A model for digital literacy enhancement through technology adoption in resource-constrained environments

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A model for digital literacy enhancement through technology adoption in resource-constrained environments

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNATURE DATE

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Abstract

The ubiquitous and pervasive nature of Information and Communication Technologies (ICT) fosters societies driven by knowledge rather than traditional capital and labour through the simplified socio-economic participation. No longer are individuals impacted by spatial and environmental conditions when conducting personal, community and even national obligations and duties. However, the effective use of ICT is governed by personal, interpersonal and environmental factors. Nowhere else is this impact more evident than in rural areas.

Rural areas are plagued by a number of challenges which affect ICT use. Some of these challenges relate to the scarcity of income, education and infrastructure. A holistic investigation on the challenges experienced by rural areas was necessary. Based on the outcome of the investigation, rural areas were classified as resource-constrained environments. The study then set out to explore concepts that highlight the opportunities offered by ICT in rural areas and those that mitigate challenges posed by these environments on ICT use.

The theoretical grounding of the concepts identified in the study firstly set out to understand and explain general ICT use, then extended this ICT use to rural areas. A conceptual model explaining challenges posed by resource constraints inherent in rural areas on ICT use was incepted. This conceptual model was empirically investigated for evaluation and validation purposes resulting in the final model of the study.

The final model of the study facilitated the process of understanding and explaining the effective use of ICT in rural areas based on the inherent resource constraints in these environments. By mitigating the factors affecting ICT use in rural areas, the impact of effective ICT use can potentially be extended to resource-constrained environments, including rural areas.

List of publications

- Matyila, M., Botha, A., Alberts, R., & Sibiya, G. (2014, 7-9 May 2014). Visual interfaces as an approach for providing mobile services and mobile content to low literate users in South Africa. Paper presented at the IST-Africa Conference Proceedings, 2014.
- Matyila, M., Botha, A., & Sibiya, G. (2016). The facilitation of adoption and use of text intensive mobile services by low literate users. Paper presented at the Engaging with Participation, Activism, and Technologies: 13th Prato CIRN Conference Monash Centre, Prato Italy.
- Matyila, P. M. L., Botha, A., Alberts, R., & Sibiya, G. (2013, 25-27 Nov. 2013). The design of accessible and usable mobile services for low literate users. Paper presented at the Adaptive Science and Technology (ICAST), 2013 International Conference on.

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List of Abbreviations

ICT	Information and Communication Technology
RCE(s)	Resource Constrained Environment(s)
PC	Personal Computer
ICT4RED	(The) Information and Communication Technology for Rural Education Development
TECH4RED	(The) Technology for Rural Education Development
IT	Information Technology
TAM	Technology Acceptance Model
UTAUT	The Unified Theory of Acceptance and Use of Technology
ICT4E	Information and Communications Technology for Education
DRDLR	Department of Rural Development and Land Reform
CSIR	(The) Council for Scientific and Industrial Research
UFS	University of the Free State

Chapter 1 *Introduction*

1-1. Introduction and background

The impact of information and communication technology (ICT) in countries, their regions, communities and individuals is immense; from personal upliftment, community development, infrastructure development, and the associated value chain (Heeks, 2010, 2014). The value chain of ICT has dimensions that entail readiness, availability, uptake, and impact (Heeks, 2010). These dimensions have the potential to foster economic growth and human development (Cuervo & Menéndez, 2006; Heeks, 2010). In Africa, similar to other developing regions, the dominant aspect of ICT lies in mobile, due to the development trajectory that is playing out on the continent (infoDev, 2012).

Mobile devices possess numerous capabilities for enabling individuals to perform a variety of tasks in a number of ways, including business, recreation and communication (Böhmer, 2013; Donner, 2008; Wicander, 2010). The mobile aspect of ICT plays a crucial role in extending the capabilities of individuals, their communities, and society at large (Smith, Spence, & Rashid, 2011). Mobile device capabilities have fostered the proliferation of mobile phones among users of all ages and socio-economic backgrounds.

The socio-economic impact of ICT, particularly the associated mobile infrastructure and technologies, have contributed towards the impact of the global Sustainable Development Goals (SDGs) and other regional goals such as poverty eradication, e-services, gender equality, and others. (GSMA, 2017; Sharma, Fantin, Prabhu, Guan, & Dattakumar, 2016). Regional goals and the SDGs are driven towards challenging (social) inequality, eradicating poverty, protecting the planet, and ensuring prosperity for all through a sustainable development agenda (ISCC, IDS, & UNESCO, 2016).

However, the proliferation of ICT is not without challenges. This proliferation does not imply automatic and instinctive use of ICT by individuals. Challenges with ICT use are more pronounced in deep rural, rural, and semi-urban environments, which are prone to resource constraints that affect the socio-economic participation of individuals residing in those areas. Rural areas are plagued by a number of resource constraints, notwithstanding ICT use. These

environments experience the lowest use of ICT, potentially with detrimental impact on participation in the digital age (DiMaggio & Hargittai, 2001; Sithole et al., 2013).

In light of the scarcity challenges experienced by individuals in resource-constrained environments (RCEs), it is essential for these individuals to focus their limited resources on areas that yield greater impact on their day-to-day activities. ICT use has been shown to optimise individuals' efficiency in achieving routine goals (infoDev, 2012). It is therefore the aim of the researcher to identify models and frameworks that will facilitate the adoption and use of ICT by individuals in RCEs in their day-to-day activities by using approaches that impose the least challenges to their constrained environment – that is, approaches that will facilitate ICT use in RCEs in light of the scarcity challenges that relate to the availability of resources inherent in this environment.

The major factors that affect the use of ICT by individuals are as follows: access, literacy related to equitable use of ICT, and relevant content (Servon, 2008; Warren, 2007). However, Servon (2008) points out that individuals may experience challenges in accessing relevant content, even when it is available, if their literacy levels do not support the necessary ICT use. This implies that access and ICT-related literacy play a more crucial role in ICT use than the availability of content. The factors relevant for ICT use are then narrowed down to ICT access and ICT-related literacy. The research will then explore and understand frameworks and models from the field that facilitate ICT access, as well as frameworks and models that facilitate ICT-related literacy.

Technology access has been shown to play an important role in the adoption and use of that technology (Davis, Bagozzi, & Warshaw, 1989; Venkatesh & Davis, 2000). This research will therefore investigate technology adoption towards facilitating ICT use for individuals in RCEs.

ICT-related literacy has been noted to play a significant role in ICT use. Despite formal education being recognized as facilitator of the improvement of an individual's cognitive abilities and self-belief (Bandura, 1993), thus enabling ICT use, ICT-specific literacy plays a more direct role in ICT use. The successful and effective use of ICT, similar to numerous new technologies, places specific mental requirements on individuals (Torraco, 2002). A higher level of literacy, with specific emphasis on individuals' adoption and use of ICT, is

necessary to empower individuals in the ever-changing digital landscape (Krumsvik, 2008; Šorgo, Bartol, Dolničar, & Boh Podgornik, 2017).

Digital literacy is an ICT-specific literacy that has been shown to facilitate the use of ICT by individuals with differing socio-economic backgrounds (Ozdamar-Keskin, Ozata, Banar, & Royle, 2015). This research will investigate the elements of digital literacy in the context of RCEs significant to ICT use, and will further explore digital literacy attainment through *technology adoption* towards improving the adoption and use of ICT by individuals in the selected context. Constructs and elements of technology adoption and those of digital literacy will be brought together in synergy towards affording individuals in RCEs equitable use of ICT.

The motivation toward exploring digital literacy through technology adoption stems from the fact that technology adoption plays a role in explaining the acceptance and use of ICT in general (Liao, Palvia, & Chen, 2009; Oliveira & Martins, 2011; Straub, 2009). Technology adoption, acceptance, and use have long been recognised as prerequisites for technology realisation and utilisation (Momani, Jamous, & Hilles, 2018), thus facilitating digital literacy. Digital literacy constitutes a system of skills and strategies that can assist individuals to responsibly and intuitively use ICT in their day-to-day activities (Alkali & Amichai-Hamburger, 2004; Eshet-Alkalai, 2004) and to contribute to their communities and society, thus participating in the digital age.

Having introduced the study, the rest of the chapter will outline avenues explored in the research towards mitigating these challenges. This section introduced the challenge to be addressed by the research. Section 1.2 presents the problem statement. Section 1.3 presents the main research question and the sub-research questions, while the significance of the research is presented in Section 1.4. Section 1.5 outlines the research methodology. Section 1.6 presents trustworthiness in the research, with the Assumptions and the Delineations of the research presented in Sections 1.7 and 1.8 respectively. The key definitions used in the research are discussed in Section 1.9. Section 1.10 presents the chapter overview, and the research contribution is presented in Section 1.11. Finally, the chapter is summarised in Section 1.12.

1-2. Problem statement

The use of ICT by users in RCEs presented the study with challenges and opportunities. In light of these challenges and opportunities, the **research purpose** is to explore the attainment and enhancement of digital literacy through technology adoption for supporting individuals in RCEs with ICT use. Digital literacy has specifically been identified in the research due to its role in ICT use.

1-3. Research questions

The research question that facilitates the research purpose to be addressed is as follows:

> ***(MRQ) What elements should a model comprise of to enhance digital literacy through technology adoption in resource-constrained environments (RCEs)?***

This research question plays the role of guiding the research process (Salkind, 2012; Saunders, Lewis, & Thornhill, 2016). In this research, the main research question was broken down into the following sub-research questions:

> ***(SRQ1)What are the elements of digital literacy that are relevant to technology use?***
>
> ***(SRQ2)What are the elements of technology adoption that influence the attainment of digital literacy?***
>
> ***(SRQ3)What constraints does an RCE present for the attainment of digital literacy through technology adoption?***

The following key concepts were identified for investigation in addressing the main research question as well as the sub-research questions: digital literacy, technology adoption, and resource-constrained environments.

1-4. Research aims and objectives

Having stated the research questions, the research ***aims***, based on the main research questions and the sub-research questions, are as follows:

- To identify elements of digital literacy relevant for technology use which are facilitated by technology adoption; and
- To mitigate the constraints of RCEs to technology adoption towards the attainment of digital literacy.

The following ***objectives*** were considered as necessary in addressing these aims:

- To establish the significance of digital literacy to ICT use;
- To establish the significance of technology adoption to ICT use;
- To confirm the significance of digital literacy and technology adoption to ICT use; and
- To identify the opportunities and mitigate the challenges of RCEs to technology adoption and digital literacy.

These research objectives highlight the piecemeal goals that the study needs to realise in order to address the research questions and eventually the research purpose. In light of the research aims and objectives, the next section presents the significance of the research.

1-5. Significance

Technology adoption and digital literacy were noted as important concepts that facilitated ICT use. Technology adoption was noted as a means towards ICT acceptance, adoption, and use (Davis, 1985; Straub, 2009). Digital literacy was noted to have elements that play an important role in the effective use of ICT (Alkali & Amichai-Hamburger, 2004; Ng, 2012a, 2012b). The study aimed to facilitate the attainment of digital skills for the use of ICT through digital literacy and technology adoption. The research identified the context of RCEs for the study, guided by the premise that the context presented the most potential in highlighting the significance of digital literacy attainment and enhancement for ICT use through technology adoption.

The research outlined elements of technology adoption and those of digital literacy, and synthesized these to design and develop a model to understand and explain the use of ICT by individuals in RCEs. *The research choice for constructing this model will be outlined in the research methodology, evaluated in the research design, and validated in the analysis process*. The next section briefly outlines the research methodology and motivates for its adoption.

1-6. Research methodology

The research methodology facilitates the systematic addressing of a research problem (Kothari, 2004). The research problem was solved empirically by using the data collection

processes, and then analysing and interpreting the associated findings. Research methods support the research methodology through research processes and techniques (Hofstee, 2006; Kothari, 2004). The research process outlines the research philosophies, approaches, strategies, and time horizons, including the techniques and procedures adopted in the research (Saunders et al., 2016). As part of the empirical investigation, the research methodology then facilitated the research, data collection, and data analysis processes. Figure 1-1 illustrates:

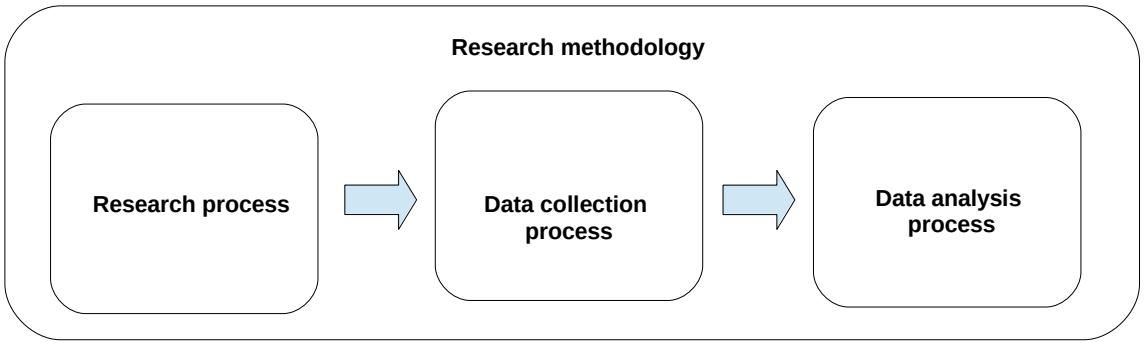

Figure 1-1: Research methodology

The research investigated an ICT phenomenon involving individuals in RCEs, and hence the interpretive research philosophy was adopted. The philosophy of interpretivism relates to the study of a social phenomenon in a natural environment, and focuses on conducting research among people rather than objects, with researchers adopting an empathetic stance so as to understand their social world and the meaning that they allocate to it from their point of view (Saunders & Tosey, 2012). Interpretivism plays an important role in explaining phenomena involving human participants (Klein & Myers, 1999). In the research, this entailed socially constructing the perspectives of participants to the challenges posed by ICT in the context of interest, and qualitatively creating an in-depth understanding (Barker, 2014; Creswell, 2012).

The research identified key concepts related to the research enquiries, and undertook empirical investigations related to these concepts. Concepts were theoretically grounded, using a series of literature reviews to conceptually address the research challenges. Empirical investigations were undertaken to evaluate and validate these theoretical findings and, where possible, extend the theories. As a result, the inductive research approach was used for theory development, based on empirical investigations.

A case study research strategy was adopted for data collection. The motivation for the selection of this research strategy stemmed from the fact that case studies are empirical enquiries that facilitate the investigation of phenomena within their real life context using one or more sources of evidence (Noor, 2008; Yin, 2017). The adoption of a case study afforded the research multiple data collection tools for evaluating and validating the attainment and enhancement of digital literacy through the process of technology adoption in RCEs.

The research investigated ICT use by participants from RCEs by following the concepts of digital literacy and technology adoption. ICT use has been noted to have dependencies on ICT acceptance and adoption (Davis, 1985; Dillon, 2001). Dillon (2001) pointed out that, due to the complexity of ICT acceptance and notwithstanding adoption and use, a simple explanation of acceptance by the intended users was unlikely. Digital literacy addresses diverse and complex ICT-related concepts, thus also making its explanation intricate (Iordache, Mariën, & Baelden, 2017; Pangrazio, 2016). Further, RCEs were expected to provide more complexities to technology adoption and digital literacy.

The instruments used in the case study were to facilitate the data collection and analysis processes. The research activities from broad assumptions to detailed methods for data collection, analysis, and interpretation represented the choices adopted in the research (Saunders et al., 2016). Three research choices were identified from literature, namely, quantitative, qualitative, and mixed method research approaches (Creswell, 2013; Saunders et al., 2016). *In light of the complex nature of concepts facilitating ICT use for RCEs, mixed method research approaches were adopted for the data collection process*. The motivation for adopting this research approach is provided in Subsection 5.4.4.2.

The data analysis process facilitated the synthesis of the data collection process towards the findings and conclusions of the research, and were conducted using coding and thematic analysis (*cf.* Section 5.6 and Chapter 7). The findings and conclusions from the empirical investigations were aligned to the questions underlying the research enquiry. The research design facilitated this process; it provided the logic that linked the research questions to the empirical data, research findings, and the research conclusions (Creswell, 2013; Yin, 2015, 2017). More detail on the research design was provided in Chapter 8 (see Section 8.4).

Finally, the multiple data collection tools afforded by the case study facilitated the evaluation and validation of the research process through trustworthiness. Trustworthiness facilitates

triangulation and ethical considerations in the research (Curtin & Fossey, 2007; Heigham & Croker, 2009). The next section provides a broad overview of trustworthiness.

1-7. Trustworthiness

Trustworthiness was used in the research as part of empirically evaluating and validating the model resulting from theoretical foundations. According to Curtin and Fossey (2007), trustworthiness refers to the extent to which research findings are an authentic reflection of the personal or lived experiences of the participants involved in the phenomenon under investigation. The trustworthiness of qualitative research was judged by two sets of standards, namely, whether the study meets general guidelines in the field for acceptable and competent practice and whether the study demonstrated sensitivity to ethical issues (Heigham & Croker, 2009). These two concepts were considered to contribute to trustworthiness.

Strategies for competent practice, which contributed to trustworthiness, were as follows: triangulation, prolonged engagement, participant validation, using critiques from practitioners and colleagues, and theoretical foundations of ethical practice evaluation (Heigham & Croker, 2009). It was further noted that there were four criteria that a qualitative researcher should adhere to in pursuit of a trustworthy study, namely, *credibility*, *transferability*, *dependability*, and *confirmability* (Guba, 1981; Shenton, 2004).

The research was guided by principles of Information Systems, with the emphasis on communities and society in addressing the challenges posed by the study; it ensured that the findings informed research and practise and further contributed to the use of ICT by individuals with appropriate digital literacy as facilitated through digital literacy. Further, the research strived to adhere to the criteria for trustworthiness, as was evident throughout the study.

1-7-1. Triangulation and its challenges

Triangulation is one of the strategies for competent research practice embedded in trustworthiness. A number of triangulation types were noted in literature – for example, method triangulation, theory triangulation, investigator triangulation, and data source triangulation (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). Due to the multiple data collection tools employed in the research, method triangulation (and specifically time triangulation) was adopted, since it facilitated the collection of data at different times (Polit & Beck, 2008).

Triangulation is noted to contain several challenges. Barbour (1998) cautions that triangulation has origins in the quantitative tradition, and is embedded in the notions of proof and confirmation; it often constitutes an attempt to claim rigor rather than provide a description on how rigor is to be achieved.

1-7-2. Ethical consideration

Ethical consideration is one of the standards for judging trustworthiness in researches involving human participants. Ethical considerations needed to be given attention and reflected upon prior to conducting the research; they should be anticipated throughout, from the beginning of the study, during data collection and analysis, and in sharing, reporting, and storing the data (Creswell, 2013). The study attained ethical clearance from the University of South Africa, Pretoria (see the certificate in Appendix A).

The study was informed by the principles of research ethics as highlighted by Flick (2009), which indicated that researchers should avoid harming participants involved in the research process by respecting them and taking their needs into account. Further, the study was cognisant of significant issues to consider when involving human subjects, namely, non-malfeasance, beneficence, autonomy or self-determination, and justice (Murphy & Dingwall, 2001). The research ensured that participants were not harmed during the research process, but rather benefited positively from the research – for example, through motivation or by being better informed about issues related to ICT use. Participants were treated equally and were not coerced or mislead; instead, the research process was informed by their concerns and voluntary contributions.

The research adopted informed consent, and all participants were required to provide consent before taking part in the research (Saunders et al. (2016)). Language barriers were mitigated where necessary.

1-8. Assumptions

The research assumptions provide the context that forms the natural settings of the participants. The context of the current research entails RCEs. For the purposes of this study, rural communities were selected as a representative context for RCEs. Further, for the considerations of comprehensively understanding digital use in RCEs the research assumes that the selected participants use ICT in their day-to-day activities particularly at the workplace.

The criteria for selecting participants were informed by the sampling considerations of the study. Particularly, teachers were selected to participate in the study based on their availability, willingness to participate, and anticipated contribution to the research process.

1-9. Delineations of the research

The delineations of the research are as follows:

- The study was restricted to the context of RCEs, as defined in Table 1-1;
- The research adopted qualitative research, and used mixed methods for data collection; and
- Since teachers were selected as a sample for participation in the research, the study was restricted to activities undertaken in the classroom and during training sessions. Typical activities in the classroom involved the interaction between the learners and the teacher, and activities in the training sessions involved the interaction of teachers with the facilitators.

The identified delineations contributed to the success of the research process by focusing its scope to sufficiently justify the results and outcomes.

1-10. Key definitions

The key definitions used in the study are outlined in the Table 1-1:

Table 1-1: Definitions used in the study

Concept	Definition including citations
Model	A ***model*** is a systematic description of an object or phenomenon that shares important characteristics with its real-world counterpart and supports its detailed investigation (Börner, Boyack, Milojević, & Morris, 2012). Models are often used for constructing scientific theories.
Conceptual model	A ***conceptual model*** is not intended to represent what exists, but to represent a view of what could exist (Gregory, 1993).
Resource-constrained environments (RCEs)	According to Anderson, Anderson, Borriello, and Kolko (2012a) and Anderson and Kolko (2011), ***RCEs*** are defined as environments affected by a range of conditions including material issues such as limited resources, infrastructure, and societal conditions.
Technology	According to Hevner and Chatterjee (2010), technology represents practical

	implementations of intelligence and is not an end itself, but is instead practical and useful.
Documentation	According to Yin (2017) documentation is documentary information taking many forms and may be the object of explicit data collection.
Age of majority / Majority status	The age of eighteen years old; where an individual has adult legal status and has the right to bring matters to court, own and administer property, children custody, marriage and so forth (Republic of South Africa, 2005; Van Hook & Ngwenya, 1996).

These definitions are relevant to the research and are used throughout the study.

1-11. Brief chapter overview

The research will address the challenges of the study as outlined as follows:

Chapter 1

The Introduction presents the background of the research as well as the research challenges and opportunities; it indicates how the opportunities may be enhanced in the research and the challenges addressed. The Introduction outlines the research processes to be undertaken.

Chapter 2

This chapter represents the first chapter of the literature review, and addresses the first sub-research question. This sub-research question drives the theoretical considerations of digital literacy. The significance of digital literacy to the research is also outlined. The chapter concludes by presenting the inception of the conceptual model of the research.

Chapter 3

This chapter represents the second chapter of the literature review, and addresses the second sub-research question. This sub-research question drives the theoretical considerations of technology adoption. The relevance of technology adoption to the research is highlighted. The chapter concludes by extending the conceptual model to include technology adoption considerations.

Chapter 4

This chapter represents the final chapter of the literature review, and defines and describes RCEs. It addresses the third sub-research question, and thus the main research question, by

including the context of RCEs in digital literacy and technology adoption considerations. The chapter concludes by extending the conceptual model to RCEs, thus presenting the full conceptual model for the research.

Chapter 5

This chapter adopts a methodology for the research, which will facilitate the undertaking of the empirical investigations to evaluate and validate the conceptual model in a systematic manner. The philosophical underpinnings of the research, as well as the research design which dictates the research strategy, are also adopted. The chapter motivates for adopting mixed methods research in the data collection process. The chapter concludes by presenting the foundation for the qualitative data analysis and interpretation processes.

Chapter 6

This chapter presents the data collection results in light of the mixed method research choice. This implies that the results of both the quantitative and qualitative data collection need to be presented. Trustworthiness, including ethical considerations and triangulation, resonates throughout the data collection and data analysis processes.

Chapter 7

This chapter presents the data analysis of the research. In light of the sequential explanatory mixed methods research, integration takes place at the interpretation phase. The final model of the research is presented in light of the empirical investigations undertaken in the research.

Chapter 8

In this chapter, the researcher reflects on the research, that is, the research questions, research methodology and methods, and research contributions. The limitations of the research are presented, and further research is outlined, before concluding with the final reflections.

