. I., & Igartua, J.-J. (2018). Skills of digital literacy to address the risks of interactive communication *Information and Technology Literacy: Concepts, Methodologies, Tools, and Applications* (pp. 621-632): IGI Global.

Rodriguez, d.-D. I., & Igartua, J.-J. (2018). Skills of digital literacy to address the risks of interactive communication *Information and Technology Literacy: Concepts, Methodologies, Tools, and Applications* (pp. 621-632): IGI Global.

Roman, R., Colle, R. D., & Hall, K. (2003). Content creation for ICT development projects : Integrating normative approaches and community demand. *10*, 85-94.

Ruby, G. (2006). *e-learning strategy*. Retrieved from https://www.utwente.nl/en/bms/cheps/education/phd.../2006boezerooydissertation.pdf:

Russell, F., Rawson, C., Freestone, C., Currie, M., & Kelly, B. (2018). Parallel Lines: A Mixed Methods Impact Analysis of Co-Curricular Digital Literacy Online Modules on Student Results in First Year Nursing. *College & Research Libraries*.

Sachs, J. D. (2000). ``Readiness for the Networked World: A Guide for Developing Countries.''Harvard University. *Center for International Development, Cambridge, Mass*.

Sadaf, A., & Johnson, B. L. (2017). Teachers' Beliefs About Integrating Digital Literacy Into Classroom Practice: An Investigation Based on the Theory of Planned Behavior. *Journal of Digital Learning in Teacher Education, 33*(4), 129-137.

Saunders, M. N., & Bezzina, F. (2015). Reflections on conceptions of research methodology among management academics. *European management journal, 33*(5), 297-304.

Saunders, M. N. K., & Lewis, P. (2017). *Doing Research in Business and Management*: Pearson.

Savić, M. (2018). Lecturer perceptions of im/politeness and in/appropriateness in student e-mail requests: A Norwegian perspective. *Journal of Pragmatics, 124*, 52-72.

Saxena, P., Gupta, S. K., Mehrotra, D., Kamthan, S., Sabir, H., Katiyar, P., & Prasad, S. S. (2017). Assessment of digital literacy and use of smart phones among Central Indian dental students. *Journal of Oral Biology and Craniofacial Research*.

Schreuers, K., Quan-Haase, A., & Martin, K. (2017). Problematizing the digital literacy paradox in the context of older adults' ICT use: Aging, media discourse, and self-determination. *Canadian Journal of Communication, 42*(2), 1.

Schutt, R. K. (2009). *Investigating the social world: The process and practice of research*: Pine Forge Press.

Sedgwick, P. (2014). Cross sectional studies: advantages and disadvantages. *Bmj, 348*(mar26 2), g2276-g2276. doi:10.1136/bmj.g2276

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*(15), 1699-1710. doi:10.1016/j.jclepro.2008.04.020

Sharon, M. (2003). an Introduction To Mobile Technologies and services. *Machine Learning, 2010*(June), 9128-9128.

Sharples, M., Sánchez, I. A., Milrad, M., & Vavoula, G. (2009). Mobile learning Small devices, big issues (pp. 20-20).

Sherwood, R. (2017). Supporting eLearners by increasing Digital Literacy Skills in Healthcare Educators. *Compass: Journal of Learning and Teaching, 10*(1).

Shuler, C. (2009). Pockets of potential: Using mobile technologies to promote children's learning.

Shulman, L. E. E. S. (1986). Understand : Knowledge. *educational Researcher, 15*(2), 4-14. doi:http://www.jstor.org/stable/1175860

Sibanda, K., Muyingi, H., & Mabanza, N. (2008). *Building wireless community networks with 802.16 standard.* Paper presented at the Broadband Communications, Information Technology & Biomedical Applications, 2008 Third International Conference on.

Siemens, G. (2017). [Learning as Artifact Creation].

Singh, P., & Ramshirish, M. (2006). E-learning : Tools and Technology.

Siniscalco, M. T., & Auriat, N. (2005). Questionnaire design. *Quantitative research methods in educational planning*, 1-92.

Siragusa, L., Dixon, K. C., & Dixon, R. (2007). Designing quality e-learning environments in higher education. *Proceedings ascilite Singapore*, 923-935.

Smit, B. (2010). Using ATLAS . ti for Qualitative Data Analysis. *Social Science Data and Software, 20*(September), 65-76.

Spangler, S. C. (2015). *What is the cultural experience of the digital native student today (2015)?*

Statistics South Africa. (2004). *Census 2001: Concepts and Definitions*. Retrieved from

Stats SA. (2015). *Statistical Release PO318 General Household survery*. Retrieved from

Steyn, J., Rampa, m., & Marais, M. (2013). Participatory Development of ICT Entrepreneurship in an Informal Settlement in South Africa. *The Journal of Community Informatics, 9*(4).

Strauss, A., & Corbin, J. (1998). Basics of qualitative research. Thousands Oaks. *CA: Sage. Straus, EE (2009). Unequal pieces of a shrinking pie: The struggle between African Americans and Latinos over education, employment, and empowerment in Compton, California. History of Education Quarterly, 49*(4), 507-529.

Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Procedures and techniques for developing grounded theory: Thousand Oaks, CA: Sage.

Sullivan, G. M., & Artino, A. R., Jr. (2013). Analyzing and interpreting data from likert-type scales. *J Grad Med Educ, 5*(4), 541-542. doi:10.4300/JGME-5-4-18

Supachayanont, A. (2011). *Workaround as a craft skill of the computerised paper production process.* University of St Andrews.

Takavarasha, J. S., & Adams, C. (2018). *Affordability Issues Surrounding the Use of ICT for Development and Poverty Reduction*: IGI Global.

Takei, J. (2008). *WAN, MAN, LAN, PAN*. Retrieved from https://www.techopedia.com/2/29090/.../lanwanman-an-overview-of-network-types

Tapscott, D. (2009). *Grown up digital* (Vol. 361): McGraw Hill New York.

TechDifferences. (2016). Difference Between LAN, MAN and WAN.

Thomas, A. (1998). The Foundations of Social Research: Meaning and Perspective in the Research Process [Book Review]. *Rural Society, 8*(3), 289.

Thomas, D. R. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation*(27), 237-237. doi:10.1177/1098214005283748

Thompson, P. (2013). Computers & Education The digital natives as learners : Technology use patterns and approaches to learning. *65*, 2012-2014.

Thompson, V. (2015). EVIDENCE OF IMPACT OF 1:1 ACCESS TO

TABLET COMPUTERS IN THE CLASSROOM.

Thompson, V. (2015). *Literature review evidence impact of 1:1 access to tablet computers in the classroom*. Retrieved from creative.eun.org/c/document_library/get_file?uuid=f90beb15-d561-4ed3:

Thurmond, V. A. (2001). The point of triangulation. *Journal of nursing scholarship, 33*(3), 253-258.

Tilson, D., Sorensen, C., & Lyytinen, K. (2012). Change and Control Paradoxes in Mobile Infrastructure Innovation. *Systems Science*. doi:10.1109/HICSS.2012.149

Traxler, J. (2007). Defining, Discussing and Evaluating Mobile Learning: the moving finger writes and having writ. *The International Review of Research in Open and Distance Learning, 8*(2).