Figure 1-2 illustrates these phases:

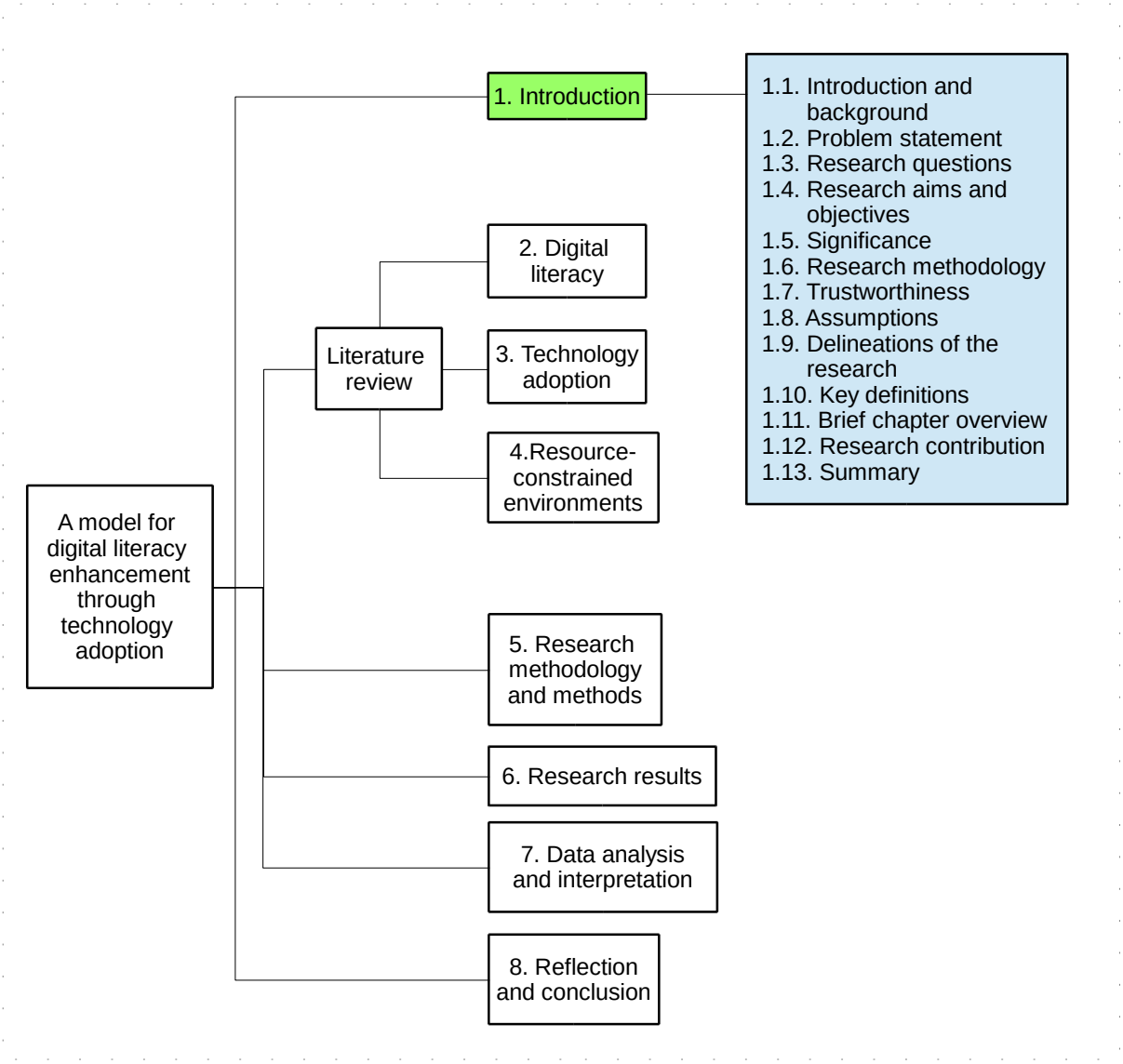

Figure 1-2: Research outline overview with emphasis on the introduction

1-12. Research contribution

The research contributes towards theories related to digital literacy and technology adoption. The main contribution is theory generation in the form of a model (Yin, 2015, 2017). Concepts related to digital literacy and technology adoption will be used in the construction of a model to understand and explain the effective use of ICT by individuals in RCEs.

1-13. Summary

This chapter presented the opportunities and challenges of ICT use by individuals in RCEs in their day-to-day activities. The chapter outlined how the research intends to mitigate the challenges posed, and how it will enhance the opportunities. The research questions that

inform the research process were presented. The case study was adopted as qualitative research methodology to guide the research process. The research design was also presented to facilitate the research process. Trustworthiness was highlighted as a key concept to be adopted in the research. This concept includes triangulation for validation, and ethical consideration for good research practise. Finally, assumptions and delineations were presented as a means of scoping the research, and the overview of the process was presented to highlight the direction of the research.

Chapter 2 *Digital Literacy*

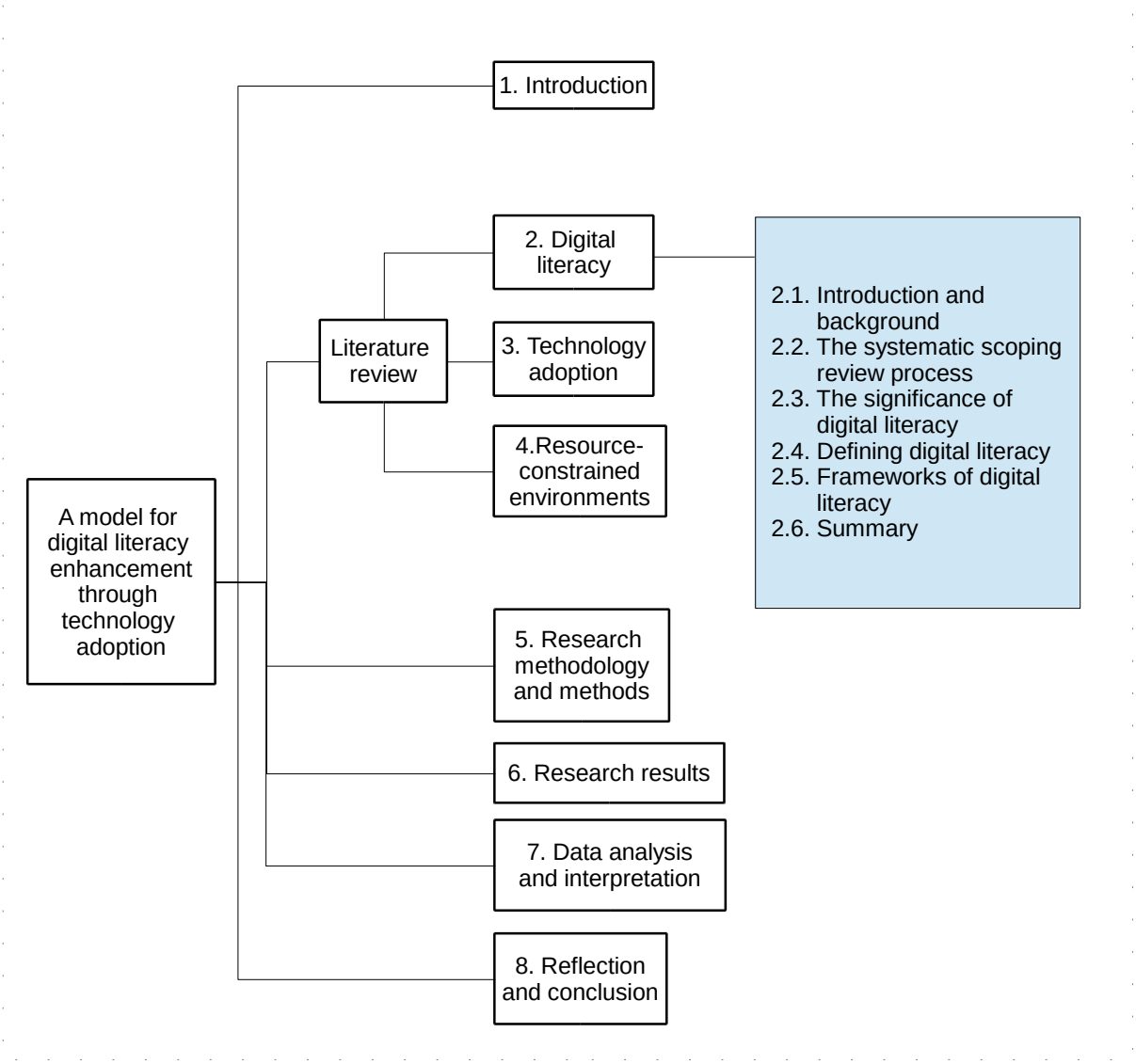

Figure 2-1: Research outline overview with emphasis on digital literacy

The aim of this chapter is to address sub-research question 1, which is reiterated below (see Section 2.1). The sub-research question seeks to guide and explain digital literacy and to identify from digital literacy models a model to adopt that would best facilitate the attainment and enhancement of digital literacy through technology adoption. Based on the complexity of the landscape of the 'new literacies', the identified digital literacy model would need to facilitate ICT use by individuals in their day-to-day activities.

2-1. Introduction and background

Chapter 1 introduced the opportunities and challenges offered by ICT in society. A particular emphasis was placed on resource-constrained environments (RCEs), in light of the potential impact of ICT in this environment. The introduction chapter also explored how the challenges posed by ICT can be mitigated and the opportunities enhanced. Further, three key concepts were identified for investigation in the research, namely, digital literacy, technology adoption, and RCEs. For the purposes of this research, a literature review was undertaken for each of these concepts. This chapter is the first of three chapters that address the overall literature review; it culminates in the inception of the conceptual model. Each of the literature review chapters outlines how the model evolved as more details were introduced.

The current chapter outlines a literature review on digital literacy. Technology adoption and RCEs are addressed in the next two chapters.

The first sub-research question from Chapter 1, which is reiterated below, prompts the literature review:

SRQ 1 – What are the elements of digital literacy that are relevant to technology use?

The literature outlines the significance of literature reviews in establishing the theoretical grounding of concepts when undertaking a research process such as a graduate dissertation (Creswell, 2012; Fink, 2013; Hart, 2018). The current research adopted a *systematic scoping literature review*, since it avoids the biases inherent in conventional literature reviews and has attributes that satisfy the concept-driven graduate literature review undertaken in this study (Okoli & Schabram, 2010; Oya, 2013; Petticrew & Roberts, 2006). The systematic scoping review contains attributes of both systematic reviews and scoping reviews, and appeals to the study due to the depth and breadth of theoretical grounding that it can provide to the research process. Due to the dependence of the literature review on concepts related to scoping reviews and systematic reviews, definitions of each of these review types will be provided.

The research acknowledges that there are numerous definitions of systematic literature reviews; however, for illustration purposes, a few will be presented. Some of the definitions of a systematic literature review are as follows:

- According to Green and Higgins (2005), a *systematic literature review* attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to

answer a specific research question using explicit, systematic methods that are selected with a view to minimise bias, thus providing more reliable findings from which conclusions can be drawn and decisions made.

- Kitchenham (2004) defined a systematic literature review as a means of identifying, evaluating, and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest.

No universal definition of scoping reviews exists; however, definitions of scoping reviews in literature commonly refer to a mapping of concepts, which is a process of summarising a range of evidence in order to convey the breadth and depth of a field (Levac, Colquhoun, & O'Brien, 2010). Scoping reviews have been noted to facilitate the mapping of key concepts underpinning a research area and to clarify working definitions or conceptual boundaries of a research area (Arksey & O'Malley, 2005; Mays, Roberts, & Popay, 2001). In the current chapter, this will entail identifying key concepts, working definitions, and conceptual boundaries of digital literacy.

Scoping reviews differ from systematic literature reviews in that they offer flexibility while facilitating an in-depth treatment of a topic (Peterson, Pearce, Ferguson, & Langford, 2017). A comparison between scoping reviews and systematic reviews is provided by Brien, Lorenzetti, Lewis, Kennedy, and Ghali (2010) and Armstrong, Hall, Doyle, and Waters (2011), as illustrated in the Table 2-1:

Table 2-1: A comparison between scoping reviews and systematic reviews (Armstrong et al. (2011))

Systematic review	**Scoping review**
Focused research question with narrow parameters	Research question(s) often broad
Inclusion/exclusion usually defined at outset	Inclusion/exclusion can be developed post hoc
Quality filters often applied	Quality not an initial priority
Detailed data extraction	May or may not involve data extraction
Quantitative synthesis often performed	Synthesis more qualitative and typically not quantitative
Formally assess the quality of studies and generates a conclusion relating to the focused research question	Used to identify parameters and gaps in a body of literature

This research will adopt the Arksey and O'Malley framework for undertaking the systematic scoping review on digital literacy (Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2015; Pham et al., 2014).

2-2. The systematic scoping review process

The Arksey and O'Malley framework advocates six consecutive stages to be followed when undertaking a scoping literature review, namely, identifying the research question, identifying relevant studies, study selection, charting the data, collating, summarizing, and reporting results, and an optional step for consulting stakeholders or validating the findings. For the purposes of the current research, the optional consultation stage was not relevant. Contrary to the prescriptions of the framework (Arksey & O'Malley, 2005; Pham et al., 2014), the systematic scoping review was undertaken by the researcher alone, thus introducing a potential for bias. The application of this framework in the current research for digital literacy is motivated by Levac et al. (2010), who also provides a description of these stages. Table 2-1 illustrates:

Table 2-1: Overview of the Arksey and O'Malley methodological framework for conducting a systematic scoping study as applicable to digital literacy (adapted from Levac et al. (2010))

Framework stage	Description	Relevance to digital literacy review
Identification of the research question	Identification of the research question provides the roadmap for subsequent stages. Relevant aspects of the question must be clearly defined, as they have ramifications for search strategies. Research questions are broad in nature as they seek to provide breadth of coverage.	The following research question was identified for this scoping review: *How does digital literacy contribute to the effective use of information and communication technology*?
Identification of relevant studies	This stage involves identification of the relevant studies and development of a decision plan for where to search, which terms to use, which sources to search, time span, and language. Comprehensiveness and breadth is important in the search. Sources include electronic databases, reference lists, hand searching of key journals, and organizations and conferences. Breadth is important; however, practicalities of	• The review focused on studies from 1997 to date. • The search process of the review was mainly undertaken with Google scholar through Harzing's publish or perish tool (Harzing, 2010). Google scholar indexes the following academic journals: Taylor & Francis Online, JSTOR, ACM Digital Library, Wiley Online Library and

	the search are as well. Time, budget, and personnel resources are potential limiting factors, and decisions need to be made upfront about how these will impact the search.	ScienceDirect, among other journals; note that, theoretically, Google scholar indexes all of them (Falagas, Pitsouni, Malietzis, & Pappas, 2008). No databases or other sources were searched manually. • The search terms used were generated from the review research question. **The final *search terms* used were as follows**: digital literacy and digital literacy framework. Some of the search terms were excluded based on relevance, and these are listed in the study selection section.
Study selection	Study selection involves post-hoc inclusion and exclusion criteria. These criteria are based on the specifics of the research question and on new familiarity with the subject matter through reading the studies.	The following criteria were adopted in terms of inclusion and exclusion for digital literacy: • The study selection comprised a total of 2940 articles that were generated through the search process. • Only publications written in English were included. • Only studies that included the search terms were selected. • Duplicates were excluded. • The challenge of irrelevant studies (vom Brocke et al., 2015) was mitigated through the use of Harzing's publish or perish tool (Harzing, 2010).
Charting the data	A data-charting form was developed and used to extract data from each study. A 'narrative review' or 'descriptive analytical' method was used to extract contextual or process-oriented information from each study.	The four-phase PRISMA[1] flow chart was used (see Figure 2-2).
Collation, summary, and	An analytic framework or thematic construction was used to provide an	This is outlined in Sections 2.3 to 2.5.

reporting of results	overview of the breadth of the literature, but not a synthesis. A numerical analysis of the extent and nature of studies using tables and charts is presented, followed by a thematic analysis. Clarity and consistency are required when reporting results	
Consultation (optional)	Provides opportunities for consumer and stakeholder involvement to suggest additional references and provide insights beyond those in the literature.	This is not relevant and was not undertaken in this research.

[1] ***PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses from the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009)***

Based on Table 2-1, the research question of the literature review was derived directly from the first sub-research question. The identification of the relevant studies by means of the search process was facilitated by Google Scholar® and Harzing's publish or perish tool. Due to the diversity of the digital literacy concept, only two search terms were used for scoping purposes: digital literacy and digital literacy framework. As pointed out in the table, charting of the data was undertaken using a flow diagram. Figure 2-2 illustrates:

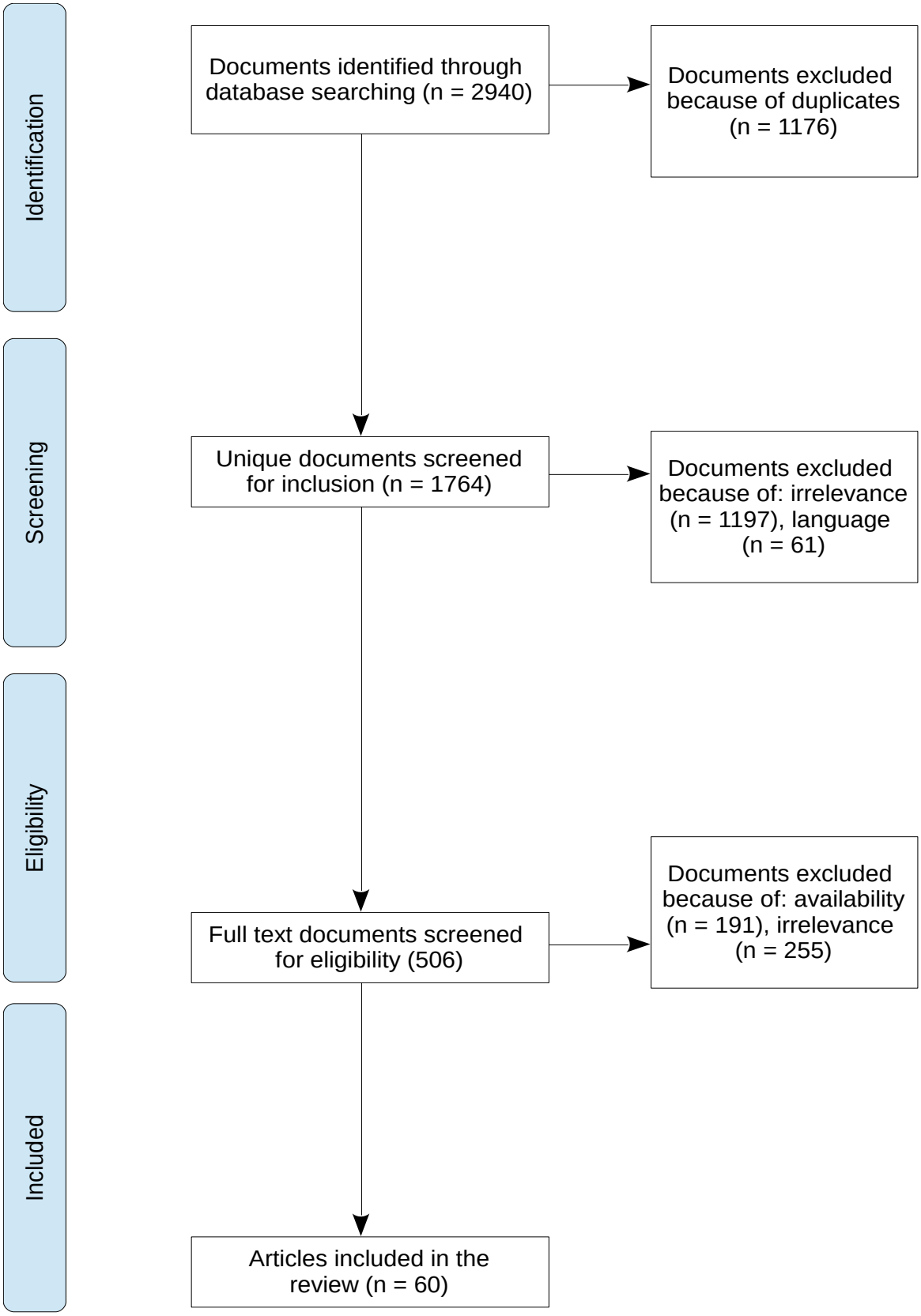

Figure 2-2: The application of the flow diagram for the data charting stage of the Arksey and O'Malley methodological framework (adapted from Pham et al. (2014))

The literature search returned 2940 articles for the search terms ‘digital literacy’ and ‘digital literacy framework’. 2880 articles were excluded through the exclusion process, with sixty (60) articles remaining. These articles are listed in Table 2.2 below:

Table 2-2: Article listing based on the search terms (digital literacy, digital literacy framework, and resource-constrained environments)

Article listing: Digital literacy and digital literacy framework
1. Bawden, D (2001). Information and digital literacies: a review of concepts. *Journal of documentation*, emeraldinsight.com
2. Eshet-Alkalai, Y (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and …*, search.proquest.com
3. Eshet, Y. (2002). Digital Literacy: A New Terminology Framework and Its Application to the Design of Meaningful Technology-Based Learning Environments.
4. Knobel, M (2008). Digital literacies: Concepts, policies and practices., books.google.com
5. Bawden, D (2008). Origins and concepts of digital literacy. *Digital literacies: Concepts, policies and practices*, pages.ucsd.edu
6. Buckingham, D (2015). Defining digital literacy-What do young people need to know about digital media?. *Nordic Journal of Digital Literacy*, idunn.no
7. Ng, W (2012). Can we teach digital natives digital literacy?. *Computers & Education*, Elsevier
8. Marsh, J (2005). Popular culture, new media and digital literacy in early childhood., books.google.com
9. Alkali, YE, & ... (2004). Experiments in digital literacy. *CyberPsychology & …*, online.liebertpub.com
10. Koltay, T (2011). The media and the literacies: Media literacy, information literacy, digital literacy. *Media, Culture & Society*, journals.sagepub.com
11. Martin, A (2008). Digital literacy and the 'digital society'. *Digital literacies: Concepts, policies and …*, digitalfuturesoer3.pbworks.com
12. Aviram, A, & Eshet-Alkalai, Y (2006). Towards a theory of digital literacy: three scenarios for the next steps. *European Journal of Open, Distance and E …*, eurodl.org
13. Eshet, Y. (2012). Thinking in the digital era: A revised model for digital literacy. Issues in Informing Science and Information Technology, 9(2), 267-276.
14. Martin, A (2005). DigEuLit–a European framework for digital literacy: a progress report. *Journal of eLiteracy*, Citeseer
15. Gui, M, & Argentin, G (2011). Digital skills of internet natives: Different forms of digital literacy in a random sample of northern Italian high school students. *New media & society*, journals.sagepub.com
16. Hargittai, E (2009). An update on survey measures of web-oriented digital literacy. *Social science computer review*, journals.sagepub.com
17. Lanham, RA (1995). Digital literacy. *Scientific American*, elibrary.ru (http://museum.doorsofperception.com/doors3/texts/lanhamtxt.html)
18. Martin, A, & Grudziecki, J (2006). DigEuLit: concepts and tools for digital literacy development. *Innovation in Teaching and Learning in …*, Taylor & Francis
19. Lankshear, CJ, & Knobel, M (2008). Introduction: Digital literacies: Concepts, policies and practices., researchonline.jcu.edu.au
20. Park, YJ (2013). Digital literacy and privacy behavior online. *Communication Research*, journals.sagepub.com
21. Pool, CR (1997). A new digital literacy a conversation with Paul Gilster. *Educational Leadership*, namodemello.com.br
22. Knobel, M, & Lankshear, C (2006). Digital literacy and digital literacies: policy, pedagogy and research considerations for education. *Nordic Journal of digital literacy*, idunn.no

23. Hague, C, & Payton, S (2010). Digital literacy across the curriculum., Futurelab
24. Belshaw, D (2012). What is' digital literacy'? A Pragmatic investigation.., etheses.dur.ac.uk
25. Tsai, HS, Shillair, R, & Cotten, SR (2017). Social Support and “Playing Around” An Examination of How Older Adults Acquire Digital Literacy With Tablet Computers. *Journal of Applied …*, journals.sagepub.com
26. Scarcelli, CM, & Riva, C (2017). Digital literacy circulation: Adolescents and flows of knowledge about new media. *… : Italian Journal of Science & Technology …*, tecnoscienza.net
27. Schreurs, K, Quan-Haase, A, & ... (2017). Problematizing the Digital Literacy Paradox in the Context of Older Adults' ICT Use: Aging, Media Discourse, and Self-Determination.. *Canadian Journal of …*, search.ebscohost.com
28. Pangrazio, L (2016). Reconceptualising critical digital literacy. *Discourse: Studies in the cultural politics of education*, Taylor & Francis
29. Sefton-Green, J, Marsh, J, Erstad, O, & Flewitt, R (2016). Establishing a research agenda for digital literacy practices of young children: a white paper for COST action IS1410., dro.deakin.edu.au
30. Prior, DD, Mazanov, J, Meacheam, D, Heaslip, G, & ... (2016). Attitude, digital literacy and self efficacy: Flow-on effects for online learning behavior. *The Internet and Higher …*, Elsevier
31. Tang, CM, & Chaw, LY (2016). Digital Literacy: A Prerequisite for Effective Learning in a Blended Learning Environment?.. *Electronic Journal of e-Learning*, ERIC
32. Alexander, B, Adams, S, & Cummins, M (2016). Digital literacy: An NMC Horizon project strategic brief., learntechlib.org
33. Sharma, R, Fantin, AR, Prabhu, N, Guan, C, & ... (2016). Digital literacy and knowledge societies: A grounded theory investigation of sustainable development. *Telecommunications …*, Elsevier
34. Phuapan, P, Viriyavejakul, C, & ... (2016). An analysis of digital literacy skills among Thai university seniors. *International Journal of …*, online-journals.org
35. Reynolds, R (2016). Defining, designing for, and measuring “social constructivist digital literacy” development in learners: a proposed framework. *Educational Technology Research and Development*, Springer
36. Mohammadyari, S, & Singh, H (2015). Understanding the effect of e-learning on individual performance: The role of digital literacy. *Computers & Education*, Elsevier
37. Blikstad-Balas, M (2015). Digital literacy in upper secondary school–what do students use their laptops for during teacher instruction?. *Nordic Journal of Digital Literacy*, idunn.no
38. Ting, YL (2015). Tapping into students' digital literacy and designing negotiated learning to promote learner autonomy. *The Internet and Higher Education*, Elsevier
39. Radovanović, D, Hogan, B, & Lalić, D (2015). Overcoming digital divides in higher education: Digital literacy beyond Facebook. *New media & society*, journals.sagepub.com
40. Price-Dennis, D, Holmes, KA, & Smith, E (2015). Exploring digital literacy practices in an inclusive classroom. *The Reading Teacher*, Wiley Online Library
41. Bekker, T, Bakker, S, Douma, I, Poel, J Van Der, & ... (2015). Teaching children digital literacy through design-based learning with digital toolkits in schools. *International Journal of …*, Elsevier
42. Bhatt, I, Roock, R de, & Adams, J (2015). Diving deep into digital literacy: emerging methods for research. *Language and Education*, Taylor & Francis
43. Csernoch, M, & Biró, P (2015). The power in digital literacy and algorithmic skill. *Procedia-Social and Behavioral Sciences*, Elsevier
44. Mesko, B, Győrffy, Z, & Kollár, J (2015). Digital literacy in the medical curriculum: a course with social media tools and gamification. *JMIR medical education*, ncbi.nlm.nih.gov
45. Galante, A (2015). Developing EAL learners' intercultural sensitivity through a digital literacy project. *TESL Canada Journal*, teslcanadajournal.ca
46. Galán, JG (2015). Media Education as Theoretical and Practical Paradigm for Digital Literacy: An Interdisciplinary Analysis. *European Journal of Science and Theology*, ejst.tuiasi.ro
47. Ozdamar-Keskin, N, Ozata, FZ, Banar, K, & Royle, K (2015). Examining digital literacy competences and learning habits of open and distance learners.. *Contemporary Educational …*, ERIC