Traxler, J. M. (2018). Learning with Mobiles in Developing Countries: Technology, Language, and Literacy *Information and Technology Literacy: Concepts, Methodologies, Tools, and Applications* (pp. 774-790): IGI Global.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K., Colquhoun, H., Kastner, M., . . . Wilson, K. (2016). A scoping review on the conduct and reporting of scoping reviews. *BMC medical research methodology, 16*(1), 15.

Trochim, W. M. K. (2010). The Logic of Deductive and Inductive Reasoning Methods.

Tsai, H.-y. S., Shillair, R., & Cotten, S. R. (2017). Social support and "playing around" an examination of how older adults acquire digital literacy with tablet computers. *Journal of Applied Gerontology, 36*(1), 29-55.

Tunstall, R., & Lupton, R. (2003). *Is Targeting Deprived Areas an Effective Means to Reach Poor People ? An assessment of one rationale for area- based funding programmes*. Retrieved from

Umar, I. N., & Jalil, N. A. (2012). ICT skills, practices and barriers of its use among secondary school students. *Procedia-Social and Behavioral Sciences, 46*, 5672-5676.

Unesco. (2007). *The UNESCO ICT in Education Programme*. Retrieved from https://en.unesco.org/themes/ict-education/action

UNESCO. (2011). UNESCO ICT competency framework for teachers.

UNESCO. (2015). *UNESCO'S contribution to the 2030 Agenda for sustainable development*. Retrieved from unesdoc.unesco.org/images/0024/002477/247785e.pdf

Unit, E. I. (2008). E-readiness rankings 2008: Maintaining momentum. *The Economist*.

Uzunboylu, H., Bicen, H., & Cavus, N. (2011). The efficient virtual learning environment: A case study of web 2.0 tools and Windows live spaces. *Computers & Education, 56*(3), 720-726.

Valk, J.-H., Rashid, A. T., & Elder, L. (2010). Using mobile phones to improve educational outcomes: An analysis of evidence from Asia (Vol. 11, pp. 117-140).

Valk, j.-H., Rashid, A. T., & Elder, L. (2010). Using mobile phones to improve educational outcomes: An analysis of evidence from Asia. *International Review of Research in Open and Distance Learning, 11*(1), 117-140.

Van Biljon, J., & Kotzé, P. (2007). *Modelling the factors that influence mobile phone adoption.* Paper presented at the Proceedings of the 2007 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries.

Van Biljon, J., & Renaud, K. (2017). *Harnessing both Information and Knowledge Visualisation to Represent a Community of Practice: Depicting the South African ICT4D Researcher Community*.

Van Biljon, J. V., Traxler, J., Van der Merve, R., & Van Heerden, D. (2015). Curriculum Development for Mobile Digital Literacy Skills Acquisiton Using a Design Science Approach. *The Journal of Community Informatics, 11*(3).

Van Der Merve, A. v. d., Kotze, P., & Cronje, J. (2005). Selecting a qualitaitve research approach for information systems research. *South African Computer Lecturer Assciation (SACLA 2005)*(Sacla).

Vavoula, G., Sharples, M., Lonsdale, P., Rudman, P., & Meek, J. (2007). Learning Bridges: a role for mobile technologies in education. *Educational Technology*, 33-37.

Vega, C. (2017). [Get smart: The 25 best educational apps for iPhone and Android].

Ventimiglia, P., & Pullman, G. (2014). Working Party on Measurement and Analysis of the Digital Economy. (2015).

Ventimiglia, P., & Pullman, G. (2016). From Written to Digital: The New Literacy. *Educause Review, 51*(2).

Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning, 29*(5), 403-413. doi:10.1111/jcal.12029

Vosloo, S. H.-J., & West. (2012). *Turning on mobile learning in Asia*.

Walls, E. (2017). *The perceived relation between ICTs and social good.* University of Southampton.

Wang, J., & Gu, L. (2014). School-based research and learning activities: An innovative model for promoting teacher professional development. *innovation in Science Teacher Education in the Asia Pacific, 20*, 37-53.

Warschauer, M. (2007). [11519_2007_1_1_1-web 41..49 - WarschauerDigitalLearning.pdf].

Wenglinsky, H. (2001). Teacher Classroom Practices and Student Performance: How Schools Can Make a Difference. *ETS Research Report Series, 2001*(2), i--37. doi:10.1002/j.2333-8504.2001.tb01861.x

White, S., & Reid, J.-a. (2008). Placing Teachers ? Sustaining Rural Schooling through Place-consciousness in Teacher Education. *23*(7).

Williams, C. (2011). Research methods. *Journal of Business & Economics Research (JBER), 5*(3).

Yin, K. R. (2003). *Case Study Research* (3rd ed.): Sage.

Yin, R. K. (1996). *Case Study Research: Design and Methods*. Thousand Oaks: Sage.

Yin, R. K. (2017). *Case study research and applications: Design and methods*: Sage publications.

Yu, T.-K., Lin, M.-L., & Liao, Y.-K. (2017). Understanding factors influencing information communication technology adoption behavior: The moderators of information literacy and digital skills. *Computers in Human Behavior, 71*, 196-208. doi:http://dx.doi.org/10.1016/j.chb.2017.02.005

Zapata, G. C. (2018). The Role of Digital, Learning by Design Instructional Materials in the Development of Spanish Heritage Learners' Literacy Skills *Multiliteracies Pedagogy and Language Learning* (pp. 67-106): Springer.

Zhai, X., Zhang, M., & Li, M. (2018). One-to-one mobile technology in high school physics classrooms: Understanding its use and outcome. *British Journal of Educational Technology, 49*(3), 516-532.

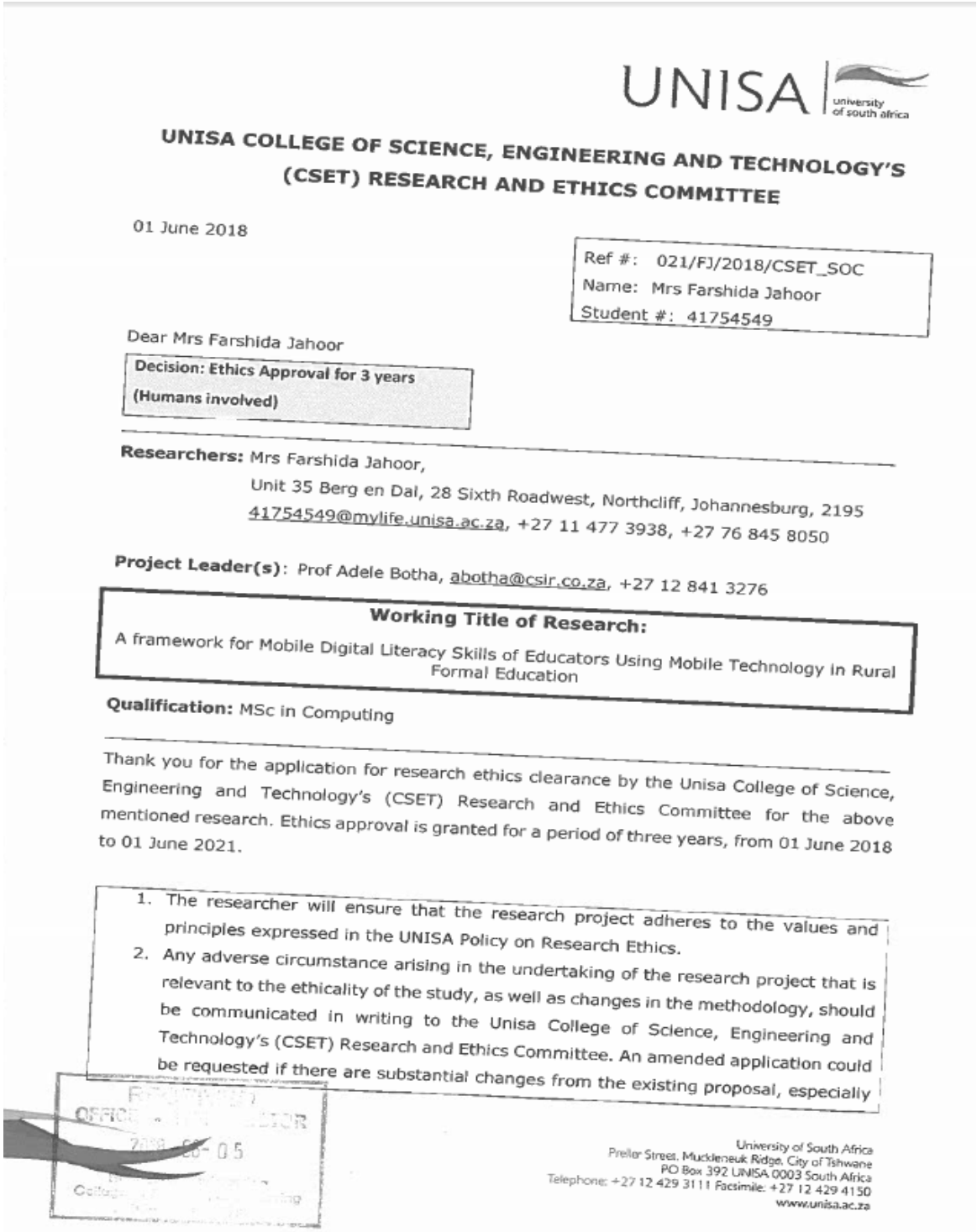
Zhang, L. (2018). Automatic Traffic Scheduling for Internet Connectivity Failures.

Zheng, B., Yim, S., & Warschauer, M. (2018). Social media in the writing classroom and beyond. *The TESOL Encyclopedia of English Language Teaching*, 1-5.

Zoo, H., Lee, H., & Yoon, J. (2017). *Assessing the E-Government Maturity for Public Sector Innovation in Developing Countries: Case of National Informatization Assessment Tool (NIAT).* Paper presented at the International Conference on Social Implications of Computers in Developing Countries.

APPENDICES

APPENDIX A: ETHICAL CLEARANCE (UNISA)



UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) RESEARCH AND ETHICS COMMITTEE

01 June 2018

Ref #: 021/FJ/2018/CSET_SOC
Name: Mrs Farshida Jahoor
Student #: 41754549

Dear Mrs Farshida Jahoor

Decision: Ethics Approval for 3 years
(Humans involved)

Researchers: Mrs Farshida Jahoor,
Unit 35 Berg en Dal, 28 Sixth Roadwest, Northcliff, Johannesburg, 2195
41754549@mylife.unisa.ac.za, +27 11 477 3938, +27 76 845 8050

Project Leader(s): Prof Adele Botha, abotha@csir.co.za, +27 12 841 3276

Working Title of Research:
A framework for Mobile Digital Literacy Skills of Educators Using Mobile Technology in Rural Formal Education

Qualification: MSc in Computing

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee for the above mentioned research. Ethics approval is granted for a period of three years, from 01 June 2018 to 01 June 2021.

1. The researcher will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially

OFFICE 05

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

if those changes affect any of the study-related risks for the research participants. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.

3. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
4. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
5. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
6. No field work activities may continue after the expiry date (01 June 2021). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number 021/FJ/2018/CSET_SOC *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee.*

Yours sincerely

Dr. B Chimbo

Chair: Ethics Sub-Committee SoC, College of Science, Engineering and Technology (CSET)

Prof I. Osunmakinde

Director: School of Computing, CSET

Prof B. Mamba

Executive Dean: CSET

Approved - decision template – updated Aug 2016

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX B: PERMISSION LETTER FROM CSIR

Prof M. Herselman

CHIEF RESEARCHER

Tel: +27 12 841 3265

Email: mherselman@csir.co.za

14 May 2018

Mrs Farshida Jahoor

Research student at UNISA

Dear Mrs Jahoor

PERMISSION TO DO RESEARCH USING CANDIDATES FROM THE ICT4RED AND DRDLR ICT4D PROJECTS

A study towards: "A Framework for Mobile Digital Literacy Skills of Educators Using Mobile Technology in Rural Formal Education".

Your application regarding permission to conduct research using teachers and TPD trainers from the ICT4RED and DRDLR ICT4D has been received and considered.

It is my pleasure to inform you that permission has been granted for this study as set out in your application.

I wish you well in your research undertaking.

Kind regards

Prof M. Herselman

CHIEF RESEARCHER

APPENDIX C: EXPERT REVIEW QUESTIONNAIRE

Dear Participant,

Thank you for your willingness to review the Theoretical framework in this research. Please note that the main focus is to evaluate the mobile digital literacy skills an educator should have for the efficient and effective use of mobile technology in the rural classroom. The main focus is on mobile technology and rural education. The framework as has been sent to you has been derived from relevant literature. The purpose for this review is to obtain input from experts regarding the relevance, applicability, conciseness and comprehensiveness of the skills that could influence the educators effective use of mobile technologies in the rural classroom. Your feedback will help to improve on the skills in the framework in order to expand the questionnaire that will go out to educators for data collection in the case study.

Purpose of the study

The purpose of this study is to explore and develop a framework for mobile digital literacy skills for educators using mobile technology in rural formal education. This study identified frameworks with different digital skills, but nothing specific to mobile digital literacy skills in the context of rural formal education. This study will be an extension of the current digital literacy skills frameworks to adapt to mobile technologies in rural formal education. The framework under consideration will be the Technological pedagogical content knowledge (TPACK) Framework (Mishra & Koehler 2006) (Mishra & Koehler 2006), specifically the technological pedagogical sub-category.

Please feel free to comment and provide input regarding the relevance, applicability, conciseness and comprehensiveness of the skills that an educator needs to use mobile technologies in rural formal education. Please feel free to comment on the structuring of a statement as well. I highly value any form of feedback.