48. Cihak, DF, Wright, R, Smith, CC, McMahon, D, & ... (2015). Incorporating functional digital literacy skills as part of the curriculum for high school students with intellectual disability. *Education and Training in …*, JSTOR
49. Mihailidis, P (2015). Digital curation and digital literacy: evaluating the role of curation in developing critical literacies for participation in digital culture. *E-learning and Digital Media*, journals.sagepub.com
50. Burton, LJ, Summers, J, Lawrence, J, Noble, K, & ... (2015). Digital literacy in higher education: the rhetoric and the reality. *Myths in education …*, Springer
51. Hall, R, Atkins, L, & Fraser, J (2014). Defining a self-evaluation digital literacy framework for secondary educators: the DigiLit Leicester project. *Research in Learning Technology*, Taylor & Francis
52. Rosado, E, & Bélisle, C (2006). Analysing digital literacy frameworks. *… framework for digital literacy …*, halshs.archives-ouvertes.fr
53. Spengler, SS (2015). Educators' Perceptions of a 21st Century Digital Literacy Framework., search.proquest.com
54. Kim, JM, & Porter, A (2002). A history-based test prioritization technique for regression testing in resource constrained environments. *… , 2002. ICSE 2002. Proceedings of the 24rd …*, ieeexplore.ieee.org
55. Mikic-Rakic, M, & Medvidovic, N (2002). Architecture-level support for software component deployment in resource constrained environments. *International Working Conference on …*, Springer
56. Satoglu, SI, & Suresh, NC (2009). A goal-programming approach for design of hybrid cellular manufacturing systems in dual resource constrained environments. *Computers & industrial engineering*, Elsevier
57. Gilbert, M, & Namagembe, F (2013). Understanding user adoption of mobile health technology in a resource constrained environment. *Information Science, Computing and …*, ieeexplore.ieee.org
58. Weimann, E, & Patel, B (2017). … by the Paris Agreement (COP 21): Green leadership empowers public hospitals to overcome obstacles and challenges in a resource-constrained environment. *SAMJ: South African Medical Journal*, scielo.org.za
59. Osterman, M. D. (2013). Digital literacy: Definition, theoretical framework, and competencies.
60. Rivoltella, P. C. (Ed.). (2008). *Digital Literacy: Tools and Methodologies for Information Society: Tools and Methodologies for Information Society*. IGI Global.

Finally the collating, summarising, and reporting results stage was undertaken using these articles. Articles from this table were used based on significance and relevance towards the research process, as outlined in Sections 2.3 to 2.5. The significance of digital literacy is presented in Section 2.3, particularly in light of the challenges that it can alleviate. The motivation for a definition of digital literacy, as well as the adoption of a working definition for the research, will be done in Section 2.4. Section 2.5 will present the frameworks of digital literacy, and motivate for an adoption of a framework for the research.

2-3. The significance of digital literacy

ICT plays a critical role in the digital age, in light of its impact of ICT in modern economies; it further plays an important role in the knowledge economy and knowledge society (Anderson, 2008; Chen & Dahlman, 2005). This is particularly characterised by the shift from print-based to screen-based societies, which necessitates the integration of digital literacy in pedagogy to prepare learners for the digital age – thus making digital literacy an

essential life skill (Bawden, 2008; Cihak, Wright, Smith, McMahon, & Kraiss, 2015). The purpose of digital literacy, as it relates to the research, is to facilitate ICT use. According to Ng (2012b), digital literacy has the potential to empower individuals to use ICT resources, leading to the empowerment of those individuals through mitigation of digital challenges. Some of the major digital challenges can inhibit individuals from using ICT in their day-to-day activities (Avgerou, Hayes, & La Rovere, 2016; Ndou, 2004).

To highlight the significance of digital literacy in ICT use, it is defined in the next section.

2-4. Defining digital literacy

Digital literacy is an old concept that has diversified over time with the evolution of technology (Mohammadyari & Singh, 2015). One of the earlier definitions of digital literacy were by Pool (1997), as informed by Gilster and Glister (1997). Pool (1997) defined digital literacy as the ability to understand (*digital*) information – more importantly – to evaluate and integrate information in the multiple formats that a computer can deliver. This served as one of the early attempts to associate digital literacy with an aspect of ICT, namely the computer. Later, Martin (2005) provided the following more comprehensive definition of digital literacy: "Digital Literacy is 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. 255).

Inoue, Naito, and Koshizuka (1997) outlined some of the precursors of digital literacy, such as computer literacy and information literacy. Computer literacy relates to users' knowledge of, and proficiency with, the computer environment (Ferrari, 2012; Simonson, Maurer, Montag-Torardi, & Whitaker, 1987), while information literacy relates to the cognisance of the need for information (digital) and the ability to locate, evaluate, and effectively use the needed information (digital) (American Library Association, 1989). Information literacy also simply relates to the techniques of searching for information on a computer repository (Robertson, 2005). In light of expanding digital environments, a computer is here assigned a wider context than simply a personal computer (PC). These precursors of digital literacy shaped what is meant by digital literacy, as will be illustrated in Section 2.5.

Socially, digital embodies a set of digital related skills and knowledge for empowering individuals with a repertoire of enabling tools, cognitive and technical abilities that would allow them to adopt existing digital tools, adapt to the evolving digital landscape and facilitate their socio-economic participation (Ng, 2012a).

2-4-1. Digital literacy as a collection of literacies

Some practitioners do not consider digital literacy as a singular literacy for a particular aspect of the digital age, but rather as a collection of literacies that assist individuals in coping with the digital age. Some of these identified literacies are photo-visual literacy, lateral literacy, reproduction literacy and information literacy (Eshet, 2002). The diverse nature of digital literacy is also captured by Ng (2012a), pointing out that digital literacy refers to the multiplicity of literacies associated with the use of digital technologies. Belshaw (2012) also did not attempt to define digital literacy singularly, but identified ambiguities and potential re-definitions associated with such; he instead opted to use digital literacies in the plural in an effort to highlight the constituent of literacies necessary in the digital age. This approach that the plural view of digital literacies provides a number of benefits – namely, the diversity of digital literacy, the strength and usefulness of the socio-cultural perspective of literacy as a practise, and the benefits of adopting an expansive view of digital literacy – is further supported by Lankshear and Knobel (2008).

2-4-2. Approaches of defining digital literacy

Several approaches are used in literature in an attempt to define digital literacy. Theorists see digital literacy as a combination of terms, that is, literacy and digital (Jones-Kavalier & Flannigan, 2008). In that context, literacy is seen as applying to the education of individuals, communities, and society. Beyond the ability to read or write (Kodagoda, Wong, Rooney, & Khan, 2012; Perry, 2012; Posel, 2011), literacy is normally considered a very complex concept. Some illustrations are highlighted from literature to provide perspective. According to Martin (2006), the possession of tools that enable an individual to cope in society is captured in the concept of literacy. According to Street (1984), literacy refers to the social conceptions and practises of reading and writing. The social aspect of literacy is also captured by Perry (2012), pointing out that literacy has socio-cultural perspectives, namely, social practice, multiliteracies, and critical literacy. The general significance of literacy is clearly resonated by Bélisle (2006), who acknowledges the pedagogical, cultural, and knowledge-driven aspects of literacy. Bélisle (2006) provides an overarching view of literacy, which is

significantly grounded in theory by researchers such as Street (1984). According to Bélisle (2006), literacy has three complementary approaches, namely, an autonomous model, a socio-cultural model, and a strong claim model. Table 2-3 provides an elaboration of these concepts:

Table 2-3: Literacy perspectives (Bélisle (2006))

Literacy perspective		
Autonomous model	***Socio-cultural model***	***Strong claim model***
The skills of reading and writing associated with literacy are simply technical skills	All literacies are socially and ideologically embedded	Literacy is based on the anthropological statements of the revolutionary power of instrumented thinking processes

The significance of literacy for individuals and in society is also acknowledged. Thorne (2013) acknowledges the significance of literacy in *society* by pointing out that it is a social practise and not merely an *individual* or cognitive one. Ferrari (2012) sees literacy as implying that basic skills and knowledge of an *individual* are associated with books and printed matter. Literacy is noted to evolve with time, despite having core principles. Thorne (2013) notes the evolutionary form of literacy, pointing out that literacy is understood as a set of cognitive and technical skills used to read and write graphically rendered languages across time periods, communities, cultures, and contexts. However, Jones-Kavalier and Flannigan (2008) bring literacy closer to ICT by relating it more to digital environments, and by noting that literacy relates to acquiring and using knowledge that is applicable to successful functioning in digital environments.

The digital aspect of digital literacy is also noted to be significant. Belshaw (2012) notes that the digital aspect can relate to anything digital; potentially calculators, but more so computers connected to the Internet, as well as watches – especially in the advent of the so-called smart watches under the umbrella of interactive computing technology (Chen, Grossman, Wigdor, & Fitzmaurice, 2014). In light of the evolution of computing technology, Belshaw (2012) analogy may extend to mobile and wearable devices. Jones-Kavalier and Flannigan (2008) still associated the digital aspect with information in textual form, that is primarily in use by a computer.

Belshaw (2012) extends digital literacy beyond simple literacy by further noting that digital literacies must include more than simply dealing with text in a digital environment. Alkali and Amichai-Hamburger (2004) provide a more grounded view of digital literacy by noting that digital literacy requires more than just the ability to use software or to operate a digital device; it includes a large variety of complex skills such as cognitive, motor, sociological, and emotional skills that individuals need to have in order to use digital environments effectively. This view on literacies necessary to cope with digital environments is extended by Ng (2012), and will be elaborated on in the next section when discussing frameworks of digital literacy. The latter came about with the maturity of the concept. Some practitioners extend the significance and impact of digital literacy beyond the needs of an individual, to society at large. Erstad (2008) and Pangrazio (2016) see digital literacy as playing a significant role in shaping the aspirations of citizens in education, employment, and society at large, and as being a tool that provides citizens with the necessary competence that enables them to take advantage of the possibilities offered by the digital age.

Lankshear and Knobel (2008) formalized the *definition* of digital literacy by categorizing it into conceptual and standardized definitions. According to Lankshear and Knobel (2008), conceptual definitions present in digital literacy are expressed as an idea or ideal, while standardized definitions outline the requirements of digital literacy based on tasks, performances, skills, and so on; these are advanced as standards for general adoption. An illustration of the skills underlying digital literacy is noted by Eshet-Alkalai (2004), according to whom digital literacy can be defined as a survival skill in the digital era that constitutes a system of skills and strategies used by individuals in digital environments. Bélisle (2006) captures the individual and societal significance of digital literacy, pointing out that it is necessary for mastering digital knowledge and new meta-cognitive processes, and also necessary for socio-cultural practises, especially in relation to the emerging digital environments facilitating ICT. (Ferrari, 2012) and Ilomäki, Kantosalo, and Lakkala (2011) see digital literacy and digital competence as similar concepts to some extent – but with digital competence seen as an embodiment of essential knowledge, skills, and attitudes for successfully using ICT, while digital literacy is emanating from means and tools derived from the technological surge and convergence of Internet literacy, ICT literacy, media literacy, information literacy, and many other digital age-related literacies. The significance of digital

literacy to digital competence and digital citizenship is acknowledged, but will not be discussed in this research due to the limited contribution that they may provide.

2-4-3. Digital literacy definitions – conclusion

In conclusion, these definitions provide some evidence of the non-trivial nature of digital literacy for individuals, communities, and society at large. *Despite the apparent differences in these definitions, it is evident that digital literacy requires competency in a skill set that enables the user to easily use and adopt evolving ICT services, irrespective of the platform upon which the services are offered. These skills also need to evolve as digital environments evolve in order to be effective* (Lankshear & Knobel, 2008). Further, there is a need for individuals to be able to use their cognitive abilities when dealing with ICT use by being aware, reflective, and vigilant within digital environments when accessing ICT services, whether for consumption or production purposes (Ng, 2012a). This awareness and these skills can be acquired through digital literacy (Bawden, 2001, 2008; Reynolds, 2016). The current research advocated digital literacy attainment through technology adoption; the latter is one of the core concepts of this research, and is addressed in-depth in the next chapter. The next section addresses frameworks of digital literacy.

2-5. Frameworks of digital literacy

As digital literacy matured, the understanding thereof moved beyond simply defining and describing it. There is general consensus in literature on the lack of depth associated with digital literacy and other associated literacies of the digital age – hence the numerous definitions associated with these concepts. The definitions themselves appear to reflect parallel concepts; this forces theoretical frameworks to be explored for providing digital literacy a theoretical grounding (Ilomäki et al., 2011). As a result, theoretical frameworks attempt to give digital literacy a more holistic understanding, as is evident in some practitioner views. The framework nature of digital literacy was noted by Bawden (2008), who considered digital literacy as a framework for integrating various literacies and skill sets, though not necessarily encompassing them all.

One of the earlier theoretical frameworks of digital literacy originated with Eshet (2002), who outlined a terminology framework for digital literacy in which he incorporated *four types of literacy*: photo-visual literacy, lateral literacy, reproduction literacy, and information literacy. The framework extended the impact of digital literacy from individuals, communities, and society to the education system, and further outlined approaches to digital literacy based on

their maturity, namely the technological mode and the pedagogical mode (Eshet, 2002). The former is more concerned with visual dimensions of digital literacy, and the latter with cognitive dimensions.

The terminology framework (Eshet, 2002) later evolved to the new conceptual framework for digital literacy. This framework adopted three earlier identified types of literacy: photo-visual literacy, reproduction literacy and information literacy, but excluded lateral literacy, and however, included newly introduced types – branching literacy, and socio-emotional literacy (Eshet-Alkalai, 2004). It was anticipated that the new conceptual framework would enhance the understanding of users' performance in relation to tasks that require the use of different digital skills, since they were considered to encompass most of the cognitive skills necessary for effectiveness in digital environments (Eshet-Alkalai, 2004). Aviram and Eshet-Alkalai (2006) also provided a theoretical framework of digital literacy, which he considered to be of utmost importance in effective functioning, learning, and teaching in digital environments, thus providing and extending the theoretical basis of digital literacy which had resulted in a multitude of seemingly unrelated definitions.

2-5-1. Domain specific digital literacy frameworks

With the proliferation of digital literacy frameworks, some practitioners sought to find encompassing frameworks that would be domain specific. One such effort was by Almerich, Orellana, Suárez-Rodríguez, and Díaz-García (2016) to establish a framework on the required ICT competency across the different education levels for teachers, particularly with the domains of pedagogical background and technology acknowledgement. The emphasis was on understanding the competency levels of teachers in these two domains. Other domains that could be considered included fun, interest, and others. Almerich et al. (2016) noted the significance of improving teachers' ICT competency, thus boosting their confidence and enabling these teachers to be agents of change in ICT teaching and learning (Meyer, Marais, Ford, & Dlamini, 2017). In education, a well-known challenge is that access does not always equate to use.

Closer to home, in South Africa, the information and communication technology for rural education development (ICT4RED) conceptual framework was one initiative that reflected success stories in which ICT access was provided to teachers in rural contexts, for the benefit of their learners (Botha & Herselman, 2015; Ford, Botha, & Herselman, 2014; Meyer et al., 2017). The ICT4RED initiative is a subset of the technology for rural education development

(TECH4RED) research programme, which aimed to contribute to the improvement of rural education through technology-led innovation (Ford et al., 2014; Herselman & Botha, 2014). The ICT4RED conceptual framework focused on twelve components, which represented focal points of ICT rollout and teacher inclusion towards learners in rural contexts. This construct reflects another domain-specific framework that supports digital literacy through empowering teachers in rural environments. However, the initiative does not provide evidence of a focus on digital literacy and digital competence, despite providing support for the empowerment of teachers by using ICT as part of the primary drivers of the ICT4RED conceptual framework. According to Ford et al. (2014) and Were, Rubagiza, and Sutherland (2011), teachers are not necessarily empowered sufficiently to apply their knowledge of pedagogy and ICT in their domain. The emphasis is more on acquiring the necessary skills to meet objectives as set out in their *learning objectives*, which is insufficient for extending their knowledge to their learners, similar to the 'learn to pass approach', due to cognitive overload when learners are faced with complex material (Van Merrienboer & Sweller, 2005). This approach clearly does not encompass all the dimensions of digital literacy as set out by Ng (2012a). However, the ICT infrastructure rollout accompanying the ICT4RED initiative was a positive step towards digital literacy and digital competency.

Belshaw (2012) also noted that the domain of organisations and institutions has core elements of a contextualized and negotiated definition of digital literacy, and provided the following listing of these elements: cultural, cognitive, constructive, communicative, confident, creative, critical, and civic. These elements further highlighted the significance of digital literacy as dealing with more than simply text in digital environments.

2-5-2. The digital literacy framework

The significance of education as a context of inquiry was noted earlier by Ng (2012a) in the context of urban areas and metropolitans, in the sense that the 'new literacies' (which also included digital literacy) emphasise social practises that are shaped by emerging technologies within educational contexts. In noting that digital literacy is a broader term that embraces technical, cognitive, and socio-emotional perspectives of learning with digital technologies, Ng (2012a) also developed his own framework of digital literacy. This framework emphasizes that digital literacy results from three intersecting dimensions, namely, the technical, cognitive, and socio-emotional dimensions of digital literacy. This view of digital literacy is closely aligned with the view of Aviram and Eshet-Alkalai (2006), who note that

digital literacy is conceived as a combination of technical-procedural, cognitive, and emotional-social skills. This digital literacy framework will be adopted in the current study as it clearly outlines areas of focus when dealing with digital literacy. The dimensions of digital literacy (technical, cognitive, and socio-emotional) by Ng (2012a) are highlighted in Figure 2-3:

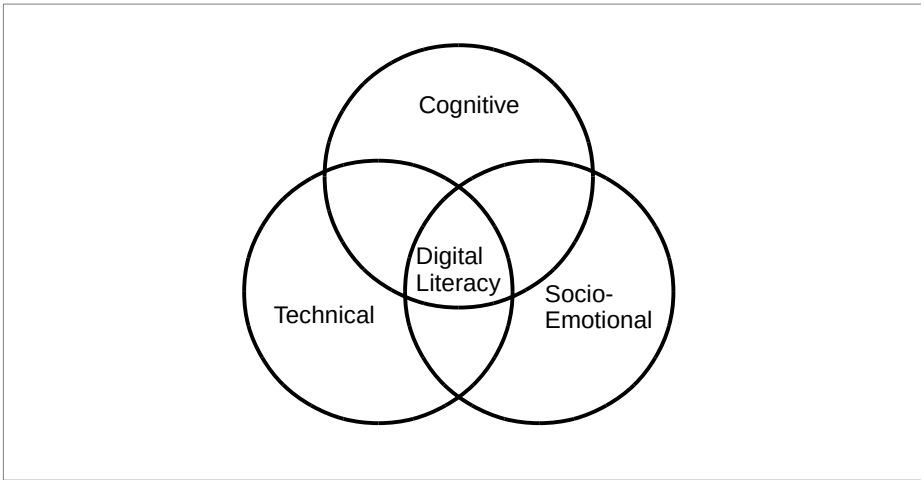

Figure 2-3: The digital literacy conceptual framework (Ng (2012a))

These dimensions contain attributes that comprise their building blocks; these are expanded in Table 2-4:

Table 2-4: Digital literacy dimensions, building blocks and their roles ((Ng, 2012a))

Digital literacy dimension	**Building blocks**	**Role**
Technical	• Operational literacy • Critical literacy	• The technical and operational skills necessary for use in day-to-day activities
Cognitive	• Information literacy • Critical literacy • Multilitiracies	• The cognitive skills necessary for handling digital information
Socio-emotional	• Socio-emotional literacy • Critical literacy	• The ability to responsibly utilise communication skills in a digital social environment

According to Ng (2012a), critical literacy is central to all three dimensions of digital literacy – that is, the ability to critically evaluate information and learn as neutral as possible in light of the potential bias associated with the authors of that information, particularly in relation to the Internet. The intersection of the technical and cognitive dimensions form the *reproduction* and *branching* literacy; the intersection of the cognitive and socio-emotional dimensions form the *socio-emotional* and the *critical* dimensions; and the intersection of the socio-emotional and technical dimensions form the *social networking functional* literacy. These intersections further intersect to form digital literacy. Figure 2-4 illustrates and outlines the digital literacy framework, with emphasis on the different dimensions:

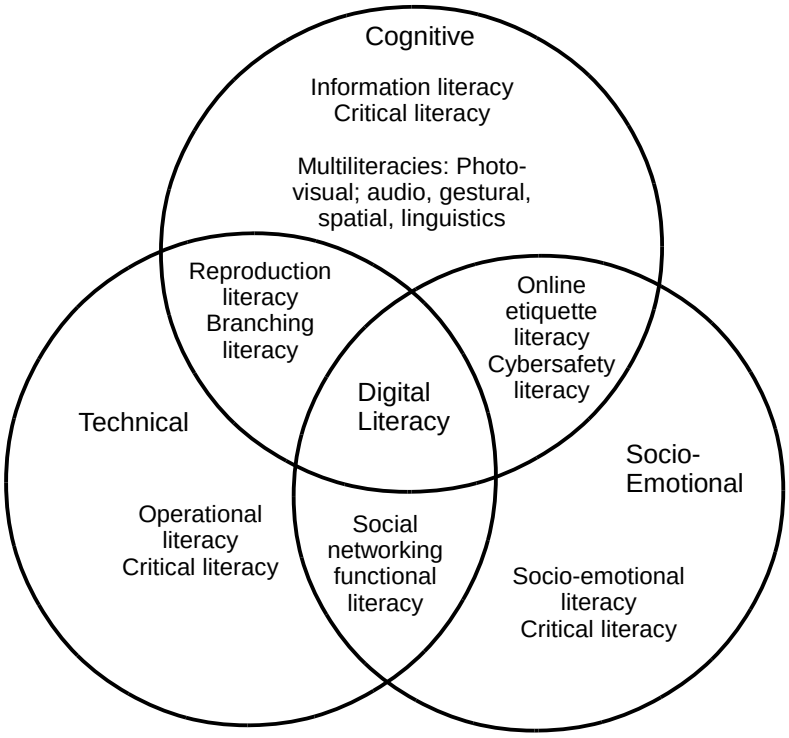

Figure 2-4: The digital literacy framework (Ng (2012a) and Ng (2012b))

Ng (2012a) pointed out that digital literacy equips individuals with tools and cognitive capabilities to help them live in a technologically oriented society; the latter would inevitably require them to be able to adopt new technologies or adapt to changes in existing technologies. Thus, digital literacy can play a pivotal role in facilitating the use of ICT by individuals, thus enabling these individuals to participate in the digital age and knowledge society. The current research then adopted the digital literacy framework by Ng (2012a) and Ng (2012b) to understand and explain digital literacy.

2-6. Summary

This chapter addressed the first of the three key concepts identified from the research questions posed in this study – digital literacy. The research adopted the digital literacy framework by Ng (2012a) and Ng (2012b) to understand and explain digital literacy. In adopting the digital literacy framework, the research addressed the first sub-research question:

SRQ 1 – What are the elements of digital literacy that are relevant to technology use?

This allowed the inception of a conceptual model for digital literacy attainment and enhancement through technology adoption. The first version of the model is outlined in Figure 2-4 above.

The model contains the dimensions of digital literacy, namely, technical, cognitive, and socio-emotional dimensions. Digital literacy has the potential to empower individuals to cope with the challenges of the digital age. Such individuals can possess the knowledge and cognitive ability, including the reflection necessary to participate effectively and successfully in the digital age as brought about by the proliferation of ICT.