A Theoretical framework for mobile digital literacy skills for an educator using mobile technologies in rural education

Dimensions: Digital Literacy Model	Category of Digital literacy skills	Mobile digital literacy skills for the use of mobile technologies	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning	Evaluator's feedback				
				Please mark the column that indicates the importance of each skill in your opinion				Please provide comments on the relevance, applicability and conciseness of the skill
				Very important	Moderately important	Slightly important	Not important	
Technical dimension	Operational literacy	Getting started with a mobile device	The educator should know how to operate multiple devices including his/her own in the classroom					
			The educator should be able to charge the many devices					
			The educator should use technology in the classroom to support subject specific content					
			The educator should work electronically with the aim of going paperless in the classroom					
		Personalisation of one's device	The educator should be able to maintain uniformity across all devices by creating a standard practice to facilitate efficient learning					
		Underpinnings -skills to	The educator should be able to connect a					

		operate a device	device to a Wi-Fi network					
			The educator should understand the usage of data and the financial implications associated to the data service providers					
			The educator should be able to use Bluetooth in the classroom for data sharing and communication					
			The educator must be able to connect input and peripheral devices to facilitate teaching e.g. a projector					
			The educator should access and use the troubleshooting guide on a device for basic problem solving					
		Understanding mobile hardware operation, affordances and specifications of a device	The educator should know the affordances of a mobile device for learning and teaching, with the aim of digitising an activity to add value					
			The educator should know devices capabilities and specifications for devices that are available in rural areas,					

			thus maximising its use in the classroom					
		Using basic functionalities on a mobile device to organise one's life	The educator should use time management apps for productivity and planning of school activities					
			The educator should be able to create worksheets					
			The educator should know how to record data using appropriate affordances					
		Adaptability	The educator should be able to create content for example low cost videos in the local language to facilitate better learning					
			An educator should be able to scan textbooks to create e-books for learners as rural areas lack textbooks					
			An educator should be able to assist learners in the transition to mobile devices as some learners may be using a mobile device for the first time					
			An educator should be able to teach					

			learners the many benefits a mobile device has to offer therefore making up for what rural areas are lacking e.g. library, computer labs for research, using as a dictionary					
			An educator should be able to manage lack of sufficient devices due to learners not being able to afford a device or school not being able to facilitate a device for each learner by have knowledge on shared computing facilities to overcome the challenge of lack of one device per learner					
			The educator should be able to plan proficiently how learners will share a device efficiently amongst each other					
			The educator should be able to work around power shortage issues by charging devices on time and in designated areas.					
			The educator should know					

			how to use the different back up power supplies e.g. power bank, UPS, generator and solar powered classrooms					
			The educator should be able to save content for offline use in case the educator does not have connectivity in the class					
			The educator should know how to use caching and distribution of digital content. Thus, enabling off-line access to vast online educational content					
			The educator should be able to access digital books to share amongst learners					
			The educator should encourage file sharing and transfer using Bluetooth when there is no connectivity					
			If there is a lack of training facilitates in rural areas, educators should know how to get online training and tutorials to adapt mobile technology in the class					

		Navigation-use of fingers to navigate	The educator should understand how touch screens operate and navigate between screens whilst teaching					
			The educator should know how to multitask whilst teaching e.g. cross-referencing, making notes, searching information etc.					
			The educator should be able to navigate between his/her device and the learner whilst addressing the classroom					
		Application management	The educator should know how to use the different user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.					
			The educator should know how to disable automatic update of applications to avoid increased data charges.					
			The educator should know how to use educational games and					

			apps that support learning in the classroom					
			The educator should know how to use appropriate application that is specific to their subjects e.g. a geography teacher should be able to use a maps application					
			The educator should be able to use digital assessment tools like online quiz and real time survey through electronic polls					
		Securing one's device and its contents	The educator should educate learners on safe keeping of devices by setting an example					
			The educator should avoid damages caused by power surges due to sporadic electricity supply					
			The educator should lock away devices after use					
			Please recommend any additional skills applicable to the technical dimension that could be beneficial to an educator:					
			The educator should have an					

Social-emotional dimension	Social-emotional literacy	Understanding the internet platform	understanding of browser elements, search engines, tabs, bookmarks, new window, hyperlinks, hypertexts, browsing history and navigation					
			The educator should be able to manage learners on the internet platform to cater for the slow connections					
			The educator should be able to use an online browser on your device as well as the cache memory for offline use					
		Use the internet to search information	The educator should be able to find relevant information using the internet especially e-books for rural learners who lack access to textbooks					
			The educator should be able to share information from the web by sending links					
	Social networking functional literacy	Use of social networks for collaborative learning and teamwork	The educator should be able to collaborate with colleagues and learners by using social media					
			The educator should be able					

			to tele-conference with colleagues and learners through skype					
		Being part of online groups	The educator should have an understanding of the different social media available and be able to create an online learning group					
			The educator should be able to use a mobile device as a blogging tool					
		Sharing and storing of information – cloud computing	The educator should be able to share content and thoughts with learners and fellow colleagues e.g. dropbox					
			The educator should be able to use blogs and Wikis to create content online and receive feedback					
			The educator should be able to partake in knowledge generating activities e.g. through wikis and Google Docs					
		Using social networks	The educator should be able to create a digital e-portfolio for professional development e.g. LinkedIn and to use educational					

			networks like EduBlogs, MindMeister and ePals					
		Communication	The educator should be able to communicate with learner and colleagues through email, social networks, via phone and text messages					
	Online etiquette Literacy	Conduct and demeanour over the internet	The educator should behave in a decent manner over the internet and avoid vulgarity					
			The educator should be aware of Netiquette					
	Cyber Safety Literacy	Being safe in the online world	The educator should be aware of what to publish on social media as this leaves a print in the online world therefore keeping private information disclosed					
			The educator should ensure that learners are safe by educating them as well e.g. on cyberbullying					
			The educator should understand the dangers of unsafe networks					
			The educator should be able to identify threats and know how to					

			deal with such situations					
			The educator should avoid copying published work					
			The educator should know about legal rights when using online services Please recommend any additional skills applicable to the social-emotional dimension that could be beneficial to an educator:					
Cognitive dimension	Reproduction Literacy	Dealing with graphics, video and animation	The educator should know how to differentiate different file formats by understanding different file formats e.g. Audio, video, text					
			The educator should be able to create a YouTube video or a vodcast or lesson video and online tutorials on their device					
		Content recreation	The educator should be able to integrate information and create meaningful information					
			The educator should be able to find information and experiences across a number of					

			means e.g. through photos, audio, videos, numerical representations and text					
			The educator should be able to adapt web content to the classroom					
		Word processing and electronic spreadsheets	The educator should be able to edit in a word processor e.g. by copying and pasting					
			The educator should be able to use tools such as Excel to generate reports with statistical and graphical representation					
	Branching Literacy	Multidimensional skills at sourcing information	The educator should know how to find answer to a particular question and seek advice and also find information sources that leads to other useful information					
		Connecting information	The educator should know how to access, manage, integrate, evaluate and synthesize digital resources					
		Having visual and media knowledge	The educator should be able to assign a meaning to images and graphics					
			The educator should be able					

			to express themselves through edited photos, videos, sketches, blogs, podcasts and other forms					
			The educator should be able to listen to music and watch videos					
			The educator should be able to understand information in different forms like in text, video, audio, maps					
			The educator should be able to understand media expressions					
			The educator should be able to capture images					
	Information Literacy	Background knowledge in acquiring information	The educator should be able to contribute, search and construct knowledge					
		Real-time thinking	The educator should be able to process and evaluate large amounts of information at the same time					
			The educator should be able to assess quality and validity and be able to create information through different domains					

			The educator should be able to access e-publications and e-books					
			Please recommend any additional skills applicable to the cognitive dimension that could be beneficial to an educator:					
Literacy for all dimensions	Critical Literacy	Being a data critique	The educator should be able to use information responsibly by sourcing information from credible sites and giving credit to the respective authors. In addition, the educators should discourage learners from committing plagiarism by copying and pasting					
			The educator should be able to teach learners to analyse information for its authenticity, quality, usefulness and free from bias					
			The educator should be able to evaluate web content for authenticity					
Other literacies identified	Financial literacy	Understanding data cost implications	The educator should have an idea of the data costs implications whilst using a					

			device in the classroom					
	Workaround literacy	Adapting to the rural context	An educator should have workaround skills to deal with challenges of a rural nature like lack of electricity					
			Please recommend any additional skills applicable to all the dimension that could be beneficial to an educator:					

APPENDIX D: PARTICIPANT QUESTIONNAIRE

A Framework for Mobile Digital Literacy Skills for an Educator using technologies in rural education

Dear Participant,

My name is Farshida Jahoor, a Master's student under the supervision of Prof Adele Botha (abotha@csir.co.za) at UNISA. I am conducting a research to develop a framework for mobile digital literacy skills required by an educator to facilitate the use of mobile technologies in rural education.

A literature review on mobile digital literacy skills was carried out and an initial framework was conceptualised. To evaluate the framework, knowledgeable educators in the rural schooling system using mobile technology are required to assist.

Kindly note that participation in this research is voluntary, and you have the right to, at any time, withdraw or refuse to participate without explanation. All responses from participants will be kept confidential. All responses will be coded during analysis; therefore, participants' names will be kept confidential.

You are therefore kindly requested to answer the questions below. This survey should not take more than 15 minutes.

Thank you

Section A: Demographics/ general information

1. The schooling sector you are currently in

   Tick the one that applies

   ☐ Primary education

   ☐ High school education

   ☐ Tertiary education

2. The subject you are teaching _____
3.
4. Gender

   ☐ Male

   ☐

Female

5. Age
Tick the one that applies

☐ Younger than 30
☐ 31 - 40
☐ 41 – 50
☐ 51 – 60
☐ 60+

6. Do you use mobile technology in the classroom? ☐ Yes ☐ No

7. If yes, how would you rate your expertise level in the classroom?

Novice ☐ ☐ ☐ ☐ ☐ Experienced expert

8. How long have you been integrating technology in the classroom?

☐ Less than a year
☐ One year to three years
☐ More than three years

Section B

The questions in this section relates to the mobile digital literacy skills that you feel are important for an educator to have for the successful use of mobile technologies in a classroom in a rural context.

This section comprises of different groups of skills. Please complete the following questions by ticking the importance of each skill.

Skill educator needs to have to use mobile technology in rural formal education	Very important	Moderately important	Slightly important	Not important
The educator should know how to operate multiple devices including his/her own in the classroom				
The educator should be able to charge the many devices				
The educator should use technology in the classroom to support subject specific content				
The educator should work electronically with the aim of going paperless in the classroom				

The educator should be able to maintain uniformity across all devices by creating a standard practice to facilitate efficient learning				
The educator should be able to connect a device to a Wi-Fi network				
The educator should understand the usage of data and the financial implications associated to the data service providers				
The educator should be able to use Bluetooth in the classroom for data sharing and communication				
The educator must be able to connect input and peripheral devices to facilitate teaching e.g. a projector				
The educator should access and use the troubleshooting guide on a device for basic problem solving				
The educator should know the affordances of a mobile device for learning and teaching, with the aim of digitising an activity to add value				
The educator should know devices capabilities and specifications for devices that are available in rural areas, thus maximising its use in the classroom				
The educator should use time management apps for productivity and planning of school activities				
The educator should be able to create worksheets				
The educator should know how to record data using appropriate affordances				
The educator should be able to create content for example low cost videos in the local language to facilitate better learning				
An educator should be able to scan textbooks to create e-books for learners as rural areas lack textbooks				
An educator should be able to assist learners in the transition to mobile devices as some learners may be using a mobile device for the first time				
An educator should be able to teach learners the many benefits a mobile device has to offer therefore making up for what rural areas are lacking e.g. library, computer labs for research, using as a dictionary				
An educator should be able to manage lack of sufficient devices due to learners not being able to afford a device or school not being able to facilitate a device for each learner by have knowledge on shared computing facilities to overcome the challenge of lack of one device per learner				
The educator should be able to plan proficiently how learners will share a device efficiently amongst each other				
The educator should be able to work around power shortage issues by charging devices on time and in designated areas.				
The educator should know how to use the different back up power supplies e.g. power bank, UPS, generator and solar powered classrooms				
The educator should be able to save content for offline use in case the educator does not have connectivity in the class				

The educator should know how to use caching and distribution of digital content. Thus, enabling off-line access to vast online educational content				
The educator should be able to access digital books to share amongst learners				
The educator should encourage file sharing and transfer using Bluetooth when there is no connectivity				
If there is a lack of training facilitates in rural areas, educators should know how to get online training and tutorials to adapt mobile technology in the class				
The educator should understand how touch screens operate and navigate between screens whilst teaching				
The educator should know how to multitask whilst teaching e.g. cross-referencing, making notes, searching information etc.				
The educator should be able to navigate between his/her device and the learner whilst addressing the classroom				
The educator should know how to use the different user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.				
The educator should know how to disable automatic update of applications to avoid increased data charges.				
The educator should know how to use educational games and apps that support learning in the classroom				
The educator should know how to use appropriate application that is specific to their subjects e.g. a geography teacher should be able to use a maps application				
The educator should be able to use digital assessment tools like online quiz and real time survey through electronic polls				
The educator should educate learners on safe keeping of devices by setting an example				
The educator should avoid damages caused by power surges due to sporadic electricity supply				
The educator should lock away devices after use				
Please recommend any additional skills applicable to the technical dimension that could be beneficial to an educator:				
The educator should have an understanding of browser elements, search engines, tabs, bookmarks, new window, hyperlinks, hypertexts, browsing history and navigation				
The educator should be able to manage learners on the internet platform to cater for the slow connections				
The educator should be able to use an online browser on your device as well as the cache memory for offline use				
The educator should be able to find relevant information using the internet especially e-books for rural learners who lack access to textbooks				
The educator should be able to share information from the web by sending links				
The educator should be able to collaborate with colleagues and learners by using social media				