Chapter 3 *Technology adoption*

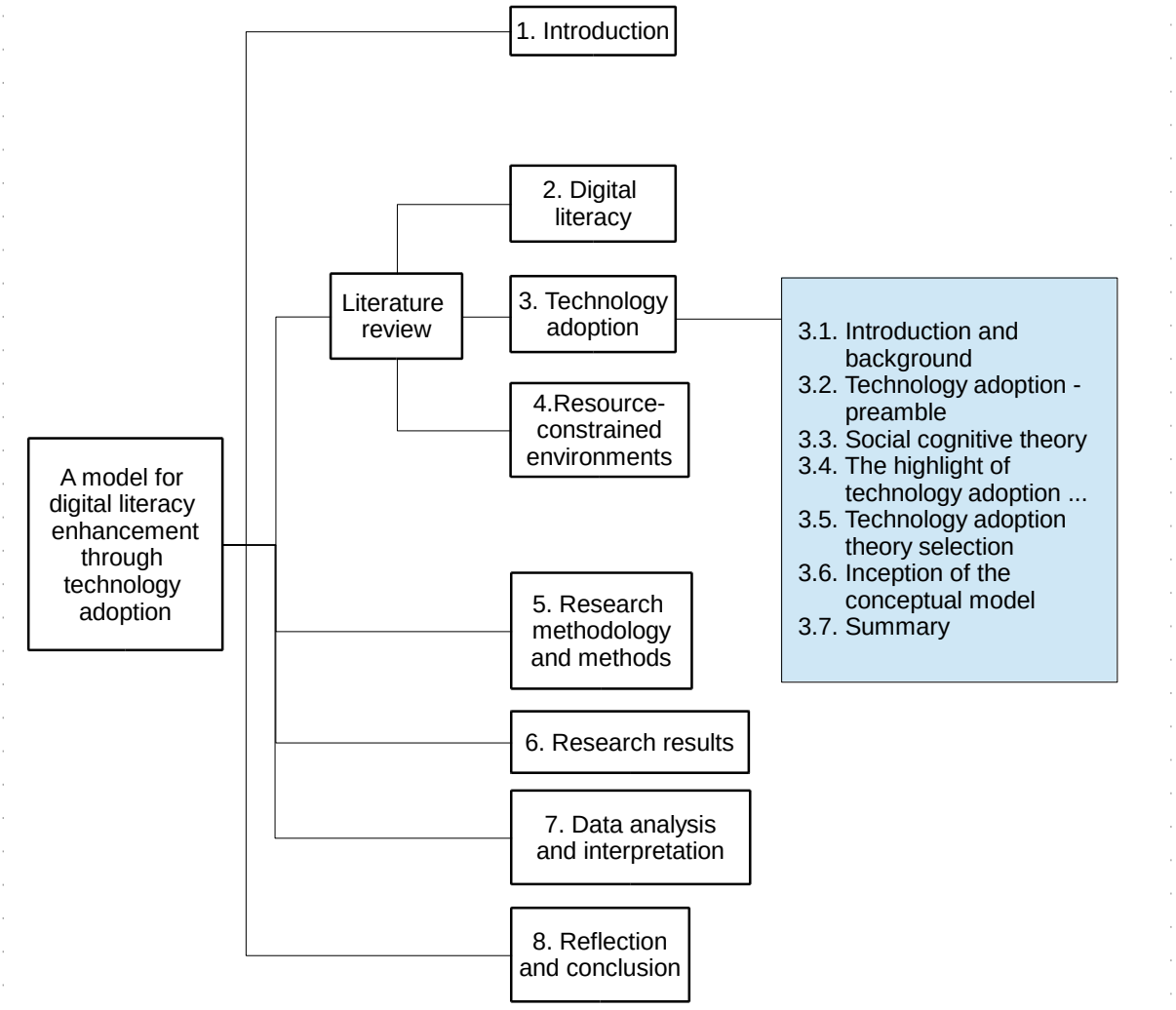

Figure 3-1: Research outline overview with emphasis on technology adoption

The aim of this chapter is to address sub-research question 2, which will be reiterated below (see Section 3.1). This sub-research question sought to explore technology adoption models and frameworks so as to adopt one that would best facilitate the attainment and enhancement of digital literacy through technology adoption. Based on the diversity of technology adoption theories and their strengths and weaknesses, a theoretical lens was used to identify an appropriate technology adoption theory. The model was then extended using attributes of both the adopted technology adoption theory and digital literacy.

3-1. Introduction and background

In Chapter 1, technology adoption was identified as one of the key concepts underpinning the current research; it plays an essential role in ICT use (Agarwal & Prasad, 1998a, 1998b; Tarhini, Arachchilage, & Abbasi, 2015). This chapter presents the theoretical grounding for technology adoption due to its significance in facilitating digital literacy attainment and enhancement towards the use of ICT. The chapter also serves as the second chapter of the literature review grounding the research. The current chapter will undertake a literature review on technology adoption towards the support that technology adoption may provide to digital literacy.

The question that informs this literature review is the second sub-research question from Chapter 1, which is reiterated below:

> ***SRQ 2*** – What are the elements of technology adoption that influence the attainment of digital literacy?

Similar to the previous chapter, the current chapter adopted the systematic scoping review that facilitates the concept-driven graduate literature review underlying the research (Okoli & Schabram, 2010; Oya, 2013; Petticrew & Roberts, 2006). The current chapter also adopted the Arksey and O'Malley framework for undertaking the systematic scoping review (Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2015; Pham et al., 2014), with the last optional consultation stage being deemed irrelevant and not undertaken. Of the three concepts identified in the first phase (Phase 1), the literature review in this chapter focused on technology adoption. The application of the framework also followed Levac et al. (2010), with the definitions of each stage not re-iterated; only the stages and their relevance to technology adoption are outlined. Table 3-1 illustrates:

Table 3-1: Overview of the Arksey and O'Malley methodological framework for conducting a systematic scoping study as applicable to technology adoption (adapted from Levac et al. (2010))

Framework stage	Relevance to technology adoption review
Identifying the research question	The following research question was identified for this scoping review: *How can elements of technology adoption enhance digital literacy?*
Identifying relevant studies	• The review focused on studies from 1985 to date. • Similar to the previous review, the search process was mainly undertaken on Google scholar through Harzing's publish or perish tool (Harzing, 2010).

	Google scholar indexes the following academic journals: Taylor & Francis Online, JSTOR, ACM Digital Library, Wiley Online Library, and ScienceDirect, among other journals, although theoretically Google scholar indexes them all (Falagas et al., 2008). No databases or other sources were searched manually. • The search terms used were generated from the review research question. The following final search terms were used: technology adoption, technology acceptance, technology adoption and digital literacy.
Study selection	The following inclusion and exclusion criteria were used[1]: • The study selection comprised of a total of 1980 articles that were generated through the search process. • Only publications written in English were included. • Only studies including the search terms were included. • Duplicates were excluded. • The challenge of irrelevant studies (vom Brocke et al., 2015) was mitigated through the use of Harzing's publish or perish tool (Harzing, 2010).
Charting the data	The flow diagram illustrated in Figure 3-2 was used. This is based on guidelines for undertaking scoping reviews (Peters et al., 2015).
Collating, summarizing, and reporting results	This is outlined in Sections 3.2, 3.4, and 3.5.
Consultation (optional)	This is not relevant and was not undertaken in this research.

[1] ***The terms used were as follows: technology adoption, technology acceptance, and digital literacy***

The research question of the review was derived from the second sub-research question. The identification of the relevant studies undertaken through the search process was facilitated by Google Scholar® and Harzing's publish or perish tool. The search terms used were technology adoption; technology acceptance; and technology adoption and digital literacy. The aim was to capture the essential elements of technology adoption, and to establish the relationship between technology adoption and digital literacy.

The stage on charting the data was undertaken using a flow diagram, as illustrated in Figure 3-2:

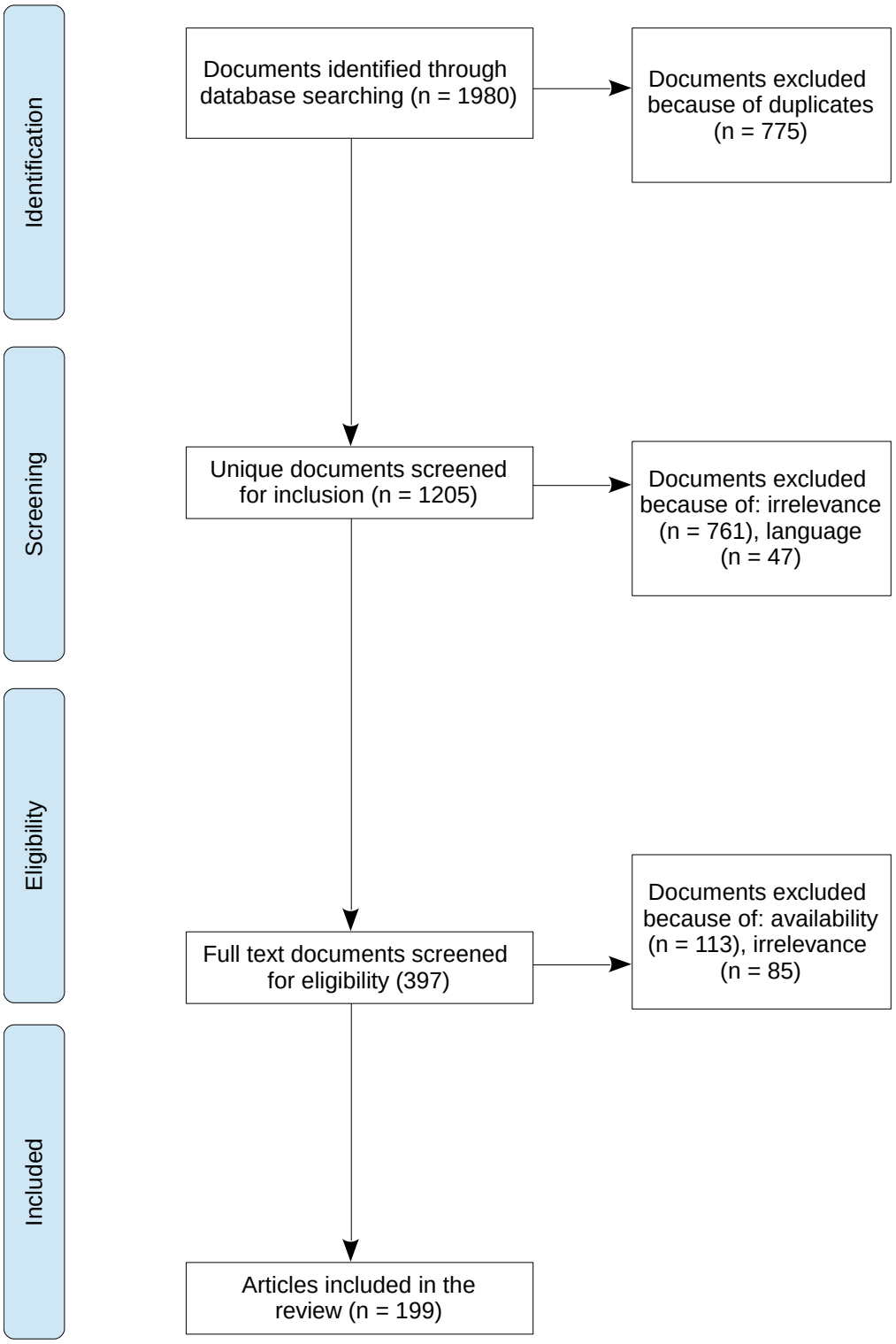

Figure 3-2: The application of the flow diagram for the data charting stage of the Arksey and O'Malley methodological framework (adapted from Pham et al. (2014))

The literature search returned 1980 articles over the search terms technology adoption, technology acceptance, and technology adoption and digital literacy. The researcher noticed that articles that combined technology adoption and digital literacy were noticeably limited.

A total of 1781 articles were excluded through the exclusion process, with 199 articles remaining. These articles are listed in Table 3-1:

Table 3-1 Partial article listing based on the search terms (technology adoption and technology acceptance)

Article listing: Technology adoption, technology acceptance, technology adoption and digital literacy	
1. Davis, FD, Bagozzi, RP, & Warshaw, PR (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, pubsonline.informs.org 2. Venkatesh, V, Morris, MG, Davis, GB, & Davis, FD (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, JSTOR 3. Venkatesh, V, & Davis, FD (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, pubsonline.informs.org 4. Taylor, S, & Todd, PA (1995). Understanding information technology usage: A test of competing models. *Information systems research*, pubsonline.informs.org 5. Davis, FD (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results., dspace.mit.edu 6. Venkatesh, V (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information systems research*, pubsonline.informs.org 7. Mathieson, K (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information systems research*, pubsonline.informs.org 8. Pavlou, PA (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International journal of electronic commerce*, Taylor & Francis 9. Venkatesh, V, & Morris, MG (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS quarterly*, JSTOR 10. Davis, FD (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International journal of man-machine studies*, Elsevier 11. Agarwal, R, & Karahanna, E (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS quarterly*, JSTOR 12. Legris, P, Ingham, J, & Collerette, P (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, Elsevier 13. Venkatesh, V, & Bala, H (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, Wiley Online Library 14. Venkatesh, V, Thong, JYL, & Xu, X (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, JSTOR 15. Heijden, H Van der (2004). User acceptance of hedonic information systems. *MIS quarterly*, JSTOR 16. Agarwal, R, & Prasad, J (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information systems research*, pubsonline.informs.org 17. Wixom, BH, & Todd, PA (2005). A theoretical integration of user satisfaction and technology acceptance. *Information systems research*, pubsonline.informs.org 18. Agarwal, R, & Prasad, J (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision sciences*, Wiley Online Library 19. Lee, Y, Kozar, KA, & Larsen, KRT (2003). The technology acceptance model: Past, present, and future. *Communications of the Association …*, aisel.aisnet.org 20. Dishaw, MT, & Strong, DM (1999). Extending the technology acceptance model with task–technology fit constructs. *Information & management*, Elsevier 21. King, WR, & He, J (2006). A meta-analysis of the technology acceptance model. *Information & management*, Elsevier 22. Gillenson, ML, & Sherrell, DL (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & management*, Elsevier 23. Chau, PYK, & Hu, PJH (2001). Information technology acceptance by individual professionals: A model comparison approach. *Decision sciences*, Wiley Online Library 24. Bagozzi, RP (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift.. *Journal of the association for information systems*, aisel.aisnet.org 25. Mathieson, K, Peacock, E, & Chin, WW (2001). Extending the technology acceptance model: the influence of perceived user resources. *ACM SIGMIS Database: the …*, dl.acm.org 26. Karahanna, E, & Straub, DW (1999). The psychological origins of perceived usefulness and ease-of-use. *Information & management*, Elsevier 27. Schepers, J, & Wetzels, M (2007). A meta-analysis of the technology acceptance model: Investigating subjective norm and moderation effects. *Information & management*, Elsevier 28. Davis, FD, & Venkatesh, V (1996). 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47. Hackbarth, G, Grover, V, & Mun, YY (2003). Computer playfulness and anxiety: positive and negative mediators of the system experience effect on perceived ease of use. *Information & management*, Elsevier
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Table 3-1 shows a partial listing of the articles, by way of illustration. Relevance, significance and overall contribution to the research process played a significant role in the inclusion of articles from the list into the literature review process, as is evident in Sections 3.2, 3.4, and 3.5. Section 3.2 presents the preamble of technology adoption due to the need for preliminary information. This is followed by the adoption of a theoretical lens in Section 3.3. Section 3.4 presents an overview of technology adoption theories, and Section 3.5 identifies a technology adoption theory for the research and motivates for its adoption. Section 3.6 establishes the relationship between the adopted technology adoption theory and digital literacy. Finally, the summary of the chapter is presented in Section 3.7.

3-2. Technology adoption – preamble

The research needed to adopt a technology adoption theory for ICT by individuals; the focus for the adoption theory was therefore on individuals. The non-trivial nature of selecting a technology acceptance model for a context is highlighted by Momani et al. (2018), who point out that, despite the in-depth investigation of technology adoption and acceptance, more investigation is required to ascertain the selection of a suitable adoption theory for a specific context and domain. In light of the challenges associated with adopting a technology adoption model, a definition of technology adoption will be presented in Subsection 3.2.1. This will be followed by the different categories of technology adoption in Subsection 3.2.2, and then by the acceptance criteria for technology adoption in Subsection 3.2.3. Finally, a motivation for a theoretical lens for the technology adoption process will be presented in Subsection 3.2.4.

3-2-1. What is technology adoption?

According to Straub (2009), technology adoption is a special case of general adoption theory; the latter examines the individual and the choices that an individual makes to accept or reject a particular innovation. An innovation was defined by Rogers (1983) as an idea, practise, or object that was perceived as new by an individual or other unit of adoption. Closely related to the adoption theory is diffusion theory, which describes how an innovation spreads through a population by communication (Rogers, 1983; Straub, 2009). The major difference between the technology adoption and diffusion theories is that technology adoption takes a micro perspective on change, focusing not on the whole but the constituents of the whole, while diffusion theory focuses on the macro perspective of the spread of innovation over time.

According to Straub (2009), the following three conclusions can be drawn with regards to technology adoption and diffusion theories:

i) Technology adoption is a complex, inherently social, development process;
ii) Individuals construct unique perceptions of technology that influence the adoption process; and
iii) Successful facilitation of technology adoption needs to address cognitive, emotional, and contextual concerns.

The definition of technology adoption by Straub (2009) will be adopted in the current research. Some categories of technology adoption are noted in literature. These categories are presented in the next subsection.

3-2-2. Categories of technology adoption

According to Oliveira and Martins (2011), technology adoption can be *categorised* at an *individual level* or at an *organisation* (or firm) *level*. Another similar categorisation was noted from Straub (2009), identifying adoption at either the environment or the innovation level. Bhattacherjee (2001) and Liao et al. (2009) highlighted several technology adoption theories at the individual level. An extensive analysis of the different categories of technology adoption is provided by Luzipo (2014), who identifies categories of technology adoption at the individual, organisational, and societal levels, and in light of identified challenges. Table 3-2 illustrates:

Table 3-2: Technology adoption categories

Author	**Proposed technology adoption categories**
Oliveira and Martins (2011)	• Individual level • Organisation / firm level
Straub (2009)	• Environment level • Innovation level
Bhattacherjee (2001) and Liao et al. (2009)	• Individual level
Luzipo (2014)	• Individual level • Organisation level

	• Societal level • Combination of levels above (based on identified challenges)

Focusing solely on a single adoption category was sometimes discouraged, and an approach advocating a combination of these categories was sometimes encouraged (Hameed, Counsell, & Swift, 2012; Luzipo, 2014).The current study was interested in investigating adoption tendencies of individuals; as a result, preference was given to technology adoption theories at the individual level as opposed to those at the organisation level, or vice versa. The *individual level approach* was *adopted* in the current study.

The potential advantage associated with combining adoption categories was noted (Hameed et al., 2012; Luzipo, 2014). However, the research avoided using combined categories, due to the following challenges:

- The potential dilution and polarization of the research due to the perceived effort of undertaking in-depth investigations;
- Finding a perfect combination of categories that would suit the study; and
- The necessary treatment of the resulting combined adopted category.

An illustration of these challenges can be found in Hameed et al. (2012), where the different constituent adoption theories for the combined adoption category did not receive the same attention and lacked depth.

3-2-3. Acceptance criteria for a technology adoption

A key question that the research needs to answer is how successful technology adoption was measured? According to Gopalakrishnan and Damanpour (1997), technology adoption in organisations can be considered successful only if the associated innovation (technology) is accepted and integrated into an environment (e.g., an organisation), with individuals adopting continuance behaviour towards that innovation (technology). According to the literature, for example, Bhattacherjee (2001) and Liao et al. (2009), there are differences in the behaviour for acceptance of technologies over the continuance behaviour. The current study is interested not only in the acceptance and use of ICT by individuals, but also in effective use. The acceptance of ICT use is in line with Dillon (2001), who noted that acceptance demonstrates the willingness within a user group to employ IT (or ICT) for the tasks that it is designed to support (Dillon, 2001). This acceptance by individuals, among other things,

highlights that sustainability and continued use may play a significant role. However, the study motivated for technology continuance as a special case of technology acceptance, as informed by Mohammadyari and Singh (2015). This motivation was further informed by Bhattacherjee (2001) that, despite the significance of technology continuance, technology acceptance and use through initial adoption is far more costly. Hence, the study concludes that technology adoption is the significant attribute necessary for investigation.

3-2-4. Motivation for a theoretical lens

In light of the numerous adoption theories available in literature, a theoretical lens was used to drive the selection of an appropriate technology adoption theory to be used in the current study. The significance of using a theoretical lens for the selection process is based on the fact that a theoretical lens facilitates the management of complexity associated with multi-dimensional approaches to human-information interaction (Byström, Cavanagh, Heinström, Wildemuth, & Erdelez, 2013; Fidel, Mark Pejtersen, Cleal, & Bruce, 2004). This entails the complexity associated with the exploration of the different technology adoption models by the researcher, and the selection of an appropriate model or theory relevant for the current study. The study adopted social cognitive theory as a theoretical lens for investigating technology adoption.

3-3. Social cognitive theory

The significance of social cognitive theory as a theoretical lens for technology adoption theories was acknowledged by Straub (2009). Social cognitive theory sometimes refers to human behaviour as psychosocial functioning, in light of the cognitive impact on human social interactions (Wood & Bandura, 1989). Contrary to other views of human behaviour, which explain human behaviour as a one-sided determinism shaped by either environmental influences or internal disposition, social cognitive theory views human behaviour as reciprocal determinism between personal attributes and factors, cognitive attributes, and environmental factors interacting as determinants that influence each other bi-directionally, resulting in a triadic reciprocity (Bandura, 1989, 2001; Pajares, 2002; Wood & Bandura, 1989). Eysenck (2004) outlines triadic reciprocal causation as in Figure 3-3:

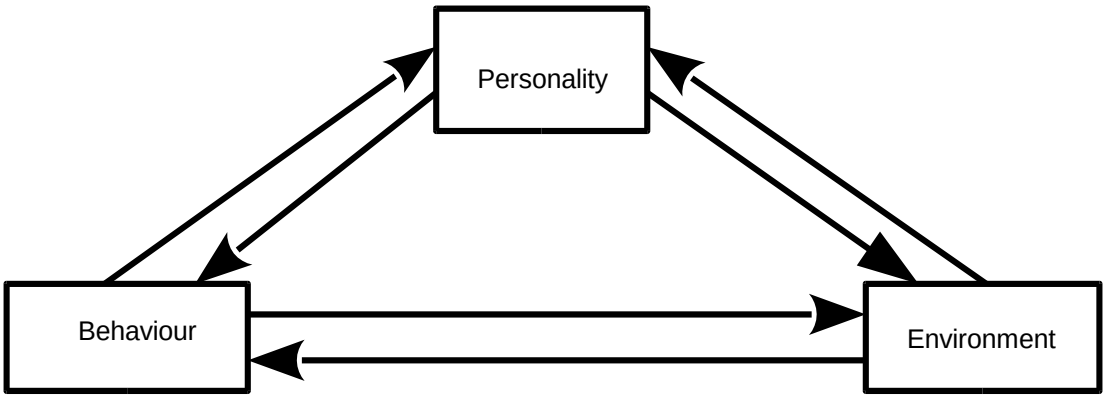


Figure 3-3: Triadic reciprocal model (Eysenck (2004))

Triadic reciprocal causation explains the bidirectional reciprocal influences based on personal factors, the environment, and behaviour, and how these attributes influence each other (Eysenck, 2004). According to Stajkovic and Luthans (2002), social cognitive theory explains the nature of the bidirectional reciprocal influences through five basic human capabilities, namely, (i) symbolizing, (ii) forethought, (iii) vicarious learning, (iv) self-regulation, and (v) self-reflection. These attributes are referred to in the text as basic human capabilities, according to social cognitive theory. Stajkovic and Luthans (2002) provide an extensive treatment of these attributes in an effort to highlight their impact on the motivation of adapting to change, that is, exploring the adoption of artefacts to improve one's performance using the context of the workplace. It is evident from the above discussion that social cognitive theory plays a key role in the interaction of an individual with the environment based on his behaviour. In the context of the current study, social cognitive theory may play an important role in explaining the interaction of technology artefacts by individuals in resource-constrained environments (RCEs) based on their personal attributes.

Social cognitive theory is based on social learning theory (Bandura, 2005; Stajkovic & Luthans, 2002), which analyzes behaviour in terms of reciprocal determinism (Bandura, 1978). In reciprocal determinism behaviour, internal personal factors and environmental influences all operate as interlocking determinants of each other (Bandura, 1978). Bandura (1978) elaborates on social learning particularly in relation to social cognitive theory. According to Bandura (1971), social learning places special emphasis on the significant roles played by secondary learning, and symbolic and self-regulatory processes, and this social learning theory is directly related to self-efficacy and behavioural change (Bandura, 1971, 1977). The significance of self-efficacy cannot be understated, since Bandura (1977) and

Brown, Malouff, and Schutte (2005) point out that individuals with high self-efficacy for a particular task tend to try harder at the task and experience more positive emotions related to the task. This implies that individuals with high self-efficacy will tend to expend more effort in understanding a technology to facilitate adoption irrespective of their contexts, including RCEs. Both self-efficacy and behavioural change impact on general adoption and technology adoption theories (Bandura, 2001; Straub, 2009).