The educator should be able to tele-conference with colleagues and learners through skype				
The educator should have an understanding of the different social media available and be able to create an online learning group				
The educator should be able to use a mobile device as a blogging tool				
The educator should be able to share content and thoughts with learners and fellow colleagues e.g. dropbox				
The educator should be able to use blogs and Wikis to create content online and receive feedback				
The educator should be able to partake in knowledge generating activities e.g. through wikis and Google Docs				
The educator should be able to create a digital e-portfolio for professional development e.g. LinkedIn and to use educational networks like EduBlogs, MindMeister and ePals				
The educator should be able to communicate with learner and colleagues through email, social networks, via phone and text messages				
The educator should behave in a decent manner over the internet and avoid vulgarity				
The educator should be aware of Netiquette				
The educator should be aware of what to publish on social media as this leaves a print in the online world therefore keeping private information disclosed				
The educator should ensure that learners are safe by educating them as well e.g. on cyberbullying				
The educator should understand the dangers of unsafe networks				
The educator should be able to identify threats and know how to deal with such situations				
The educator should avoid copying published work				
The educator should know about legal rights when using online services Please recommend any additional skills applicable to the social-emotional dimension that could be beneficial to an educator:				
The educator should know how to differentiate different file formats by understanding different file formats e.g. Audio, video, text				
The educator should be able to create a YouTube video or a vodcast or lesson video and online tutorials on their device				
The educator should be able to integrate information and create meaningful information				
The educator should be able to find information and experiences across a number of means e.g. through photos, audio, videos, numerical representations and text				
The educator should be able to adapt web content to the classroom				
The educator should be able to edit in a word processor e.g. by copying and pasting				
The educator should be able to use tools such as Excel to generate reports with statistical and graphical representation				

The educator should know how to find answer to a particular question and seek advice and also find information sources that leads to other useful information				
The educator should know how to access, manage, integrate, evaluate and synthesize digital resources				
The educator should be able to assign a meaning to images and graphics				
The educator should be able to express themselves through edited photos, videos, sketches, blogs, podcasts and other forms				
The educator should be able to listen to music and watch videos				
The educator should be able to understand information in different forms like in text, video, audio, maps				
The educator should be able to understand media expressions				
The educator should be able to capture images				
The educator should be able to contribute, search and construct knowledge				
The educator should be able to process and evaluate large amounts of information at the same time				
The educator should be able to assess quality and validity and be able to create information through different domains				
The educator should be able to access e-publications and e-books				
Please recommend any additional skills applicable to the cognitive dimension that could be beneficial to an educator:				
The educator should be able to use information responsibly by sourcing information from credible sites and giving credit to the respective authors. In addition, the educators should discourage learners from committing plagiarism by copying and pasting				
The educator should be able to teach learners to analyse information for its authenticity, quality, usefulness and free from bias				
The educator should be able to evaluate web content for authenticity				
The educator should have an idea of the data costs implications whilst using a device in the classroom				
An educator should have workaround skills to deal with challenges of a rural nature like lack of electricity				
Please recommend any additional skills applicable to all the dimension that could be beneficial to an educator:				

APPENDIX E: OPERATIONALISED THEORETICAL FRAMEWORK

Dimensions: Digital Literacy Model	**Category of Digital literacy skills (Chapter 3)**	**Mobile digital literacy skills for the use of mobile technologies (Chapter 4)**	**Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)**	**Data collection methods (Chapter 6)**	**Data collection: Questions in the Questionnaire**
Technical dimension	Operational literacy (Ng, 2012)	Getting started with a mobile device (Martin, 2018)	The educator should know how to operate multiple devices including his/her own in the classroom	Questionnaire and expert review	Manage multiple devices in the class at the same time
			The educator should be able to charge the many devices	Questionnaire and expert review	Charge multiple devices at the same time
			The educator should use technology in the classroom to support subject specific content	Questionnaire and expert review	Use mobile technology to support teaching syllabus
					Conduct a lesson using mobile technology as a medium of instruction
			The educator should work electronically with the aim of going paperless in the classroom	Questionnaire and expert review	Reverting to electronic means instead of paper
		Personalisation of one's device (Kelly et al., 2012)	The educator should be able to maintain uniformity across all devices by creating a standard practice to facilitate efficient learning	Questionnaire and expert review	Manage settings on students' devices to encourage uniformity and ease of navigation during a lesson
		Underpinnings - skills to operate a device (Brown et al., 2015; Caudill, 2007; Jere et al., 2013; Kelly et al., 2012; Pan, 2012)	The educator should be able to connect a device to a Wi-Fi network	Questionnaire and expert review	Connect a device to a Wi-Fi network
			The educator should understand the usage of data and	Questionnaire and expert review	Understand file sizes when downloading off the internet

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			the financial implications associated to the data service providers		Understand the charges associated with downloading and surfing the internet
					Understand the different data plan options from cellular service provider
			The educator should be able to use Bluetooth in the classroom for data sharing and communication	Questionnaire and expert review	Use Bluetooth for file sharing
					Manage file sharing in the classroom via Bluetooth
			The educator must be able to connect input and peripheral devices to facilitate teaching e.g. a projector	Questionnaire and expert review	Connect hardware devices to a mobile device
					Connect a printer or scanner to a mobile device
					Understand the different input and peripheral devices that can be connected to a mobile device
			The educator should access and use the troubleshooting guide on a device for basic problem solving	Questionnaire and expert review	Trouble shoot and solve basic problems by using the troubleshooting guide on a mobile device
		Understanding mobile hardware operation, affordances and specifications of a device (Brown	The educator should know the affordances of a mobile device for learning and teaching, with the	Questionnaire and expert review	Understand the features on a mobile phone that can be adapted to the rural classroom

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
		et al., 2015; Caudill, 2007; Kelly et al., 2012; Martin, 2018)	aim of digitising an activity to add value		Support classroom activities through a mobile device
			The educator should know devices capabilities and specifications for devices that are available in rural areas, thus maximising its use in the classroom	Questionnaire and expert review	Know the storage specifications of a device
					Manage the available storage space on a device
					Understand what type of images and videos are supported by devices available in rural areas
		Using basic functionalities on a mobile device to organise one's life (Jansen et al., 2007; Kelly et al., 2012; Mellow, 2005; Rashevska et al., 2018; Ventimiglia et al., 2016)	The educator should use time management apps for productivity and planning of school activities	Questionnaire and expert review	Use time management applications to enhance productivity in the classroom
					Save events and meetings in the phone calendar
					Plan timetable and lessons on a mobile device
			The educator should be able to create worksheets	Questionnaire and expert review	Create worksheets for learners using different applications
					Use worksheets to record marks, thus keeping a record for continuous assessment
			The educator should know how to record data using appropriate affordances	Questionnaire and expert review	Record an audio or video lesson

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
		Adaptability (Brown et al., 2015)	The educator should be able to create content for example low cost videos in the local language to facilitate better learning	Questionnaire and expert review	Create videos of the lessons for learners who missed a lesson
			An educator should be able to scan textbooks to create e-books for learners as rural areas lack textbooks	Questionnaire and expert review	Scan textbooks to create e-textbooks to deal with lack of textbooks in rural areas
			An educator should be able to assist learners in the transition to mobile devices as some learners may be using a mobile device for the first time	Questionnaire and expert review	Facilitate the use of mobile devices for learners that are first time users
			An educator should be able to teach learners the many benefits a mobile device has to offer therefore making up for what rural areas are lacking e.g. library, computer labs for research, using as a dictionary	Questionnaire and expert review	Use a mobile device as a research tool
					Use a mobile device as a dictionary
					Use a mobile device to access textbooks
			An educator should be able to manage lack of sufficient devices due to learners not being able to afford a device or school not being able to facilitate a device for each learner by have	Questionnaire and expert review	Facilitate device sharing amongst learners