According to Bandura (2001), adoptive behaviour is also partly governed by self-evaluative reactions to one's own behaviour, meaning that people adopt what they value but resist innovations that violate their social and moral standards or that conflict with their self-conception. This implies that the perceived significance of a technological attribute will play an important role towards its potential adoption by an individual. Social cognitive theory contains a number of attributes and concepts that can facilitate the in-depth investigation of technology adoption, and has the potential to be used as a theoretical lens for the current research. As motivated by Straub (2009), the depth and complexity of social cognitive theory is acknowledged and no attempt is made to provide an in-depth treatment thereof; only some of the concepts that relate to adoption and technology adoption theories, as pertaining to the current research, are highlighted. In light of the depth offered by social cognitive theory, it is adopted in this study for investigating technology adoption.

Having adopted a theoretical lens for adoption models, the next section will undertake an exploration and investigation of some of the influential technology adoption and diffusion theories. The exploration is not meant to be exhaustive, but instead prescriptive on the available theories that may be adopted in the current research. This exploration and investigation of technology adoption was informed by Straub (2009), who was significantly influenced by Everett Rogers' concepts on the Diffusion of Innovation from the 1960s.

3-4. The highlight of technology adoption theories

An exploration of technology adoption theories will be undertaken next, followed by a synthesis highlighting key features in an effort towards motivating for a technology adoption theory that will be adopted and used in the current study. The study will attempt to isolate the attributes of social cognitive theory as highlighted in the previous subsection. The exploration is not meant to be exhaustive, due to the numerous adoption and specifically technology adoption theories available in literature.

According to Hameed et al. (2012), the Diffusion of Innovation (DOI) theory, Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), and the Theory of Planned Behaviour (TPB) have been widely used in technology adoption studies. Extending from this knowledge, the current research will discuss the following adoption, technology adoption, and diffusion theories: diffusion of innovation theory; theory of reasoned action and theory or planned behaviour; the technology acceptance model, including some of its extensions and versions; the technology, organisation, and environment framework; the Unified Theory of Acceptance and Use of Technology (UTAUT) and its variants; the cognitive model, the Iacovou, Benbasat, and Dexter model; the technology continuance theory; and concerns-based adoption. Some of the key attributes of these models and frameworks are explained below:

- **Diffusion of innovation theory (DOI)**: Innovation is communicated through certain channels over time and within a particular social system (Oliveira & Martins, 2011; Rogers, 1983). The DOI is one of the best technology adoption theories *that can facilitate the comprehension and prediction of change* but suffers from applicability in some situations *by not being easily applicable to understanding adoption* (Straub, 2009). According to (Straub, 2009), (Rogers, 1983), and (Beal & Bohlen, 1957), the adoption decision process prescribes five stages that an individual goes through during their evaluation of an innovation, namely, the awareness (knowledge), interest (persuasion), evaluation (decision), trail (implementation), and adoption (confirmation) stages. The diffusion of innovation theory serves as a candidate for adoption in the current research, despite being categorised at an organisational level.

- **Theory of Reasoned Action and (TRA) Theory of planned behaviour (TPB)**: the ***TRA*** aims to predict an individual's behaviour based on his behavioural intention and attitude (Madden, Ellen, & Ajzen, 1992; Sheppard, Hartwick, & Warshaw, 1988). This means that the TRA may explain technology adoption based on an individual's attitude towards technology, and the individuals history in relation to technology. However, (Sheppard et al., 1988) points out that the TRA's predictive power is limited and tightly bounded by the associated attributes. The ***TPB*** extends the boundaries of the TRA by adding belief as one of the attributes to predict an individual's behaviour (Madden et al., 1992). Attitude towards behaviour, subjective norms, and perceived behavioural control dictate an individual's behavioural

intentions (Ajzen, 2002). However, the complexity of applying the TRA and TPB to computer and information systems has been noted as some of their shortcomings (Chuttur, 2009; Davis et al., 1989).

- **Technology acceptance model (TAM), including some of its extensions and versions**: The TAM aims to understand and explain the (technological) system use by an individual or an organisation. Davis (1986) asserted that system use is a response that may be explained and predicted by user motivation, which is in turn directly influenced by the system's features and attributes, and ultimately acting as a stimulus for enquiry or investigation for acceptance. The user's motivation to use a system can be explained by three factors: perceived ease of use, perceived usefulness, and attitude towards using the system (Davis, 1986; Marangunić & Granić, 2015). The strength of the TAM lies in extending it to different domains as necessary through its variants. These variants are closely linked to the attributes of the TAM, based on their significance. A highlight of these variants is presented. In the ***parsimonious TAM***, attitude does not fully mediate the perceived usefulness and the perceived ease of use on behaviour Davis (1989). In the ***TAM 2***, the TAM is used as a starting point, within which theoretical constructs spanning social influence processes and cognitive instrumental processes are incorporated to explain the behavioural intention to use a system (Venkatesh and Davis (2000). In the **TAM 3**, there are potentially four different determinants of perceived ease of use and perceived usefulness, namely, individual differences, system characteristics, social influences, and facilitating conditions (Venkatesh & Bala, 2008). The TAM also influenced some of the models outlined in this discussion.

- **The technology, organisation, and environment (TOE) framework**: Three aspects of an enterprise's context influence the process by which it implements a technological innovation, namely, the technological context, organizational context, and environmental context (Oliveira & Martins, 2011; Tomatzky & Fleischer, 1990). The TOE framework is strongly categorised at an organisational level and is unsuitable for the current study.

- **Unified theory of acceptance and use of technology (UTAUT) and some of its versions**: UTAUT is a variant and extension of the TAM. The model posits four

direct determinants of user acceptance and usage behaviour (performance expectancy, effort expectancy, social influence, and facilitating conditions), and four moderating determinants of behavioural intention are identified (age, gender, experience, and voluntariness of use). (Venkatesh, 2014; Venkatesh, Morris, Davis, & Davis, 2003). UTAUT has an extension, namely, UTAUT 2 (Nistor, 2014; Venkatesh, Thong, & Xu, 2012). UTAUT 2 incorporates three constructs into UTAUT, namely, hedonic motivation, price value, and habit (Venkatesh et al., 2012). UTAUT is a strong candidate for adoption in the current research, especially since it is categorised at an individual level.

- **Cognitive model (COG)**: This model proposes that consumer satisfaction is related to acceptance or rejection of an innovation, and that this satisfaction influences attitude towards an intention to adopt the innovation (Liao et al., 2009; Oliver, 1980). The model is categorised at the individual level. However, it is not suitable for the current study, as it is domain specific.

- **Iacovou, Benbasat, and Dexter model**: The framework explains the adoption of inter-organizational systems by firms based on the characteristics of IT innovations that influence adoption (Iacovou, Benbasat, & Dexter, 1995; Oliveira & Martins, 2011). Three key factors are identified by the framework, namely, perceived benefits, organizational readiness, and external pressures (Oliveira & Martins, 2011). However, due to its strong organisational categorisation, the framework is unsuitable for the current research.

- **Technology continuance theory (TCT)**: Integrates the TAM, ECM, and COG for representing and explaining user behaviour towards technology continuance. Specifically, it combines attitude and satisfaction into a single continuance model (Liao et al., 2009). The model is a strong candidate for adoption in the current research, especially since it is categorised at the individual level. However, it lacks the legacy expressed by some of the other models and is not as extensively evaluated and validated.

- **The Concerns-Based Adoption (CBAM)**: According to Straub (2009), the CBAM is based closely to the domain of teachers, but lacks the overall expressive power when related directly to ICT.

The depth of explanation of these models and frameworks is based on their significance to the current study, popularity, legacy, or availability of related theory through publications. Table 3.3 presents some of the most prominent technology adoption theories, with the distinction of the different categories at individual level and organisational level:

Table 3-3: Technology adoption theory categorisation

Technology adoption theories	
Individual level	***Organisation level***
• Technology acceptance model (***TAM***) • Theory of reasoned action (***TRA***) and the Theory of planned behaviour (***TPB***) • Unified theory of acceptance and use of technology (***UTAUT***) • Cognitive model (***COG***) • Technology continuance theory (***TCT***) • The Concerns-Based Adoption (***CBAM***)	• Diffusion of innovation (***DOI***) theory • The technology, organization, and environment (***TOE***) framework • Iacovou, Benbasat, and Dexter model

As pointed out earlier, the technology adoption theories that focus on the organisational level will not be investigated further. The TAM is the most prominent and most widely used theory, despite TAM together with ECM lacking the expressive power over COG and TCT (Liao et al., 2009). The theory of planned behaviour lacks the expressive power of TAM when applied to computer or information systems to obtain information about perceived ease of use and perceived usefulness (Chuttur, 2009; Davis et al., 1989). The CBAM can be used to investigate change in terms of technology, while TAM and UTAUT are more directly related to ICT acceptance and adoption (Straub, 2009). Therefore, the study will undertake detailed investigations of TAM and UTAUT for selection as a technology adoption model.

3-5. Technology adoption theory selection

From the explored literature, two adoption theories remained that could be explored for the adoption of ICT by individuals, particularly after eliminating the organisation level technology adoption and diffusion theories. These adoption models are the TAM and UTAUT.

3-5-1. The Technology Acceptance Model

TAM was incepted by Davis (Davis, 1986, 1989; Davis et al., 1989) and UTAUT by Venkatesh and others, that is, Venkatesh et al. (2003) and Venkatesh (2014); more will be elaborated on UTAUT shortly. Davis (1986) asserted that system use is a response that may be explained and predicted by user motivation, which is in turn directly influenced by the system's features and attributes ultimately acting as a stimulus for enquiry or investigation for acceptance and potential use. Davis narrowed down the explanation of user motivation to three factors, namely, perceived usefulness (PU), perceived ease of use (PEOU), and attitude towards using the system (Davis, 1986; Marangunić & Granić, 2015). The relationship between attitude, intention, and subsequent behaviour was earlier established by Bagozzi, despite this relationship being sensitive (Bagozzi, 1981). Swanson (1982) further established a positive relationship between attitude towards a system and the actual use of that system. These factors formed the basis for the original TAM, and the concepts related to the TAM were clearly captured and articulated by Marangunić and Granić (2015), according to whom the TAM presumes a mediating role of two variables; the perceived ease of use and the perceived usefulness in a complex relationship between system characteristics (external variables) and potential system usage. This relationship is captured in the conceptual framework of the technology acceptance model illustrated in Figure 3-4:

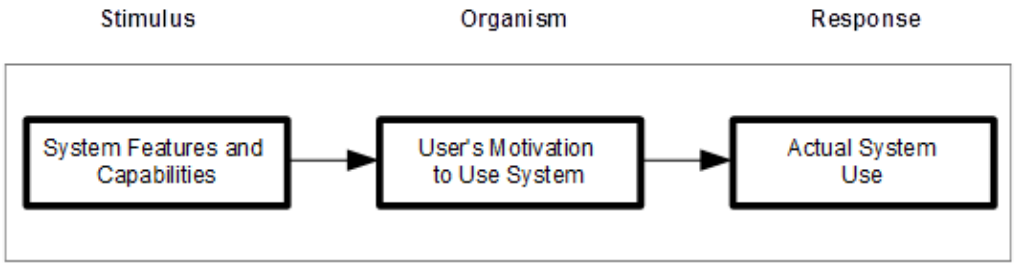


Figure 3-4: Conceptual framework of technology acceptance (Davis (1986)

Davis (1989) defined **perceived usefulness** as the prospective users' subjective probability that using a specific application system will increase his or her job performance within the context of the organisation and **perceived ease of use** as the degree to which the prospective user expects the target system to be free of effort. The significance of the TAM in the research of an individual's acceptance (Information Systems), its influence, validity, and popularity is well documented in literature (Davis, 1989; Davis et al., 1989; Hsiao & Yang, 2011; Marangunić & Granić, 2015). The shortcomings of the TAM due to the perceived

narrowness of its focus has also been noted (Bagozzi, 2007). Despite the TAM's shortcomings and the initial conception of its constructs at the organisational level of technology adoption models, they have been shown to be applicable to the individual technology adoption level (Bhattacherjee, 2001; Liao et al., 2009; Straub, 2009), thus supporting the case for adoption of the TAM in the current research.

The foundation of the TAM was grounded in psychology theories (Davis, 1986). Marangunić and Granić (2015) reiterate that the TAM was derived from the psychology based theory of reasoned action and theory of planned behaviour, and has taken a leading role in explaining users' behaviour towards technology. According to Davis (1986), attitude is a major determinant of whether an individual will use a system or not. This attitude is determined by the system's attributes through perceived ease of use and the perceived usefulness of the system (Davis, 1986). These assertions resulted in the technology acceptance model, as illustrated in Figure 3-5:

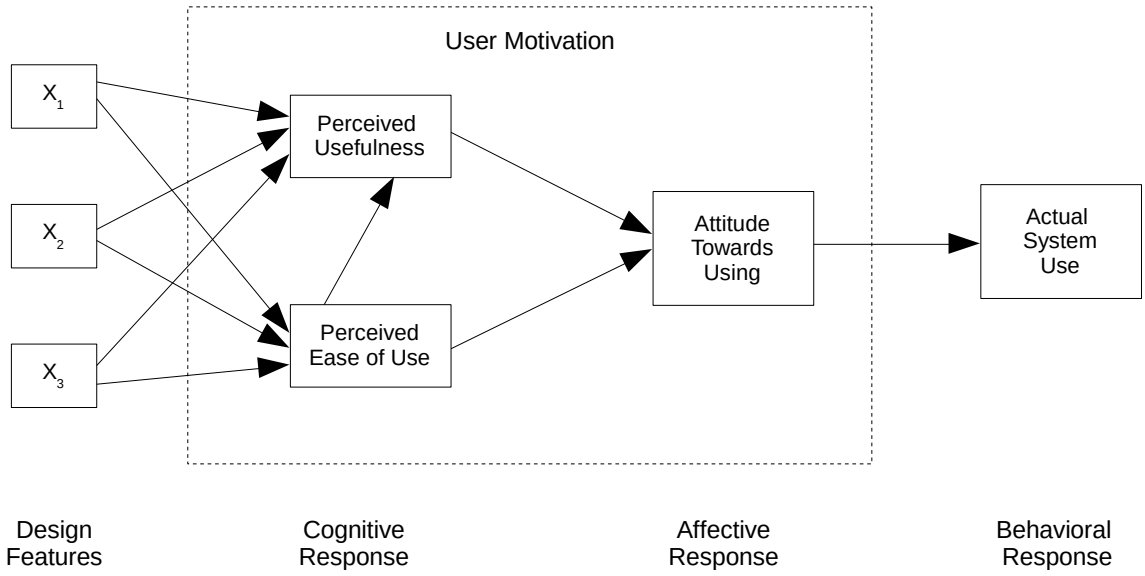


Figure 3-5: The technology acceptance model (TAM) (Davis (1986)

Figure 3-5 represents the TAM as perceived by Davis (1986). It is clearly evident that system design features, as well as the motivation of an individual to use the system, play a pivotal role in the overall use of the system. Having explored and realised the significance of TAM in individual level technology adoption, the final adoption model, UTAUT, will be investigated for adoption in the current study.

3-5-2. The Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) was conceived as an iteration and extension of the TAM that integrated fragmented theories from the several established individual acceptance theories into a single unified theory (Mohammadyari & Singh, 2015; Venkatesh et al., 2003). These theories are reiterated as follows: the theory of reasoned action (TRA), the theory of planned behaviour (TPB), the technology acceptance model and variant (TAM and TAM2), the motivational model (MM), the technology acceptance model with the theory of planned behaviour (C-TAM-TPB), the model for PC utilization (MPCU), the innovation diffusion theory (IDT), and the social cognitive theory (SCT) (Taiwo & Downe, 2013; Venkatesh et al., 2003).

According to Venkatesh et al. (2003) and Venkatesh (2014), UTAUT posits four direct determinants of user acceptance and usage behaviour (performance expectancy, effort expectancy, social influence, and facilitating conditions). In addition, four moderating determinants of behavioural intention are identified (age, gender, experience, and voluntariness of use). Figure 3-6 illustrates UTAUT:

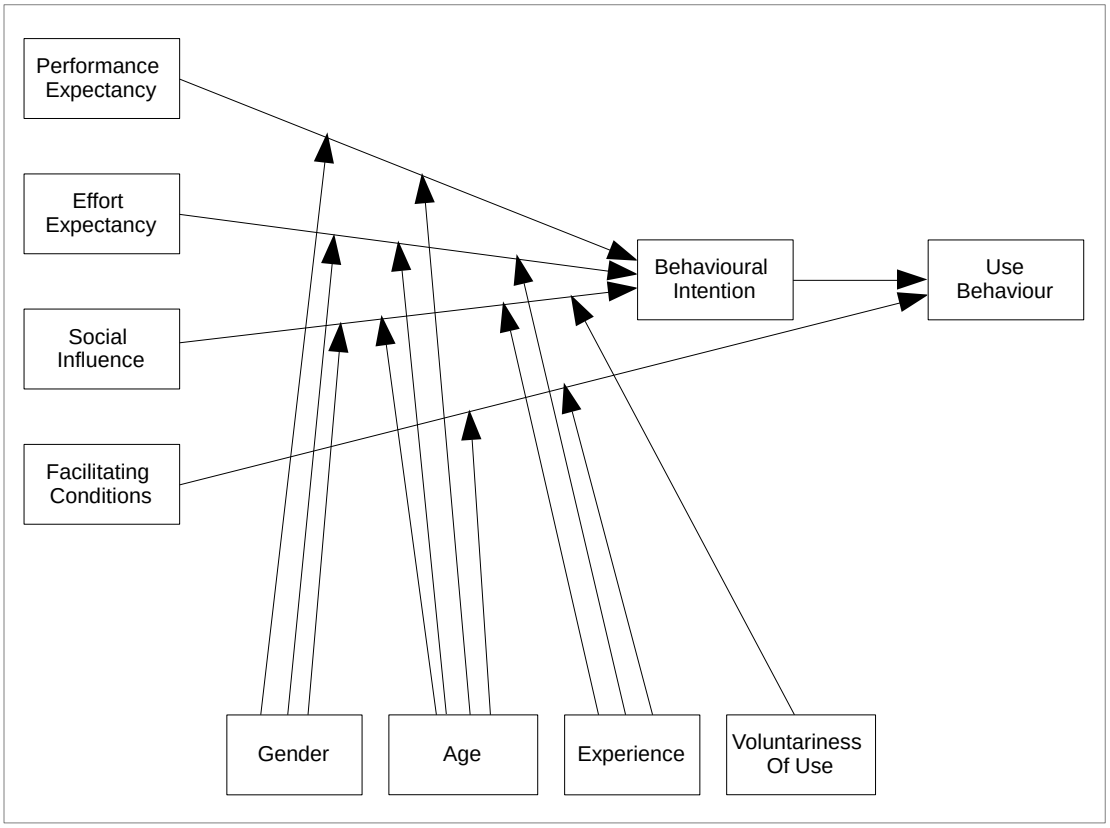


Figure 3-6: The Unified Theory of Acceptance and Use of Technology research model ((Venkatesh et al., 2003)

Venkatesh et al. (2003) provide the definitions of the core constructs, shown in Table 3-4:

Table 3-4: Core constructs of UTAUT (Venkatesh et al. (2003) and Warshaw and Davis (1985))

Construct type	**Construct**	**Definition**
Key independent construct	Performance expectancy	The degree to which an individual believes that using technology such as ICT will assist in improving that individual's job performance.
	Effort expectancy	The degree of ease associated with using technology such as an ICT system.
	Social influence	The degree to which an individual perceives that important people in the individual's circles in the workplace believe that the individual should adopt and use a technology such as an ICT system.
	Facilitating condition	The degree to which an individual believes that there is sufficient technical and organisational infrastructure to support the use of the technology.
	Behavioural intention	The degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour (Warshaw & Davis, 1985).
Moderating variables	Gender, Age, Experience, Voluntariness of use	

Despite UTAUT being a culmination of established acceptance theories, its origins can be traced to TAM and TPB (Dwivedi, Rana, Chen, & Williams, 2011). Dwivedi et al. (2011) point out that UTAUT facilitates examination of the user's intention to use an IT system (information system, computer system, mobile application, etc.), and the consequent usage behaviour. According to Venkatesh et al. (2003), UTAUT has strong empirical support from its constituent adoption theories, which include TAM.

UTAUT is noted not to necessarily be a panacea of technology adoption. Some of the shortcomings of UTAUT are as follows:

- Significant attributes such as *attitude* are not sufficiently addressed (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2017);

- Some of the key attributes of the model, such as behavioral intention and facilitating conditions, are sometimes considered to be showing weak relationships to usage behavior (Taiwo & Downe, 2013);

- Incorporating behavioral expectation instead of behavioral intention on UTAUT may increase the expressive power of UTAUT (Maruping, Bala, Venkatesh, & Brown, 2017)

Despite these potential shortcomings, UTAUT is well established and shows more expressive power than TAM (Dwivedi et al., 2011; Venkatesh et al., 2003). UTAUT has also been extensively tested in the field, signifying its maturity (Williams, Rana, & Dwivedi, 2015). The current research therefore adopts UTAUT as technology adoption theory.

The next section will investigate the ability of UTAUT to facilitate digital literacy.

3-6. Inception of the conceptual model

The adopted technology adoption model, UTAUT, has been shown to facilitate technology adoption, acceptance, and use. Through technology use, digital literacy levels can be improved, leading to the effective use of ICT. The study proposes a conceptual model that facilitates digital literacy through technology adoption. This is illustrated in Figure 3-7:

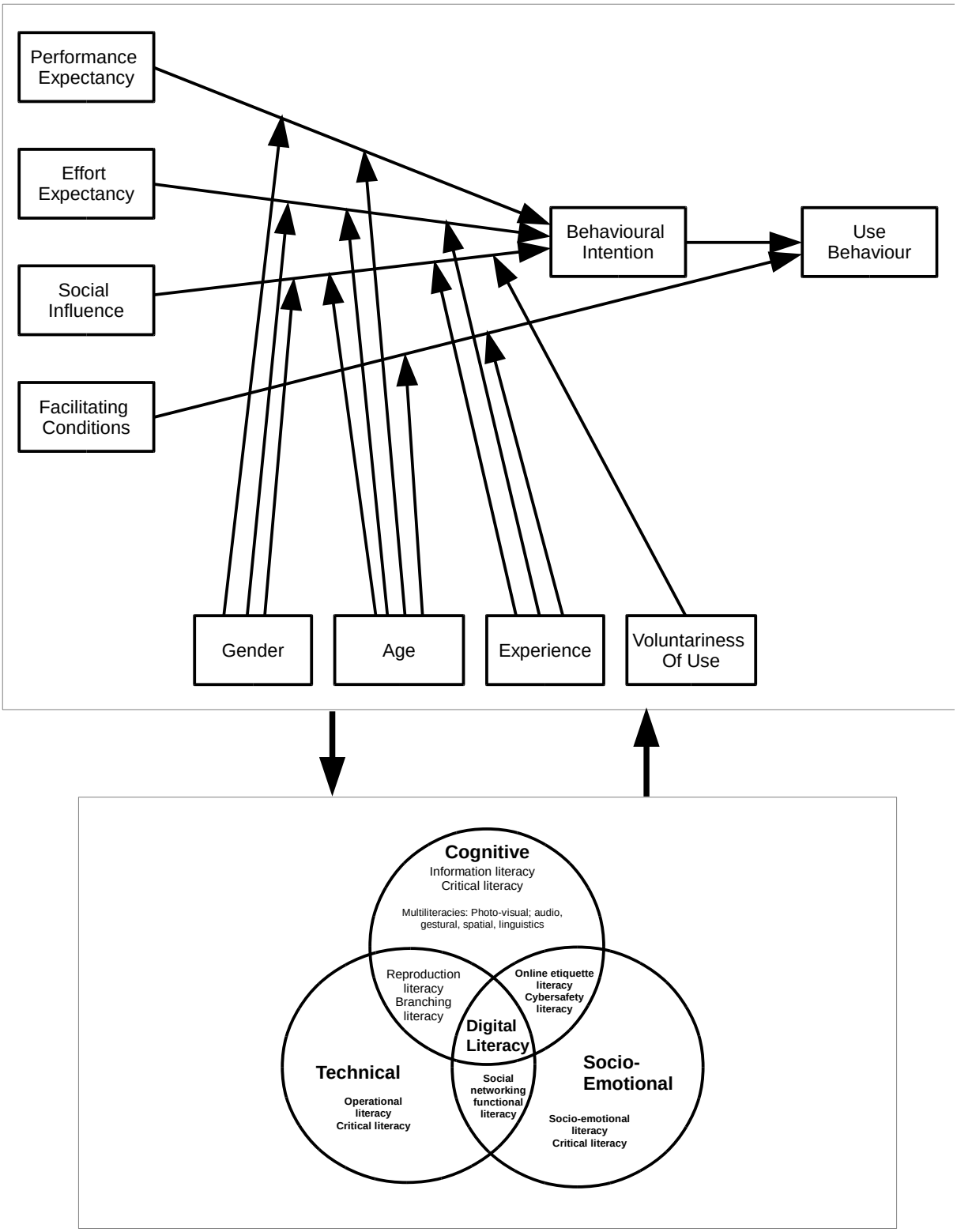


Figure 3-7: Conceptual model for enhancing digital literacy through technology adoption (adapted from Venkatesh et al. (2003) and Ng (2012a))

The model extends the digital literacy framework from Chapter 1 by incorporating UTAUT as a technology adoption model. The conceptual model further establishes a relationship

between digital literacy and technology adoption. The dimensions of digital literacy, that is, the technical, cognitive, and socio-emotional dimensions, facilitate the effective use of ICT. The core constructs of UTAUT (i.e., performance expectancy, effort expectancy, social influence, and facilitating conditions), as well as the moderating constructs (i.e., gender, age, experience, and voluntariness of use), facilitate ICT use. These dimensions and constructs, which encapsulate the characteristics of the conceptual model, are outlined in Table 3-5:

Table 3-5: The characteristics of the model to enhance digital literacy through technology adoption

<table>
<tr><td>Digital literacy</td><td>Constructs of UTAUT</td></tr>
<tr><td>Dimensions</td><td>Core constructs</td></tr>
<tr><td>Cognitive dimension – the ability to think critically in the search, evaluate, and create cycle of handling digital information.</td><td>Performance expectancy – the degree to which an individual believes that using the system (ICT) will help him to attain gains in job performance (socio-economic participation).</td></tr>
<tr><td>Technical dimension – possessing the technical and operational skills to use ICT for learning and in everyday activities.</td><td>Effort expectancy – the degree of ease of use of the system (ICT).</td></tr>
<tr><td>Socio-emotional dimension – the ability to use the Internet (ICT) responsibly for communicating, social-media, and learning.</td><td>Social influence – the degree to which an individual perceives that important others believe he should use the new system (ICT).</td></tr>
<tr><td rowspan="3">Critical literacy (applies to technical, cognitive, and socio-emotional dimensions) – understanding that people behind the scene writing the information have their own motivations, and being able to critically evaluate whose voice is being heard and whose is not important for as neutral as possible learning.</td><td>Facilitating conditions – the degree to which an individual believes that an organisational and technical infrastructure exist to support the use of the system (ICT).</td></tr>
<tr><td>Moderating constructs</td></tr>
<tr><td>Gender, Age, Experience, and Voluntariness of use.</td></tr>
</table>

From Table 3.5, UTAUT facilitates digital literacy. The constructs of UTAUT, performance expectancy, effort expectancy, social influence, and facilitating conditions facilitate ICT use and also incorporates social aspects. In the next chapter, this conceptual model will be extended to the context of resource-constrained environments. The extended model will then be evaluated and validated empirically in subsequent chapters.

3-7. Summary

The current chapter addressed the second of the three key concepts identified from the questions posed in the research, that is, digital literacy. By adopting UTAUT as a technology adoption theory for the research, the study addressed the second sub-research question:

> ***SRQ 2 –*** What are the elements of technology adoption that influence the attainment of digital literacy?

This facilitated extension of the model for digital literacy attainment and enhancement through technology adoption. Chapter 2 contributed the dimensions of digital literacy, and Chapter 3 the constructs of UTAUT, to the conceptual model. The second version of the conceptual model is outlined in Figure 3-7.

The conceptual model facilitates digital literacy attainment and enhancement through technology adoption. The model included the dimensions of digital literacy and the constructs of the UTAUT for understanding and explaining the use of ICT.

Chapter 4 *Resource–constrained environments*

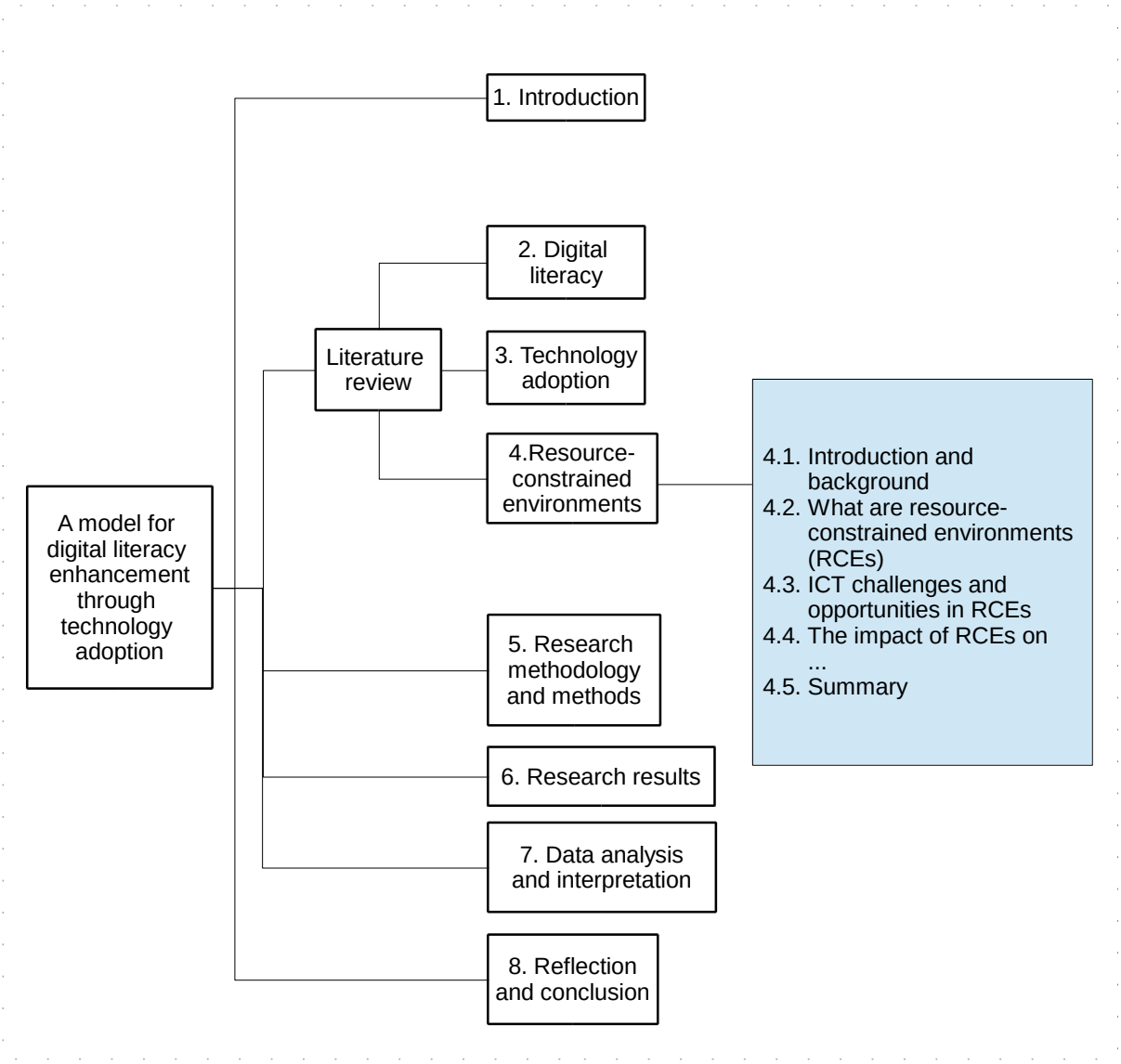


Figure 4-1: Research outline overview with emphasis on resource-constrained environments

Figure 4-1 reflects the chapter outline. The aim of this chapter is to answer the third sub-research question (see Section 4.1). It first defines resource-constrained environments (RCEs), so as to understand the opportunities and challenges of these environments for this research. This impact is then assessed, leading to the final conceptual model, which is evaluated and validated in subsequent chapters.

4-1. Introduction and background

This chapter represents the final chapter of the literature review of the research. The chapter deviates slightly from the previous literature review chapters by using a narrative literature review instead of the systematic scoping review. Narrative literature reviews have been noted to play an important role in linking studies and topics for reinterpretation or establishing interconnections (Baumeister & Leary, 1997). The potential bias associated with narrative reviews is acknowledged (Jesson, Matheson, & Lacey, 2011; Torgerson, 2003); however, the aim of this review is to identify constraints of RCEs so as to inform the research on the impact of these environments on technology adoption and digital literacy. Despite the inherent bias, narrative reviews play a fundamental role in achieving this objective.

Having developed a conceptual model for enhancing digital literacy through technology adoption in the previous chapter, the current chapter extends this conceptual model to the context of RCEs. The motivation is based on the fact that users in this context are the most affected by challenges posed by ICTs and stand to benefit the most (Salemink, Strijker, & Bosworth, 2015).

The third sub-research question from Chapter 1 informs this literature review:

> ***SRQ 1 –*** *What constraints does an RCE present for the attainment of digital literacy through technology adoption?*

RCEs will be defined as related to the research, and the challenges and opportunities they impose will be explored and explained. Finally, the model designed in the previous chapter will be extended to RCEs.

4-2. What are resource-constrained environments (RCEs)?

RCEs refer to environments with restricted resources to conduct activities towards achieving goals and objectives. A definition of RCEs is necessary to provide clarity and to direct the research. According to Anderson and Kolko (2011) and Anderson, Anderson, Borriello, and Kolko (2012b), RCEs refer to the restricted availability of resources, as reflected in a range of conditions, including material issues and societal conditions. Material issues refer to tangible issues such as electricity, running water, general infrastructure, disposable income, and others. Societal issues on the other hand refer to non-tangible aspects such as communication, collaboration, information exchange, and others.

According to Anderson et al. (2012b), some of the challenges imposed by RCEs are that, due to the scarcity of resources and environmental pressures, individuals in RCEs may evolve a culture of unfamiliarity and fear of perceived out-of-reach artefacts such as technology. In the case of ICT, this may imply that individuals from RCEs might have a lesser affinity to explore, accept, adopt, and use ICT for their day-to-day activities. This varies according to differences in age (Venkatesh, Sykes, & Venkatraman, 2014), education, gender, and income (Salemink et al., 2015).

For the purposes of this research, RCEs will be defined as environments that inhibit access and use of ICT due to the restricted availability of economic and social resources. Figure 4-2 illustrates:

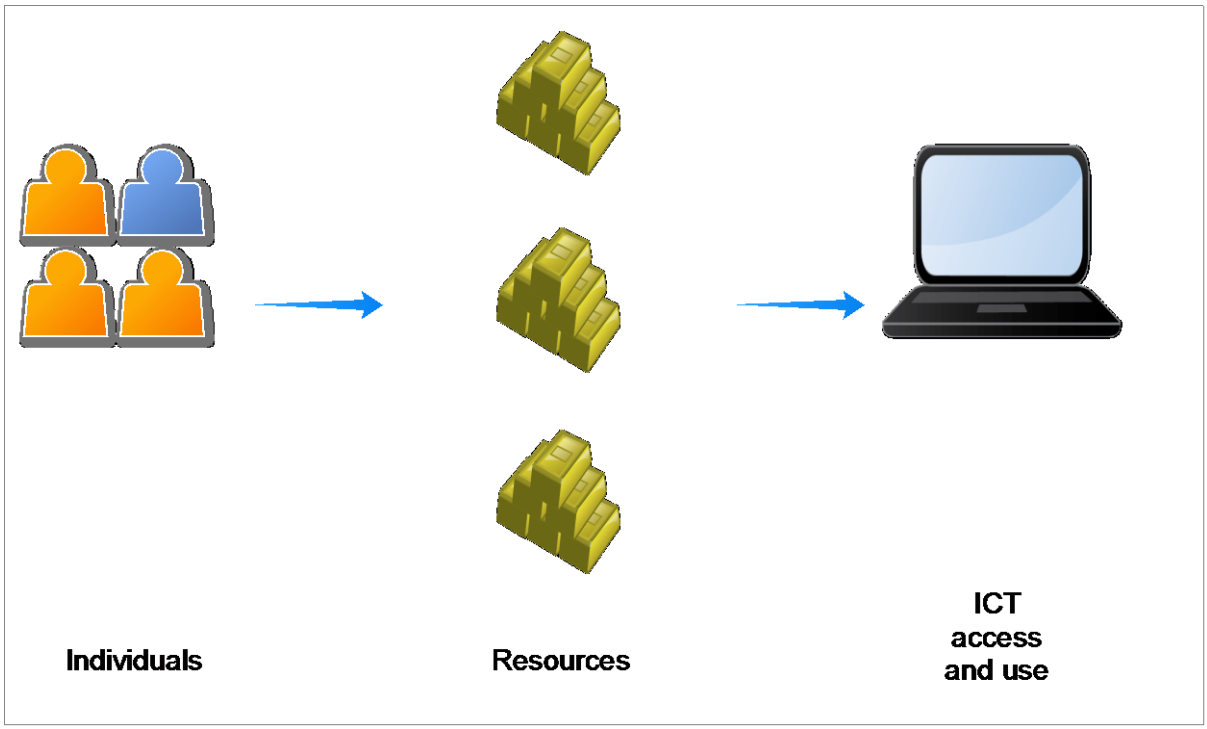


Figure 4-2: Resource constrained environments

The figure illustrates that ICT access and use are directly related to the availability of resources (socio-economic) for individuals in a specific area. The research adopts rural areas as an instance of RCE. The motivation is provided in the next subsection.

4-2-1. Profile of a rural area

Rural areas experience a scarcity of resources. Phaswana-Mafuya and Shukla (2005) pointed out that rural areas experience scarcity related to material issues, with a detrimental effect on the socio-economic conditions of individuals residing in these areas. Statistics South Africa

(Stats SA), the national statistics agency, provides statistical definitions of rural areas in relation to urban areas. Table 4-1 summarises these definitions:

Table 4-1: Definitions of rural areas based on urban areas (adapted from Statistics South Africa (2004))

Location attribute	Definition
Settlement type	Classification according to the characteristics of a residential population in terms of urban and rural, degree of planning (planned and unplanned) in the case of urban areas, and jurisdiction (in the case of rural areas). The four broad settlement types found in South Africa are: formal urban areas, informal urban areas, commercial farms, and tribal areas and rural informal settlements
Urban area	A classification based on dominant settlement type and land use. Cities, towns, townships, suburbs, and others, are typical urban settlements.
Rural area	Any area that is not classified as urban. Rural areas are subdivided into tribal areas and commercial farms.

Laldaparsad (2012) provides a classification of urban and rural areas centred on the availability of resources. Table 4-2 illustrates:

Table 4-2: Classification of urban and rural areas (in South Africa) (adapted from Laldaparsad (2012))

	Urban	**Rural (farm)**	**Rural (traditional)**
Education	Persons with complete primary and secondary schooling and higher education	Persons with limited primary schooling	Primary schooling optional
Water	Households with water provided by the municipality or private institutions	Households with water from a borehole	Households using river or spring water as the main supply of water
Sanitation	Flush	Flush but mainly pit	Occasionally pit but no formal sanitation
Energy	Households using electricity as the main source of energy	Households using gas, paraffin, wood, and coal as the main source of energy	Households using animal dung or solar as the main source of energy

Income	Higher income households	Low income households	Income optional

From Table 4-2, the major resource challenges that individuals in rural areas experience are education, running water, sanitation, energy, and income. This supports the adoption of rural areas as instances of RCEs.

The next section explores challenges and opportunities imposed by RCEs on ICT use.

4-3. ICT challenges and opportunities in RCEs

According to Foko, Thulare, Legare, and Maremi (2017), the opportunities and challenges of ICT can be clearly articulated from excerpts of the National Development Plan of South Africa (National Planning Commission, 2012). ICT use can be an enabler by speeding up delivery, supporting analysis, building intelligence, and facilitating new ways to share, learn, and engage (among individuals, businesses, and government) (Foko et al., 2017). However, when used ineffectively, ICT can be an inhibitor and disable socio-economic participation (among citizens, within businesses, and with the government) (National Planning Commission, 2012).

Foko et al. (2017) identified the following major barriers to ICT adoption and use in rural areas:

- Infrastructure development;
- Low economic activity;
- Lack of skilled individuals for information or skills transfer;
- Limited rural-specific applications, limiting rural business and individual buy-in and investment;
- Misinformation on the potential of ICT within rural environments (including the digital literacy levels necessary for ICT use);
- Barriers due to culture and traditions in rural social systems, resulting in resistance to shift to new, less controllable regimes, thus impeding social anchoring of ICT in local communities;
- Lack of a technology culture, particularly for older populations.

From the list above, major resource challenges that inhibit ICT use in rural areas are as follows: infrastructure, income, ICT skills, domain-specific applications, and knowledge.

On the other hand, some of the potential benefits of ICT in rural areas are socio-economic participation, including e-banking, e-commerce, e-government, e-learning and e-health, social-media, communication, and entertainment (Foko et al., 2017). In facilitating ICT use, Foko et al. (2017) propose the rollout of ICT platforms, managed by ICT champions, to communities where individuals of all ages can gain access and engage in all spheres of socio-economic participation using ICT.

Rural communities have been shown to benefit where this initiative has been rolled out successfully. An element of trust is generally established between the ICT champion and the community, since these ICT champions are generally from within the community that they serve. The significance of such ICT champions to the success of these ICT initiatives is highlighted by Roman and Colle (2002), who point out that ICT champions can demonstrate the relevance of ICT to their communities.

Having outlined some of the benefits and challenges of ICT in RCEs using rural areas, the next section will extend the proposed model for the enhancement of digital literacy through technology adoption to RCEs, by encompassing key attributes exhibited by individuals in these environments.

4-4. The impact of RCEs on digital literacy enhancement through technology adoption

Sections 4.2 and 4.3 identified resource challenges that affect rural areas: education, running water, sanitation, energy, income, infrastructure, ICT skills, domain-specific applications, and knowledge. Resources that have a direct impact on ICT use will affect the conceptual model outlined in Chapter 2. From the list above, these are: education, knowledge, energy, income, infrastructure, ICT skills, and domain-specific applications.

The characteristics of the model of digital literacy enhancement through technology adoption facilitated the understanding of constructs and dimensions necessary for ICT use. Table 4-3 outlines the characteristics of the model, as well as the restrictions imposed by RCEs on the model:

Table 4-3: Characteristics of the model for the enhancement of digital literacy through technology adoption in RCEs

Characteristic	**Resources that impact the**	**Description**

(s)	characteristic through its constraints	
Digital literacy dimensions		
Cognitive dimension	Education and knowledge	The resources affect the skills necessary for handling digital information.
Technical dimension	ICT skills	The resources affect the technical skills necessary for ICT use.
Socio-emotional dimension	Education and knowledge	The resources affect the emotional skills necessary for communicating in a digital social environment.
Constructs of UTAUT		
Performance expectancy	ICT skills and domain-specific applications	The resources affect the degree to which ICT will assist an individual with his job.
Effort expectancy	Education, knowledge, ICT skills	The resources affect the degree of ease of use associated with using ICT.
Social influence	Not applicable	
Facilitating conditions	Energy, infrastructure, domain-specific applications	The resources affect the availability of infrastructure to support the use of ICT.
Gender	ICT use may be gender-biased in rural areas (Salemink et al., 2015).	
Age	Older individuals experience challenges in learning new skills (Venkatesh et al., 2014).	
Experience	Inhibitor of ICT; ICT conflicts with traditions and culture.	
Voluntariness of use	Applicable to younger individuals.	
Behavioural intention	Education, knowledge, energy, infrastructure, and domain-specific applications.	The resources affect the degree to which an individual makes a decision to use or not use ICT.
Use behaviour	Education, knowledge, energy, income, infrastructure, ICT skill, and domain-specific applications.	The resources affect the use of ICT.

From Table 4-3, it is evident that all the characteristics of the model for the enhancement of digital literacy, except for social influence, are affected by resource constraints in RCEs. Figure 4-3 illustrates:

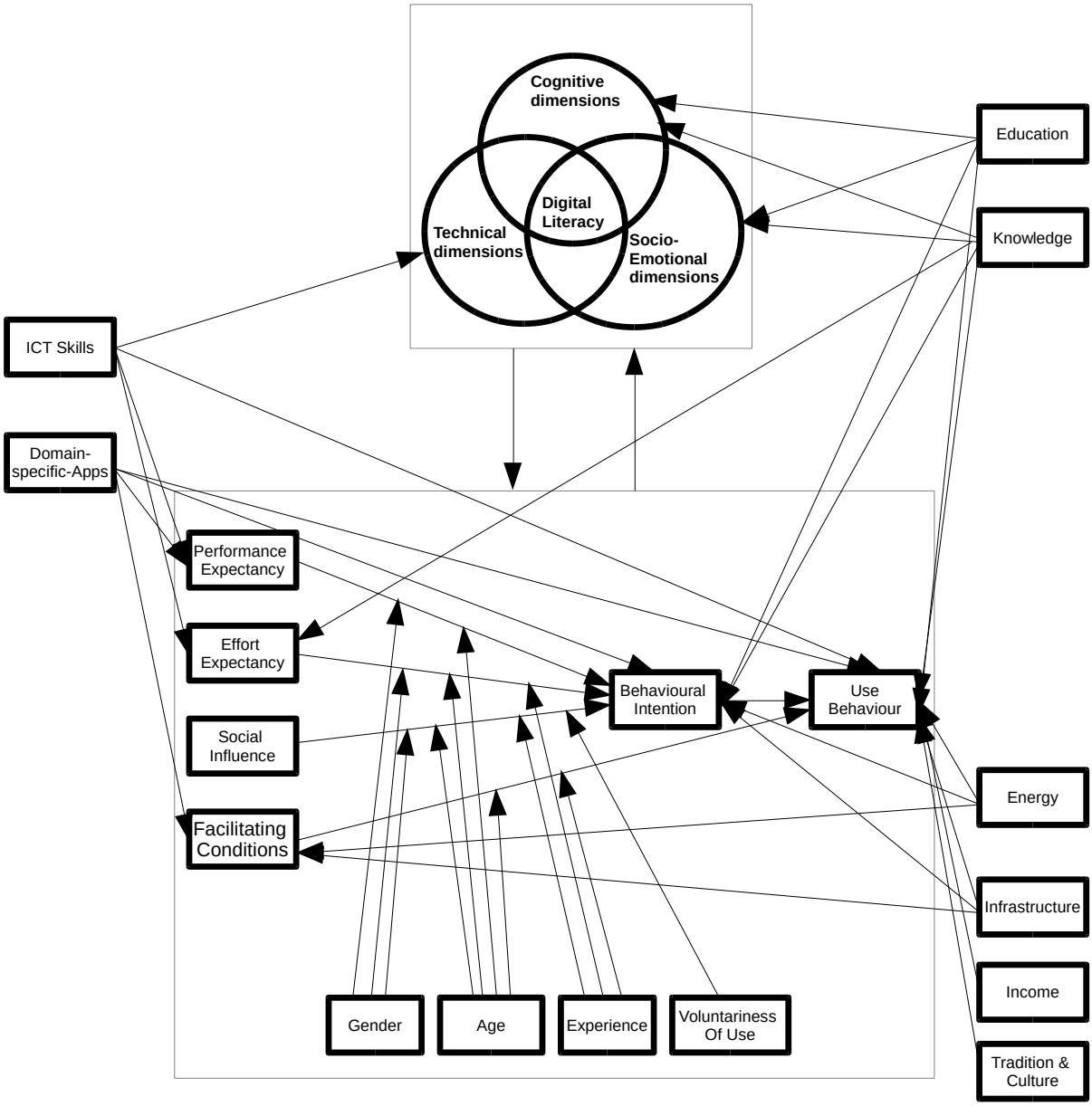


Figure 4-3: The conceptual model for ICT use through digital literacy and technology adoption in RCEs

The major driving forces for the dimensions of digital literacy are education and knowledge. These resources, together with ICT skills, further play a role in ICT use and may be acquired by introducing ICT to learners from the basic education level.

In terms of the constructs of technology adoption (through UTAUT), some of the resource constraints may be intractable. Infrastructure development, which challenges the competitiveness and return on investments, may be hard for service providers (Hindman, 2000). Local business also notes limited value in ICT due to limited sector-specific

applications, thus dampening their investment aspirations (Salemink et al., 2015). Further, the potential conflict with local cultures and traditions may inhibit ICT acceptance. Policy considerations by stakeholders may play a critical role in this regard.

Despite the challenges posed by RCEs, all the dimensions and constructs of the model for the enhancement of digital literacy through technology adoption extend successfully to RCEs.

4-5. Summary

In the current chapter, challenges imposed by RCEs on the conceptual model were identified. Individuals are affected by the socio-economic resources that available in their environment for ICT use in their day-to-day activities. The literature review undertaken in Chapter 2 elicited the dimensions of digital literacy that impact on ICT use, while the literature review undertaken in Chapter 3 elicited the constructs of UTAUT that affect ICT use. The current chapter introduced the context of RCEs and highlighted resources that affect ICT use in RCEs (see Figure 4-3).

From Figure 4-3, the conceptual model for digital literacy attainment through technology adoption is realized. ICT use by individuals is dictated by the availability of socio-economic resources in their environment. In turn, technology adoption directly impacts digital literacy for the use of ICT by individuals in that environment.