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			knowledge on shared computing facilities to overcome the challenge of lack of one device per learner		
			The educator should be able to plan proficiently how learners will share a device efficiently amongst each other	Questionnaire and expert review	Use shared computing to cater for limited devices
			The educator should be able to work around power shortage issues by charging devices on time and in designated areas.	Questionnaire and expert review	Charge devices
					Know charging facilities in the classroom
					Know charging facilities in the school
			The educator should know how to use the different back up power supplies e.g. power bank, UPS, generator and solar powered classrooms	Questionnaire and expert review	Know the different alternative power supplies
					Know the alternative power supplies provisioned by the school
					Charge a device using these alternative methods
					Use a power bank in case device runs out of power in the classroom
			The educator should be able to save content for offline use in case the educator does not have	Questionnaire and expert review	Save content for offline reading

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			connectivity in the class		
			The educator should know how to use caching and distribution of digital content. Thus, enabling off-line access to vast online educational content	Questionnaire and expert review	Save information in the cache memory to facilitate off line reading
			The educator should be able to access digital books to share amongst learners	Questionnaire and expert review	Access digital books save them for offline reading and share them with learners
			The educator should encourage file sharing and transfer using Bluetooth when there is no connectivity	Questionnaire and expert review	Share content with learners using Bluetooth due to poor network connectivity
			If there is a lack of training facilitates in rural areas, educators should know how to get online training and tutorials to adapt mobile technology in the class	Questionnaire and expert review	Use online training tutorials and videos to enhance skills to integrate mobile devices in the classroom
		Navigation- use of fingers to navigate (Bagot et al., 2018; Kelly et al., 2012; Pan, 2012)	The educator should understand how touch screens operate and navigate between screens whilst teaching	Questionnaire and expert review	Navigate between different screens whilst teaching
			The educator should know how to multitask whilst teaching e.g.	Questionnaire and expert review	Multi- tasks on a device whilst teaching

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			cross-referencing, making notes, searching information etc.		
			The educator should be able to navigate between his/her device and the learner whilst addressing the classroom	Questionnaire and expert review	Manage navigation on the learner's device through clear instructions
		Application management (Casey et al., 2016; Hausknecht et al., 2018; Kelly et al., 2012)	The educator should know how to use the different user interfaces permitted by different applications e.g. drag and drop, scroll, pinch, resizing, expandable and collapsible lists.	Questionnaire and expert review	Use drag and drop interfaces
					Use pinch and zoom into a document
					Select options from collapsible lists
			The educator should know how to disable automatic update of applications to avoid increased data charges.	Questionnaire and expert review	Turn off automatic application updates to avoid incurring unnecessary data charges
			The educator should know how to use educational games and apps that support learning in the classroom	Questionnaire and expert review	Download and use educational games and applications in the classroom
			The educator should know how to use appropriate application that is specific to their	Questionnaire and expert review	Link curriculum outcomes to specific mobile device applications

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			subjects e.g. a geography teacher should be able to use a maps application		Use applications that are subject specific and beneficial e.g. GPS for a geography teacher
			The educator should be able to use digital assessment tools like online quiz and real time survey through electronic polls	Questionnaire and expert review	Conduct real time surveys through the use of electronic polls
					Conduct online quizzes
		Securing one's device and its contents (Hicks et al., 2013; Kluzer, 2015; Paasch et al., 2012; Voogt et al., 2013)	The educator should educate learners on safe keeping of devices by setting an example	Questionnaire and expert review	Encourage learners to safely lock away devices after use
			The educator should avoid damages caused by power surges due to sporadic electricity supply	Questionnaire and expert review	Do not charge a device the whole day
			The educator should lock away devices after use	Questionnaire and expert review	Lock away all devices safely after use
Social-emotional dimension	Social-emotional literacy (Ng, 2012)	Understanding the internet platform (Clark et al., 2017; Saxena et al., 2017)	The educator should have an understanding of browser elements, search engines, tabs, bookmarks, new window, hyperlinks, hypertexts, browsing history and navigation	Questionnaire and expert review	Understand the internet and how it works
					Understand what a browser is
					Understand what a search engine is
					Know the difference between a tab and a window
					Know the difference between

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
					hyperlinks and hypertexts
					Know how to navigate between different screens whilst surfing the internet
			The educator should be able to manage learners on the internet platform to cater for the slow connections	Questionnaire and expert review	Quota learner's usage of internet to accommodate for poor speeds
			The educator should be able to use an online browser on your device as well as the cache memory for offline use	Questionnaire and expert review	Use cache memory for offline content
		Use the internet to search information (Chipangura, 2016; Qadir et al., 2018)	The educator should be able to find relevant information using the internet especially e-books for rural learners who lack access to textbooks	Questionnaire and expert review	Find subject specific content
			The educator should be able to share information from the web by sending links	Questionnaire and expert review	Share information with learners and colleagues
					Share web links with learners and colleagues
	Social networking functional literacy (Ng, 2012)	Use of social networks for collaborative learning and teamwork	The educator should be able to collaborate with colleagues and	Questionnaire and expert review	Communicate with learners and colleagues using different social media

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
		Rodriguez & Igartua, 2018a; Zhang, 2018)	learners by using social media		Create and manage at least one social media account
					Active on a social media account
			The educator should be able to tele-conference with colleagues and learners through skype	Questionnaire and expert review	Tele-conference with learners and colleagues via skype
		Being part of online groups (Krish et al., 2018)	The educator should have an understanding of the different social media available and be able to create an online learning group	Questionnaire and expert review	Create online learning groups on WhatsApp
					Create online learning groups on Facebook
			The educator should be able to use a mobile device as a blogging tool	Questionnaire and expert review	Create educational blogs
		Sharing and storing of information – cloud computing (Mitrovic, 2017)	The educator should be able to share content and thoughts with learners and fellow colleagues e.g. drop box	Questionnaire and expert review	Share content with learners and colleagues via Dropbox
			The educator should be able to use blogs and Wikis to create content online and receive feedback	Questionnaire and expert review	Comment and receive feedback on blogs and Wikis
			The educator should be able to partake in knowledge generating activities e.g.	Questionnaire and expert review	Participate in an online academic discussion

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			through wikis and Google Docs		
		Using social networks for professional growth and collaboration (Aventurier, 2014; Bansal et al., 2014; Nagel et al., 2012; Rodriguez et al., 2018)	The educator should be able to create a digital e-portfolio for professional development e.g. LinkedIn and to use educational networks like EduBlogs, MindMeister and ePals	Questionnaire and expert review	Manage a digital e-portfolio on LinkedIn or other professional development media
					Connect with other professionals on LinkedIn or other professional development media
		Communication (Chipangura, 2016; Dahlstrom et al., 2013; Harper, 2003; Jones et al., 2006; Kelly et al., 2012; Martin, 2018; Nagel et al., 2012)	The educator should be able to communicate with learner and colleagues through email, social networks, via phone and text messages	Questionnaire and expert review	Communicate through email with learners and colleagues
					Text message learners and colleagues when there is a lack of internet connectivity
	Online etiquette Literacy (Ng, 2012)	Conduct and demeanour over the internet (Chew et al., 2018; Dhir et al., 2012; Voogt et al., 2013)	The educator should behave in a decent manner over the internet and avoid vulgarity	Questionnaire and expert review	Being ethical on the internet
			The educator should be aware of Netiquette	Questionnaire and expert review	Behaving morally over the internet by following internet etiquettes
	Cyber Safety Literacy (Ng, 2012)	Being safe in the online world (Chew et al., 2018; Kluzer, 2015; Paasch et al., 2012)	The educator should be aware of what to publish on social media as this leaves a print in the online world therefore keeping private	Questionnaire and expert review	Being conscious of what one says and upload on social media
					Being aware that everyone has access to social media