Having developed a conceptual model for the attainment and enhancement of digital literacy for individuals in RCEs through technology adoption, the subsequent chapters will evaluate and validate this model using an appropriate research strategy and an appropriate sample from the context of the research.

Chapter 5 *Research methodology and methods*

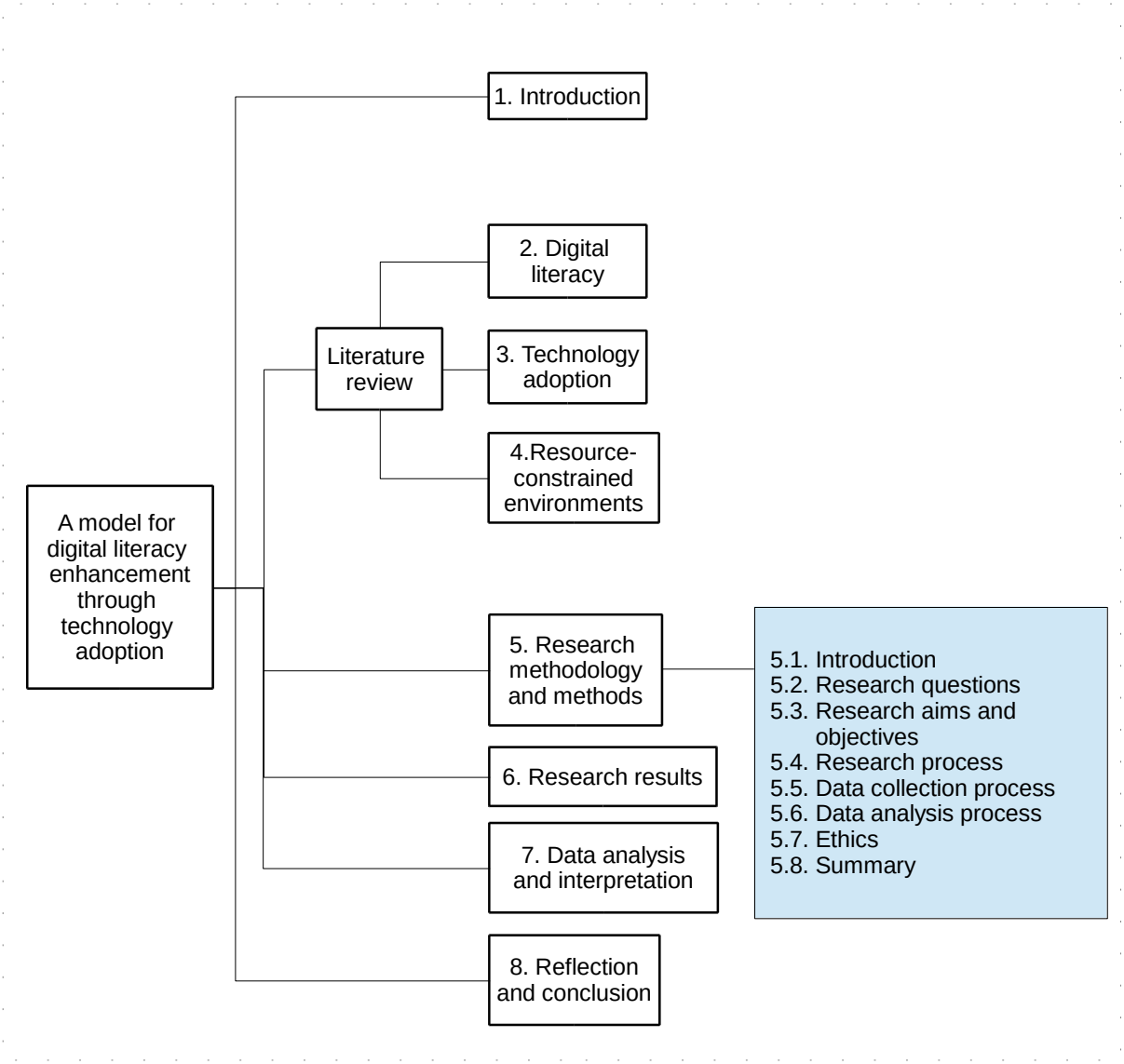


Figure 5-1: Research outline with emphasis on research methodology and methods

The diagram describes the chapter outline. The aim of this chapter is to present the research methodology and research methods to facilitate the systematic undertaking of the empirical investigation for evaluating and validating the conceptual model of the research (see Section 5.1). The conceptual model was designed based on the literature reviews undertaken in Chapters 2, 3, and 4 on key concepts underlying the research.

The philosophical underpinnings of the research will inform the research design and research strategy to facilitate the data collection process; the results will serve as input to the data analysis process. Trustworthiness will finally underpin and validate the research methodology.

5-1. Introduction

The researcher designed a conceptual model for the enhancement of digital literacy through technology adoption for ICT use in resource-constrained environments (RCEs). This conceptual model was based on theoretical underpinnings from the literature review undertaken in Chapters 2, 3, and 4. This conceptual model will inform the final model of the research. Where a conceptual model envisages a possibility, a model represents a systematic description of an actual phenomenon (Börner et al., 2012; Gregory, 1993). This chapter outlines the research methodology for empirically validating this conceptual model towards the development of a model for the enhancement of digital literacy through technology adoption for ICT use in RCEs. The research will use this methodology to outline a systematic approach to the study.

A research methodology is defined as a way to systematically solve a research problem in the context of a particular paradigm (Kothari, 2004; Wahyuni, 2012). According to Nunamaker Jr, Chen, and Purdin (1990), a research methodology consists of the combination of processes, methods, and tools used for conducting research within a specific domain; the research domain refers to the subject matter under study in a research project. Figure 1-1 on page 21 outlines the research methodology. Figure1-1 indicates that the research methodology will involve the research process, the data collection process, and the data analysis process.

In light of the significance of the research methodology in the research, the research questions as well as the research aims and objectives will be restated and discussed in depth.

The rest of the chapter is outlined as follows: Section 5.2 restates the research questions, and Section 5.3 the aims and objectives. Section 5.4 presents the research process. The data collection and data analysis processes are presented in Sections 5.5 and 5.6, respectively. Finally, Section 5.7 presents the ethical consideration of the research, before a summary of the chapter is presented in Section 5.9.

5-2. Research questions

The main research question and the sub-research questions are restated as follows:

- (**MRQ**) What elements should a model comprise of to enhance digital literacy through technology adoption in resource-constrained environments (RCE)?

The sub-research questions:

- (**SRQ1**) What are the elements of digital literacy that are relevant to technology use?
- (**SRQ2**) What are the elements of technology adoption that influence the attainment of digital literacy?
- (**SRQ3**) What constraints does an RCE present for the attainment of digital literacy through technology adoption?

The first sub-research question seeks to identify the elements of digital literacy that facilitate technology use. Individuals may comprehend the significance of ICT use vicariously, but elements of digital literacy need to be identified that will facilitate the use of ICT in day-to-day activities.

The second sub-research question seeks to identify elements of technology adoption that can facilitate the use of ICT by individuals in their day-to-day activities. In light of the Unified Theory of Acceptance and Use of Technology (UTAUT), which is used in this research as a technology adoption framework, the elements of UTAUT facilitating ICT use will be identified.

The third sub-research question seeks to identify elements of technology adoption and dimensions of digital literacy that can facilitate ICT use for individuals in RCEs for their day-to-day activities. This means that elements associated with the dimensions of the digital literacy framework, as well as the constructs of UTAUT that facilitate ICT use in RCEs, will have to be identified.

5-3. Research aims and objectives – Outcomes

The research aims and objectives were identified in Section 1-4, on page 19 with the purpose of focusing and directing the study. The research objectives represent goals that need to be addressed during the empirical enquiry, so as to eventually address sub-research questions and the main research question. Table 5-1 illustrates:

Table 5-1: Potential research outcomes based on the research objectives

Research objective	Research outcome(s)
To investigate the significance of digital literacy for ICT use	The impact of digital literacy on ICT use in day-to-day activities

To investigate the significance of technology adoption for ICT use	The impact of the constructs of UTAUT on ICT use in day-to-day activities
To confirm the significance of digital literacy and technology adoption in ICT use	The impact of elements of digital literacy and constructs of UTAUT on ICT use
To identify the opportunities and mitigate the challenges of RCEs for technology adoption and digital literacy	The mitigation of resource constraint elements that impact ICT use
To empirically contribute to digital literacy and technology adoption	A theoretical contribution to digital literacy and UTAUT through the synthesis of theory

5-4. Research process

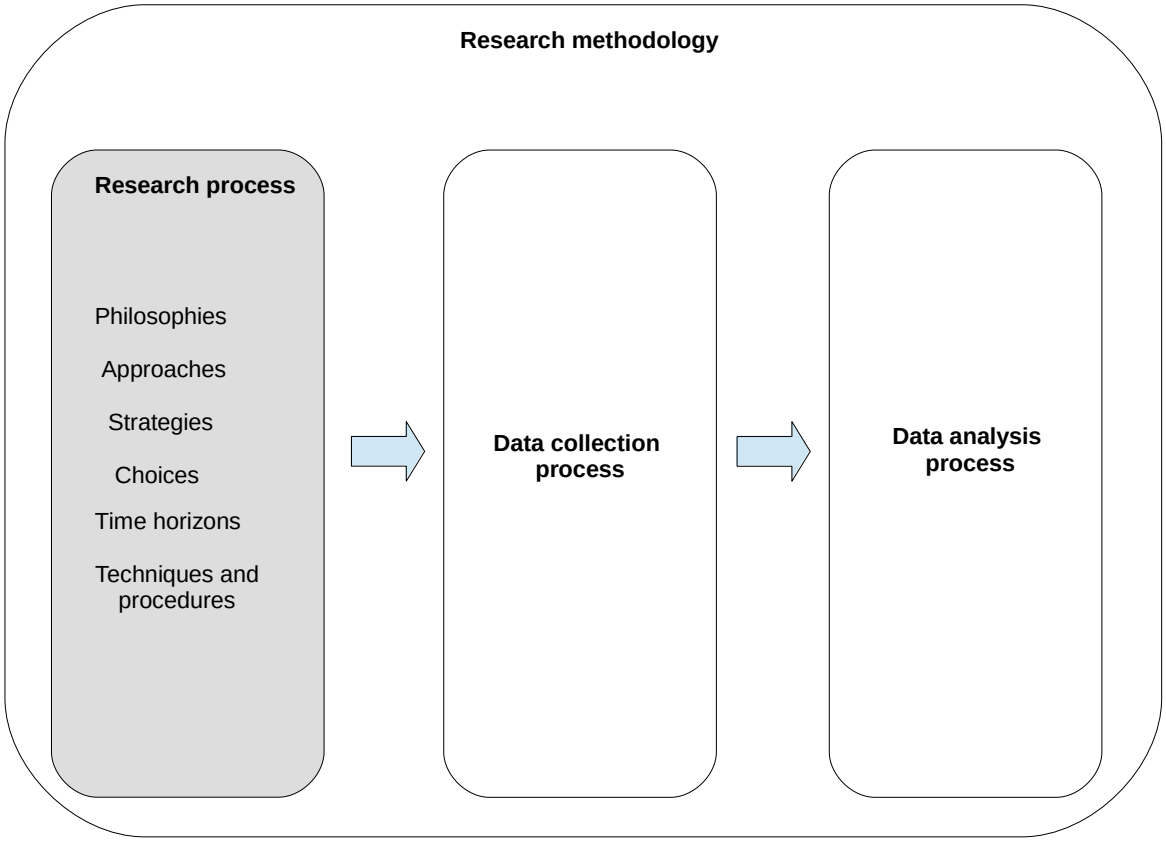


Figure 5-2: The research process

The research process is governed by the research 'onion' by Saunders et al. (2016). The research onion outlines the stages that are necessary to undertake prior to addressing the data collection and data analysis phase of an empirical enquiry. The generic research onion presented by Saunders et al. (2016) is as follows:

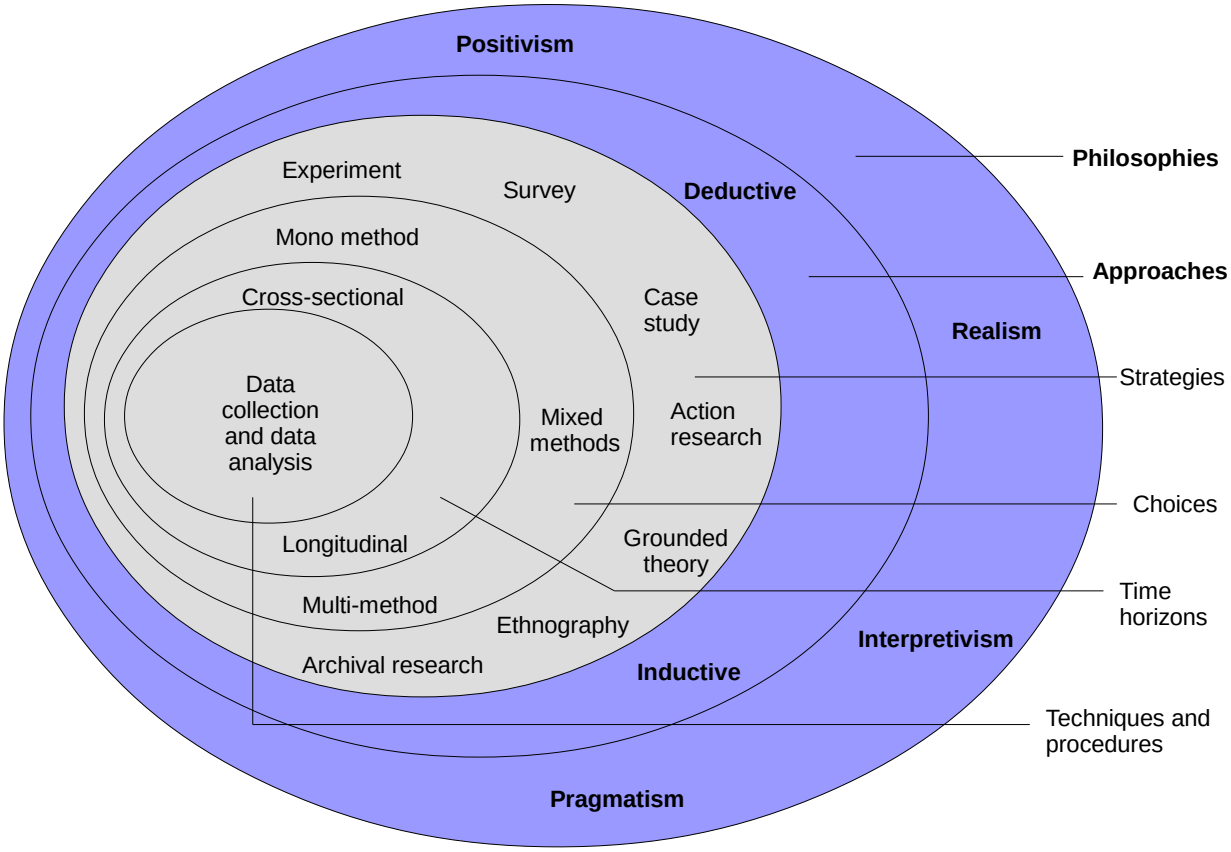


Figure 5-3: The research process as outlined through the research onion (Saunders et al., 2016)

From Figure 5-3 it is evident that the techniques and procedures that represent the data collection and data analysis processes are preceded by the time horizons, choices, strategies, approaches, and philosophies that govern the research process. The first two outermost layers (research philosophies and research approaches) are mainly concerned with the theoretical grounding of the research process, while the three subsequent layers (strategies, choices, and time horizons) focus on transforming the research questions into a research project (Robson, 2002, as cited in (Saunders et al., 2016).

The next section outlines the research philosophies.

5-4-1. Research philosophy

Research philosophies play a significant role in the research process. A research philosophy can assist the researcher in identifying an optimal research design and grounding based on the research under study (Easterby-Smith, Thorpe, & Jackson, 2012). Several definitions related to a research philosophy exist in literature. According to Mason and McBride (2014), research philosophy is concerned with the different views on how the world works, with focus on knowledge, reality, and existence. Three (research) philosophical stances that inform

the research are noted, namely, epistemology, ontology, and axiology; these are defined as follows:

- Epistemology – acceptable knowledge in reality or the field (how do we know);
- Ontology – the nature of reality (what is real); and
- Axiology – the researcher's stance on values (what is right or valuable).

Some of the prominent research philosophies by Creswell (2013) and Goldkuhl (2012) are:

- ***Positivism***. According to Saunders et al. (2016), positivism relates to the philosophical stance of a natural scientist and entails working with an observable social reality, resulting in law-like generalizations similar to those in the physical and natural sciences. Easterbrook, Singer, Storey, and Damian (2008) point out that positivism states that all knowledge must be based on logical inferences from a set of basic observable facts.
- ***Interpretivism***. According to Saunders and Tosey (2013), interpretivism relates to the study of a social phenomenon in a natural environment; it focuses on conducting research among people rather than objects, with researchers adopting an empathetic stance so as to understand their social world and the meaning that they give to it from their point of view. Data generation in interpretivism is through interpretation (Goldkuhl, 2012).
- ***Critical research (Transformative or Post-positivism)***. Myers (1997) defines critical research as assuming that social reality is historically constituted and dependent on the people for production and reproduction. This is resonated by Orlikowski and Baroudi (1991) who state that critical studies aim, through the exposure of deep-seated structural problems, to question the state of affairs and eliminate contradictions.
- ***Pragmatism***. According to Easterbrook et al. (2008) pragmatism adopts an engineering approach to research – it values practical knowledge over abstract knowledge, and uses whatever methods are appropriate to obtain it. Of essence is what works and finding solutions to problems, and it may be important to focus attention on the research problem and use pluralistic approaches to derive knowledge

about the problem (Creswell, 2013). The significance of practical solutions and knowledge in pragmatism is highlighted by Tashakkori and Teddlie (1998), namely that pragmatism is centred around values in conducting research and drawing conclusions from that research, irrespective of personal values and allegiances to certain theoretical positions (Cherryholmes, 1992, 1994; Tashakkori & Teddlie, 1998). According to Wicks and Freeman (1998) and Goles and Hirschheim (2000), pragmatism recognizes the importance of theory as a means of explaining and predicting phenomena, while subjecting it to the test of practice and time in order to determine its usefulness or value.

Informed by these different research philosophies, this study adopted interpretivism. According to Tracy (2013), from an interpretive point of view, reality and knowledge are constructed and reproduced (involving participants) through communication, interaction, and practice. Of essence in interpretivism is understanding the subjective meanings of the participants under study within their context (Goldkuhl, 2012). Some of the assumptions of an interpretivist enquiry are as follows:

Table 5-2: Assumptions for an interpretive study (adapted from Klein and Myers (1999))

Interpretive Assumption	**Relevance**
Knowledge of reality is only gained through social constructions	Challenges experienced by individuals in RCEs with ICT use can only be understood through experiencing their social interactions.
Focuses on human sense-making as the situation emerges	Isolate the dimensions of digital literacy and UTAUT constructs as participants use ICT in their day-to-day activities.
Attempts to understand a phenomenon through the meanings that people assign to them	Focus on the challenges that individuals experience in their own views regarding the impact of RCE on ICT use.
Seeks to be influenced and to influence the research context	Immerse yourself in the participants' environment and experience their challenges first hand, and further overcome those challenges in tandem with them.

In line with the research onion, the next step identifies applicable research approaches.

5-4-2. Research approach

From the research onion, two research approaches are identified: deductive and inductive. The former approach is centred on scientific research with the results leading to law-like generalizations, while the latter involves understanding based on analysed data, leading to explanation of social phenomena (Saunders et al., 2016). Eisenhardt, Graebner, and Sonenshein (2016) point out that the inductive approach facilitates theory generation through data, rather than through the type of data.

The deductive research approach relates to theory and hypothesis development, with a research strategy designed to test that hypothesis. The inductive research approach on the other hand facilitates theory development as a result of data collection and analysis, and is appropriate for investigating social phenomena (Eisenhardt et al., 2016; Saunders et al., 2016). Further, in terms of research philosophies, the inductive approach is generally associated with interpretivism, while the deductive approach is associated with positivism (Saunders et al., 2016). The research then adopts the **inductive research approach**.

Following on the research onion, the next step identifies the research strategy.

5-4-3. Research strategy

Research strategies assist the researcher in answering research questions and meeting research objectives, guided by the adopted research philosophy and approach (Saunders et al., 2016). The research strategy adopted in this research is closely aligned with interpretivism and the inductive research approach. Some of the research strategies are as follows: narrative research, phenomenology, grounded theory, ethnography, experimental research, and case studies (Creswell, 2013). Table 5-3 describes these research strategies:

Table 5-3: Research strategies (adapted from Creswell (2013))

Research strategy	**Description**
Narrative research	The researcher studies the lives of participants based on narrations of the participants themselves or other participants. The researcher also narrates this information into a narrative chronology. The final outcome is the narration of the participants and those of the researcher, thus forming a collaborative narrative.
Phenomenology	The researcher describes the experiences of individuals about a phenomenon as described by participants.
Grounded	The researcher grounds a phenomenon based on the views of participants.

theory	
Ethnography	The researcher studies the shared attributes of participants in an intact cultural group in a natural setting over a prolonged period of time.
Experimental research	The researcher assesses a specific treatment towards an outcome by controlling it between participating groups and determining its impact on the outcome.
Case study	The researcher develops an in-depth analysis of a case that is based on the phenomenon understudy.

Based on these descriptions, the case study research strategy was adopted for this study. It facilitates an in-depth investigation of a phenomenon. Some of the key attributes of case studies relevant to the research are as follows:

- Facilitates the undertaking of an in-depth investigation of a phenomenon in a specific environment using a select group of informative participants (Harrison, Birks, Franklin, & Mills, 2017; Merriam, 1998; Yin, 2017);
- Allows for the exploration and understanding of complex phenomena with unclear boundaries (Kothari, 2004; Njie & Asimiran, 2014; Zainal, 2007); and
- Facilitates exploration of a phenomenon through multiple lenses to allow multiple forms of understanding and comprehension (Baxter & Jack, 2008).

These are some of the attributes that motivated the research to adopt case studies as an appropriate strategy for investigating the phenomenon of digital literacy attainment and enhancement through technology adoption to facilitate ICT use for individuals in RCEs. Based on the use of human participants in the study, sampling considerations were necessary; these are outlined in Section 5.4.6.1. The next section provides an in-depth treatment of the case study research strategy and its implications for the research.

5-4-3-1 The case study research strategy

The case study strategy is recommended in a scenario where there is a desire to understand a complex social phenomenon (Miles, Huberman, & Saldana, 2013; Stake, 1978; Yin, 2017). Yin (2017) proposes that five key components need to be included in the research designs that adopt a case study method, namely, study questions and possible propositions, units of analysis, the logic linking of data to propositions, and the criteria for interpreting findings. These are expanded on in Table 5-4:

Table 5-4: Components of research design for case studies – Adapted from Yin (2017)

Component	Relevance
Study question(s)	*(SRQ1) What are the elements of digital literacy that are relevant to technology use?* *(SRQ2) What are the elements of technology adoption that influence the attainment of digital literacy?* *(SRQ3) What constraints does an RCE present for the attainment of digital literacy through technology adoption?*
Study propositions (optional[1])	• Technology adoption facilitates ICT use (Attuquayefio & Addo, 2014; Marnewick, 2014; Renaud & Van Biljon, 2008). • ICT adoption is a prerequisite for the attainment of digital literacy. • Digital literacy facilitates the use of ICT. • Rural areas pose challenges to technology adoption, digital literacy, and ICT use (Anderson et al., 2012b; Sithole et al., 2013).
Units of analysis	• **Main** – Technology adoption • **Embedded** – Digital literacy and RCEs
The logic linking the data to the propositions	The availability of mobile devices and appropriate training will facilitate technology adoption and the attainment of digital literacy. Digital literacy has the potential to foster ICT use by individuals in day-to-day activities, including use by individuals in RCEs.
The criteria for interpreting the findings	Findings are interpreted based on the characteristics of the developed model, which embodies the dimensions of digital literacy, the constructs of UTAUT, and the research context of RCEs.

[1]***Optional, since they are mandatory if they are available; otherwise they may be excluded.***

Yin (2017) noted the significance of these components in facilitating the process of answering research questions. These components guided the case study analysis in presenting the findings towards addressing the main research question and the associated sub-research questions.

Having highlighted the significance of the case study, the study continued by exploring the different categories of case studies. According to Yin (2017) and Saunders et al. (2016), case studies can be distinguished based on whether they are single or multiple case studies and whether they are holistic or embedded. The study employed a ***single case study*** that is

embedded in nature, which supported the longitudinal nature of the research (Yin, 2017). The study needed to develop an understanding of the participants' level of digital literacy throughout the different phases of the project, before and after the ICT training that was undertaken; this was supported by an embedded single case study. As outlined in Table 5-4, the main unit of analysis is technology adoption, and the embedded units of analysis are digital literacy and RCEs.

According to Harrison et al. (2017), case studies have fundamental elements that delineate them from other forms of research and inform critical aspects of research design and research methodology. A listing of the case study elements is as follows: the case, a bounded system, studied in context; in-depth study; case selection; multiple sources of evidence; and the case study design (Harrison et al., 2017). These elements will be expanded on in Subsection 5.4.6.2, subsequent to the discussion of sampling considerations, which addresses participant and location considerations.