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			information disclosed		Disclosing of private information on the internet
			The educator should ensure that learners are safe by educating them as well e.g. on cyberbullying	Questionnaire and expert review	Educate learners on cyberbullying
			The educator should understand the dangers of unsafe networks	Questionnaire and expert review	Understand the dangers with connecting to unsafe networks
			The educator should be able to identify threats and know how to deal with such situations	Questionnaire and expert review	Distinguish information that looks suspicious
			The educator should avoid copying published work	Questionnaire and expert review	Understand copyright material
					Reference online material as much as possible
			The educator should know about legal rights when using online services	Questionnaire and expert review	Know legal rights when being online
					Read the terms and conditions before accepting anything online
Cognitive dimension	Reproduction Literacy (Ng, 2012)	Dealing with graphics, video and animation (Dhir et al., 2012; Kelly et al., 2012)	The educator should know how to differentiate different file formats by understanding different file formats e.g. Audio, video, text	Questionnaire and expert review	Distinguish a video from an audio file
					Understand graphics and animation

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			The educator should be able to create a YouTube video or a vodcast or lesson video and online tutorials on their device	Questionnaire and expert review	Create a video and upload it to YouTube
					Create a video for an online lesson
		Content recreation (Dhir et al., 2012)	The educator should be able to integrate information and create meaningful information	Questionnaire and expert review	Integrate information from different sources
			The educator should be able to find information and experiences across a number of means e.g. through photos, audio, videos, numerical representations and text	Questionnaire and expert review	Understand information represented in photos
					Understand information represented in images
					Understand information represented in numerical form
			The educator should be able to adapt web content to the classroom	Questionnaire and expert review	Source information from the web and use it in the classroom
		Word processing and electronic spreadsheets (Martin, 2018)	The educator should be able to edit in a word processor e.g. by copying and pasting	Questionnaire and expert review	Edit a document in a word processor such as Microsoft Word
					Reconstruct a badly written sentence using copy and paste instead of deleting and retyping in a word processor

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			The educator should be able to use tools such as Excel to generate reports with statistical and graphical representation	Questionnaire and expert review	Create posters for the classroom by using graphic applications
					Create presentations using presentation software
					Draw up reports with graphics and statistical representation using Excel
	Branching Literacy (Ng, 2012)	Multidimensional skills at sourcing information (Chipangura, 2016)	The educator should know how to find answer to a particular question and seek advice and also find information sources that leads to other useful information	Questionnaire and expert review	Search online for example on Google to retrieve answers to specific questions
					Participate in academic online discussions to seek solutions
		Developing a connection between information (Mabila et al., 2017; Russell et al., 2018)	The educator should know how to access, manage, integrate, evaluate and synthesize digital resources	Questionnaire and expert review	Integrate different digital information together to create information
		Having visual and media knowledge (Dhir et al., 2012)	The educator should be able to assign a meaning to images and graphics	Questionnaire and expert review	Understand meanings conveyed by images and graphical representations
			The educator should be able to express themselves through edited photos, videos, sketches, blogs,	Questionnaire and expert review	Express one's self through images, text and graphics

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			podcasts and other forms		
			The educator should be able to listen to music and watch videos	Questionnaire and expert review	Listen to music on my device
					Watch videos on my device
			The educator should be able to understand information in different forms like in text, video, audio, maps	Questionnaire and expert review	Use information in the form of text, video, audio and geographical maps
			The educator should be able to understand media expressions	Questionnaire and expert review	Understand media expressions and know when to use them
			The educator should be able to capture images	Questionnaire and expert review	Capture an image
					Edit images
	Information Literacy (Ng, 2012)	Background knowledge in acquiring information (Mabila et al., 2017; Russell et al., 2018)	The educator should be able to contribute, search and construct knowledge	Questionnaire and expert review	Find meaningful knowledge on the internet
					Share meaningful knowledge on the internet
		Real-time thinking (Jere et al., 2013)	The educator should be able to process and evaluate large amounts of information at the same time	Questionnaire and expert review	Work between large amounts of data on my device
					Navigate between many different documents on my device
			The educator should be able to assess quality and validity and be able to create information	Questionnaire and expert review	I am aware that not all information is valid and is of good quality

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
			through different domains		
			The educator should be able to access e-publications and e-books	Questionnaire and expert review	Find digital textbooks
					Find e-publications
Literacy for all dimensions	Critical Literacy (Ng, 2012)	Being a data critique (Ng, 2012)	The educator should be able to use information responsibly by sourcing information from credible sites and giving credit to the respective authors. In addition the educators should discourage learners from committing plagiarism by copying and pasting	Questionnaire and expert review	Use of reputable sites to download information
					Reference sites and authors while using their work
					Discourage learners from copying and pasting
			The educator should be able to teach learners to analyse information for its authenticity, quality, usefulness and free from bias	Questionnaire and expert review	Encourage learners to learn about credible sites to use whilst sourcing information
			The educator should be able to evaluate web content for authenticity	Questionnaire and expert review	Assess information to see if it is free from bias
					Assess information for its usefulness
Other literacies identified	Financial literacy (Astill, 2017; Van Biljon et al., 2007)	Understanding data cost implications (Astill, 2017; Van	The educator should have an idea of the data costs implications whilst using a	Questionnaire and expert review	Understand financial constraints in a rural area

Dimensions: Digital Literacy Model	Category of Digital literacy skills (Chapter 3)	Mobile digital literacy skills for the use of mobile technologies (Chapter 4)	Rural educator's mobile digital literacy skills for the use of mobile technologies in learning (Chapter 5)	Data collection methods (Chapter 6)	Data collection: Questions in the Questionnaire
		Biljon et al., 2007)	device in the classroom		Understand the data costs associated with using internet connectivity
	Workaround literacy (Supachayanont, 2011)	Adapting to the rural context (Supachayanont, 2011)	An educator should have workaround skills to deal with challenges of a rural nature like lack of electricity	Questionnaire and expert review	Understand that ICT can revolutionise education in a rural area
					Understand that rural areas are resource constrained
					Work around the hurdles faced by rural education specifically

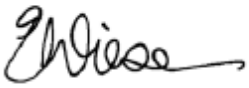
APPENDIX F: LANGUAGE EDITING CERTIFICATE

Estee Wiese
Proofreading of academic texts
BA HDE
estee.wiese@gmail.com
Mobile: +27 (0)83 6070376

Certificate of Editing

To whom it may concern

This is to certify that the manuscript detailed below was edited by an English language academic editor.



Estee Wiese
estee.wiese@gmail.com

Date:	*20/10/2018*
Manuscript Title:	*A framework for mobile digital literacy skills of educators using mobile technology in rural formal education*
Manuscript Author:	*Farshida Jahoor*
	41754549
Institution:	*University of South Africa*