5-4-4. Research choice

Research choices present options that a researcher can adopt for collecting field data, and for reporting on that data (Saunders et al., 2016). They guide the researcher on the type of data that will result from the data collection process, that is, numeric or non-numeric data or a combination thereof, and how these data can be analysed. The next subsection presents the different categories of research choices.

5-4-4-1 Categories

From the research onion, Saunders et al. (2016) presents the following research choices: mono, mixed, and multi-methods. The mono methods use a single data collection technique and analysis procedure, while mixed and multi-methods use multiple data collection techniques and analysis procedures (Saunders et al., 2016). A data collection technique may be quantitative or qualitative. Quantitative techniques generate or use numeric data, while qualitative techniques generate or use non-numeric data (Saunders et al., 2016).

According to Kothari (2004), ***quantitative techniques*** involve the generation of data in quantitative form that can be subjected to rigorous quantitative analysis in a formal and rigid fashion (these can be further classified into inferential, experimental, and simulation approaches to research). ***Qualitative techniques*** on the other hand are concerned with the subjective assessment of attitudes, opinions, and behaviour where the researcher's insights

and impressions are significant (Kothari, 2004). The multi and mixed methods are generally a combination of qualitative and quantitative techniques.

The study adopts a mixed method research choice only for the data collection. The motivation for adopting this research choice is presented next.

5-4-4-2 Motivation for a research choice

The rationale for adopting the mixed method research choice during data collection stems from the fact that neither the quantitative nor the qualitative approaches were sufficient by themselves to capture the enhancement of digital literacy through technology adoption in RCEs (Creswell, Klassen, Plano Clark, & Smith, 2011; Ivankova & Stick, 2007). Despite the mixed method research choice inherently generating numerous data, it has advantages – one which stems from the fact that qualitative and quantitative research methods have limitations, while mixed methods may neutralise the shortcomings of each research method (Creswell, Clark, Gutmann, & Hanson, 2010).

According to Creswell et al. (2010) there are six major designs of mixed method research choices based on four criteria, namely, sequential explanatory, sequential exploratory, sequential transformative, concurrent triangulation, concurrent nested, and concurrent transformative. The criteria for these choices are as follows: implementation, priority, integration, and theoretical perspective (Creswell et al., 2010). This study adopts an implementation of sequential quantitative first, followed by qualitative. The reason is that the findings of the quantitative research informed the qualitative enquiry. The priority was on the qualitative as the major aspect of the analysis process, that was informed by the initial quantitative findings. Integration took place at the interpretation stage subsequent to the data collection and analysis processes (Creswell et al., 2010). The theoretical perspective was informed by the literature reviews undertaken in Chapters 2, 3, and 4 on the key concepts of the research, that is, digital literacy and technology adoption in the context of RCEs.

The research used a pilot study to investigate the feasibility of the research and information richness of the participants and research context. A quantitative research instrument was used in the pilot for the feasibility investigation, and the associated results were used to undertake a qualitative inquiry to gain more insight into digital literacy levels and ICT use by participants in RCEs. Creswell (2007) noted that the appropriate design explaining this research approach is an explanatory mixed method design. Figure 5-4 illustrates:

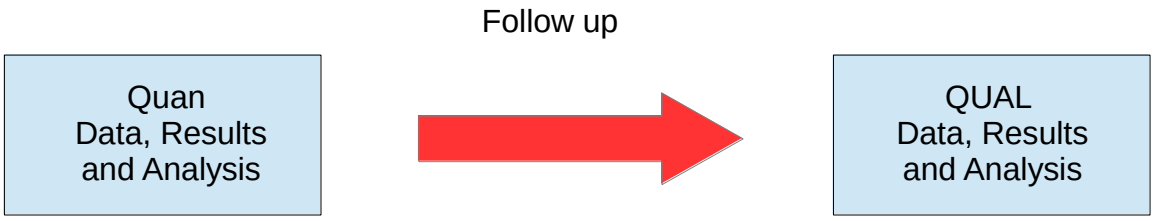


Figure 5-4: Explanatory mixed method design used in the research (Creswell (2007))

Figure 5-4 indicates that the quantitative inquiry was undertaken first, followed by the qualitative inquiry. The quantitative inquiry served as pilot, and informed the qualitative inquiry entailing the observations and interviews that represent the main research.

Informed by the six major mixed method designs, this research adopts the sequential explanatory design. The priority is on the qualitative rather than the quantitative research, with integration taking place at the interpretation phase. For the adopted mixed method, the steps of the research are as outlined in Table 5-5:

Table 5-5: The sequential explanatory mixed method design

Phase	**Research stage**
Quantitative data collection and analysis	Pilot study
Qualitative data collection and analysis	Main research
Interpretation	Pilot study findings + main research findings

Figure 5-6 illustrates the application of the sequential explanatory mixed method design in the research:

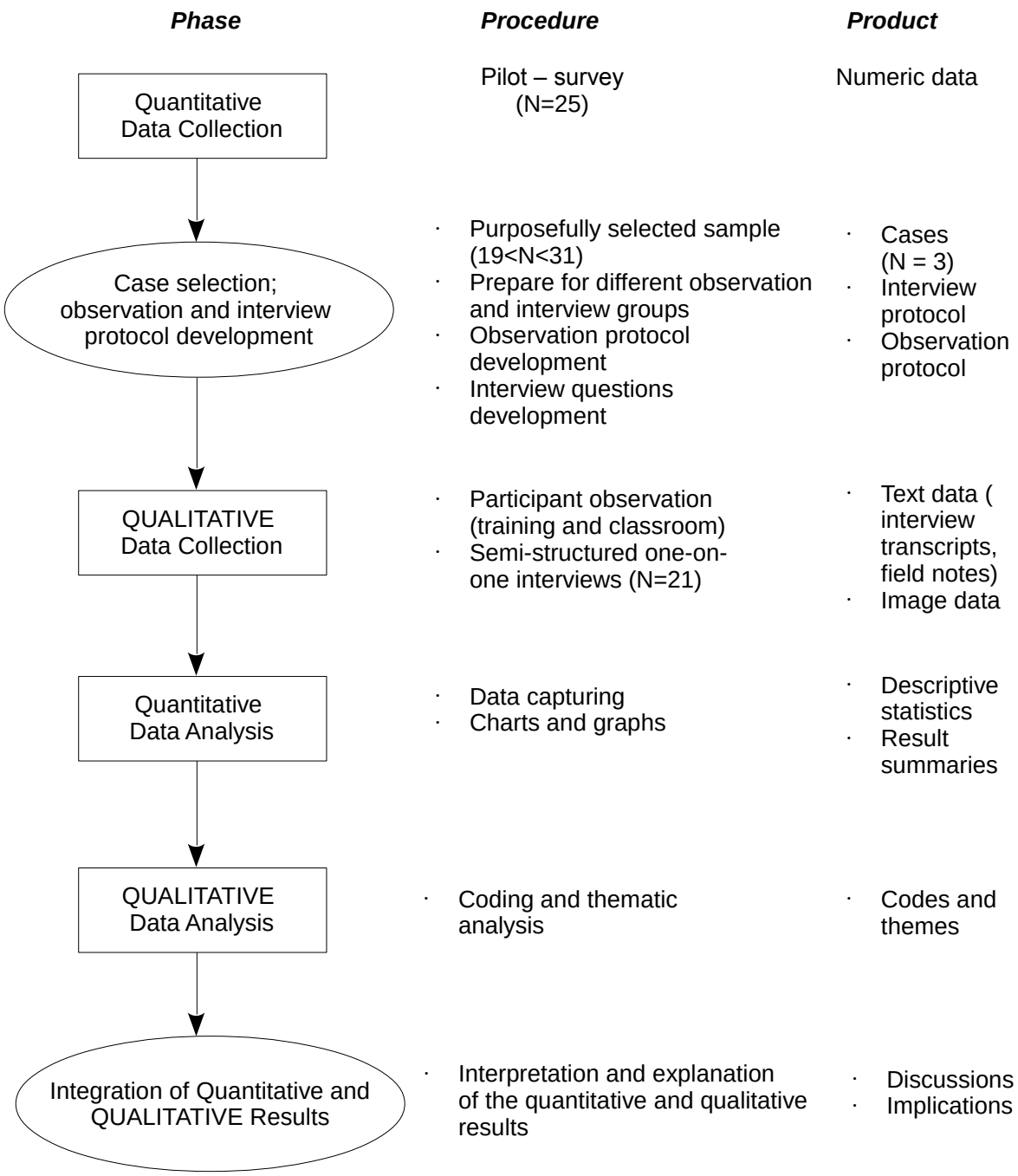


Figure 5-5: Visual model for sequential explanatory mixed method design (Ivankova and Stick (2007))

From Figure 5-5, priority is given to the qualitative research approach and not the quantitative approach. The clear separation of stages in this design facilitates clarity in implementation and reporting. Having adopted the research choice for the study, the next section outlines the time horizons.

5-4-5. Time horizons

Saunders et al. (2016) distinguish between longitudinal and cross-sectional studies, where the former collects data over time, potentially reconciling or comparing earlier captured data with the later captured data, while the latter is more interested in instantaneous data capture. The current study adopted the longitudinal study approach, as it facilitates the deployment of a pilot study first, followed at a later stage by the main field study.

5-4-6. Techniques and procedures

According to Yin (2017), the most commonly used data collection tools are documentation, archival records, interviews, direct observation, participant observation, and physical artefacts. From this list of instruments, the following data collection tools were adopted for the case study: ***documentation, semi-structured one-on-one interviews***, ***participant observation***, and ***surveys using questionnaires***.

The significance as well as the motivation for adopting these instruments are outlined in Table 5-6:

Table 5-6: Data collection tools used in the case study and their relevance to the research

Data collection tool (instrument)	**Relevance to the current research**	**Type of data collected**
Documentation[1]	• Documentation served as an additional source of information for the research. • Documentation provided the preliminary information for the Information and Communications Technology for Education (ICT4E) project. This, in turn, informed the research on the location and participants to use for the case study.	Qualitative and Quantitative
Surveys using questionnaires	• The survey was used in the research as a pilot for investigating the feasibility and information richness of the location and of the participants selected for the purposes of the research. • The survey facilitated inductive enquiry in alignment with qualitative approaches (Gill & Johnson, 2010). • Combinations of open-ended and closed questions were used. The closed questions were used to minimize item non-	Quantitative

	response and to get direct information with minimalistic pressure from the participants, while the open-ended questions were used to facilitate the qualitative enquiry and get more insight into participants' responses and further avoid bias associated with suggestions (Leung, 2001; Reja, Manfreda, Hlebec, & Vehovar, 2003). However, participants responded mainly to the closed questions, and the survey was adapted into a quantitative instrument. The small sample size required the use of non-probabilistic techniques.	
Participant observation	• The significance of participant observations is based on the fact that participant observation facilitates the gathering of data in naturally occurring social situations and potentially day-to-day activities (Cohen, Manion, & Morrison, 2007; Flick, 2009). For this research, it involved ICT use in RCEs. • Participant observation facilitates the comprehension of ill-defined behaviour and context-specific information (Merriam & Tisdell, 2015). • Saunders et al. (2016) distinguish between participation observation, which is aligned with the qualitative research approach and structured observation, which is more aligned with the quantitative research approach.	Qualitative
Semi-structured one-one-one interviews	• Semi-structured interviews facilitated open-ended questions, theory-driven or hypothesis-driven questions, and confrontational questions (Flick, 2009). The semi-structured interview process employed the interview protocol that is outlined in Appendix C. • Participants were interviewed to reflect their level of digital literacy based on their use of ICT, as facilitated by technology adoption.	Qualitative

[1] *see Table 1-1*

Table 5-6 outlines the type as well as the relevance of the data collected in the research. Despite the fact that review of documentation did not facilitate any data capture, its significance was in providing additional information for the data collection process.

The data collection process was facilitated by the ICT4E project as discussed by Maremi, Legare, and Phiri (2016). Yin (2017) notes the potential bias inherent in document reviews. However, its impact was minimised by using it as an additional source of information for the

field work only. Some key points of the ICT4E project, as provided by Maremi et al. (2016, pp. 4-5), are provided below:

> *The ICT4E project is an initiative by the Department of Rural Development and Land Reform (DRDLR), South Africa. The aim of the DRDLR ICT for Education (ICT4E) project is to improve the quality of teaching and learning in a rural context through the introduction of proven technologies, frameworks and approaches that have been tested in a rural South African context, creating an enhanced teaching and learning process. The scope of the DRDLR ICT4E Project is to: Carry out a Pre-implementation ICT Audit of the 24 schools; Procurement and deployment of ICT Infrastructure to the schools; Design, development and delivery of accredited training to NARYSEC youth to become facilitators and to the teachers at the selected schools. All training was outsourced to the University of the Free State (UFS) for both teachers and the National Rural Youth Service Corps (NARYSEC) youth. CSIR, Meraka have to ensure that there is progress, identify risks and provide proof of impact (through monitoring and evaluation, operationalization and project management)*

From this excerpt it is noted that the major stakeholders of the ICT4E project were the Department of Rural Development and Land Reform (DRDLR), The Council for Scientific and Industrial Research (CSIR), and the University of the Free State (UFS). These stakeholders were consulted directly or indirectly for access to the ICT4E project. Other stakeholders were the management and teachers of the participating schools. The teachers oversaw and supervised any potential interaction between the researchers and the learners. Since the learners were not direct participants in the research, it is noted that no direct interaction was necessary between the learners and the researcher, and no formal interaction took place.

Having outlined the role of document reviews in the data collection process, the role of the other data collection instruments will be briefly outlined, based on Table 5-6.

The surveys formed a pilot that captured the preliminary data of the research. Although the instrument was initially set out to capture qualitative responses from the participants, the participants did not furnish the details required, and the captured data were relegated to quantitative data. The remaining two instruments managed to capture qualitative data, as was

required. The deviation from the type of data did not hinder the research, since case studies offer flexibility and versatility, and facilitate the capture of both quantitative and qualitative data (Flyvbjerg, 2006; Harrison et al., 2017).

Having outlined the data collection tools used in the case study research, the research will present sampling considerations that provided information about more in-depth attributes of the research participants.

5-4-6-1 Sampling considerations

The key sampling consideration is appropriate sampling across the numerous participants and locations that were available for the study through the ICT4E project. Sampling considerations for the data collection process are discussed in three subsections. First, the significance of sampling is outlined in Subsection 5.4.6.1.1. This is followed in Subsection 5.4.6.1.2 by the sampling techniques and strategies adopted in the research. Finally, Subsection 5.4.6.1.3 discusses suitable participants to include in the research.

5-4-6-1-1 The significance of sampling

According to Kothari (2004), the complete number of items in a field of inquiry constitute a population, and a complete enumeration of all items in a population is known as a census inquiry. In the research, the ***population*** under study constitutes all individuals who use ICT in their day-to-day activities in RCEs. The general notion may be to use the entire population for data collection to achieve the best results. However, challenges are noted in literature with attempting to use a census inquiry for getting results.

According to Cohen et al. (2007), factors such as expense, time, and accessibility frequently prevent researchers from undertaking a census inquiry. Saunders et al. (2016) cautioned that a researcher should not assume that a census inquiry provides more useful results than collecting data from a sample that is representative of the population under study. The significance of choosing a portion of the population rather than the entire population was further noted by Marshall (1996), who pointed out that it is important\ for a research project to select a sample, since studying the whole population was rarely practical, efficient, or even ethical. Some of the members of the population may be part of a vulnerable group, which may elicit ethical implications (Bracken-Roche, Bell, Macdonald, & Racine, 2017).

A study may opt to select a part of the population for its purposes, based on set criteria. According to Cohen et al. (2007), a representative subset of a population is referred to as a

sample. Representativeness implies that the knowledge obtained from the sample is indicative of the knowledge that would otherwise have been obtained from the total population.

5-4-6-1-2 Sampling techniques and strategies

Having highlighted the significance of employing a sample in the research process, the research required a sampling strategy that appealed to the research data collection process. For the quantitative pilot research, no particular sampling strategies were used except for a fixed number of twenty-five participants. This was due to the fact that no generalizable sample was sought, as inference was deemed unnecessary (Ibe, 2014; Rosenthal, 2016).

The qualitative methods used sampling techniques and strategies. It is noted that sampling strategies geared for quantitative research methods, despite being well defined, rigorous, and providing the best opportunity for generalization, are not the most effective way of developing an understanding of complex issues related to human behaviour (Marshall, 1996). For the purposes of the qualitative research approach, as adopted as part of the mixed methods, the focus of the sample needed to be reliant on quality rather than quantity, and exploration or description rather than generalization (Salkind, 2012; Saunders et al., 2016). Consequently, ***inference*** in the qualitative data analysis phase became insignificant and ***non-probabilistic*** sampling became the technique of choice (Ritchie, Lewis, Nicholls, & Ormston, 2013; Saunders et al., 2016).

The non-probability sampling technique was adopted due to its emphasis on the deliberate selection of sampling units that reflected specific features of interest within the sampled population (Saunders et al., 2016; Yin, 2015). Of the non-probabilistic sampling techniques, purposeful sampling was adopted due to its facilitation of the selection of the most useful sample to support the research (Marshall, 1996; Salkind, 2012; Yin, 2015). The selection of purposeful sampling was further motivated by Palinkas et al. (2015), who pointed out that purposeful sampling is used in qualitative research to identify and select information-rich cases related to the phenomenon of interest.

5-4-6-1-3 Participants used in the sample

Having outlined the sampling techniques and strategies adopted in the research, the participants in the data collection process are presented. Teachers were selected as participants based on their availability and involvement in the ICT4E project. The project

investigated the use of ICT by teachers with their learners. In line with the requirements of non-probabilistic sampling (Ritchie et al., 2013), participants needed to be knowledgeable on the use of ICT to facilitate the investigation of technology adoption. The latter was used in the research as an agent for facilitating the investigation of digital literacy attainment and enhancement among the participants.

A key sampling consideration in the case study research strategy was that the selected sample satisfied the core attributes of the research, that is, digital literacy and technology adoption, and that the sample was located in an area that conformed with the criteria of RCEs. These attributes will be extended during the discussion of the data collection process in Section 5.5.

5-4-6-2 Case study elements

Having discussed the sampling considerations of the research, the case study elements from Subsection 5.4.3.1 can be discussed. Particularly, the relevance of these elements to the case study are highlighted:

Table 5-7: Case study elements (adapted from Harrison et al. (2017))

Element	**Relevance to the current study**
The case	The state and impact of technology availability and training to digital literacy attainment through technology adoption in schools located in RCEs.
A bounded system	• Context – RCEs. Non-voice-related activities that individuals undertake on mobile devices can also form part of the context. • Learning and teaching involving ICT in RCEs.
Studied in context	The context is RCEs, which are typically characterised by a scarcity of material issues and societal conditions. The impact of material and societal scarcity on learning and teaching ICT.
In-depth study	• The teacher was the object for intensive enquiry. Teachers were participants in investigating the technology adoption and digital literacy attainment and their impact on ICT use. • Researcher subjectively interpreted the digital literacy levels of teachers based on their interaction among themselves through collaboration, during training with facilitators, and with the learners. • The following data capturing tools were employed in querying participants: surveys, participant observations, and semi-structured one-on-one interviews. • Interpretation was used to assess the participants' levels of ICT use. Interviews

	provided in-depth enquiry, while observations provided a high-level perspective.
Selecting the case	• The case entailed the adoption of a teacher as a participant. Activities involving training, pedagogy, and socio-economic participation were investigated. • The scope was a single case. • The focus was on capturing ICT use by participants. The cycle of training, work, and personal use of ICT formed a unique scenario, as it allowed the participants and the researcher an opportunity to reflect on digital literacy levels and any technology adoption challenges and opportunities that impacted on the use of ICT.
Multiple sources of evidence	Surveys, participant observations, and semi-structured one-on-one interviews were the multiple sources of evidence employed in the case study. These facilitated triangulation (Benbasat, Goldstein, & Mead, 1987), and contributed to the evaluation and validation processes.
Case study design	• The surveys were exploratory as they facilitated the investigation of participants' digital literacy levels prior to undertaking the training facilitated by the ICT4E project. • The observations and interviews were explanatory as they described participants' digital literacy levels as well as technology adoption challenges and opportunities. The ideal scenario where the ICT4E project was a success and its objectives met was also noted.

The case study elements outlined in Table 5-7 concluded the adoption of the case study research strategy and paved the way for the data collection process.

5-5. Data collection process

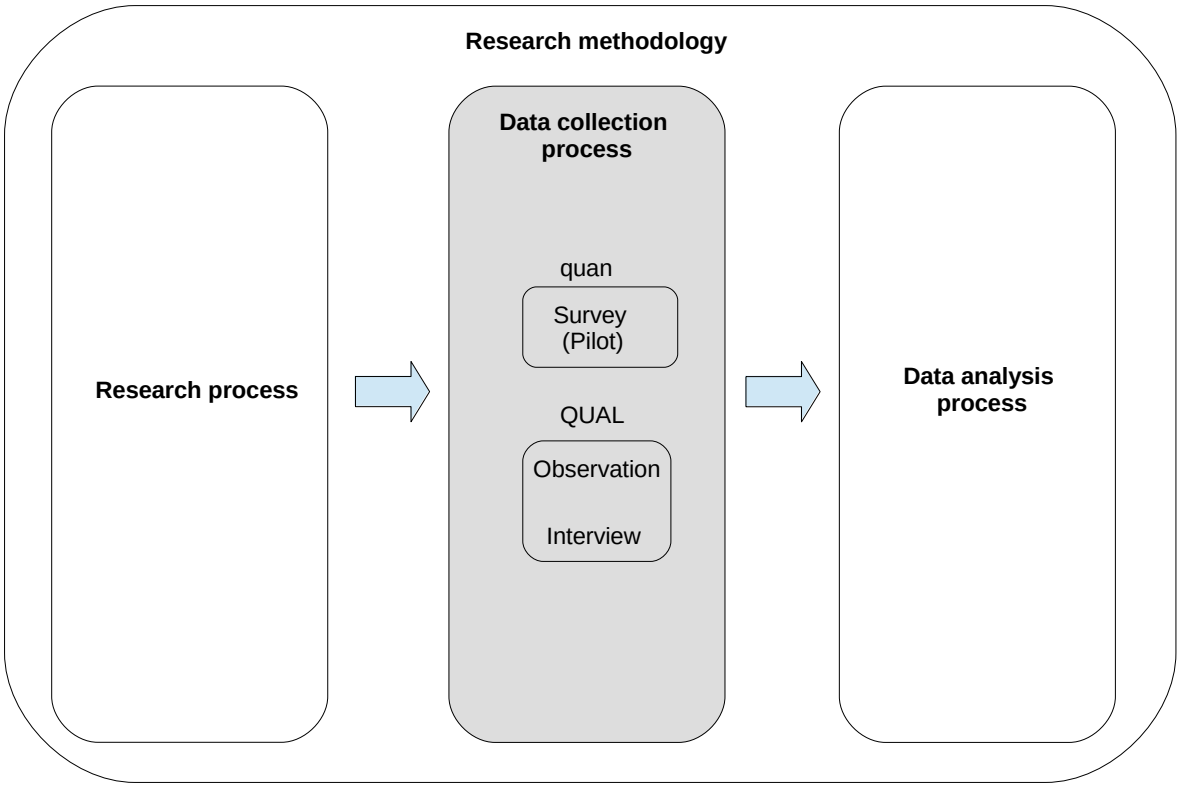


Figure 5-6: The data collection process

Figure 5-6 outlines the data collection process undertaken in the study. The data collection process facilitates the capturing of field data used for investigating the theoretical assumptions that were made in constructing the conceptual model. According to Langenhoven (2016), data collection describes ways in which the research findings are gathered. Given (2008) notes that these findings are derived from the collected data. An overview of the data collection process, data collection tools, and participants (as motivated by Langenhoven (2016)) is presented in Table 5-8:

Table 5-8: Data collection overview (adapted from Langenhoven (2016))

Data collection strategy		**Number of participants**	**Site and dates**	**Duration**	**Research Instrument**	**Role of the researcher**
Survey		25	-	-	Questionnaire	Survey administrator
Participant observation	Teacher training	Two sessions with between 20	Primary School P_1 (26 & 27	2 x 3 hour sessions	Anecdotal records and field notes*	Passive observer

		and 30 participants	Feb 2018)		Smartphone for taking pictures	
	Classroom observation	Two of the three schools with 6 observation sessions in Primary School P_1 and 5 sessions in Secondary School S_1. A total of 11 sessions with 11 teachers were observed	Primary School P_1 and Secondary School S_1 on the 27th Feb 2018 for both schools. No classroom observation was undertaken at Primary School P_2, as the school was not prepared for the process.	11 x 15 minutes		
Semi-structured one-on-one interviews		21	Primary School P_1 (28 Feb 2018) – 6 participants Secondary School S_1 (28 Feb 2018) – 10 participants Primary School P_2 (01 March 2018) – 5 participants	Each session was between 7 and 15 minutes in duration, but the actual interview duration was between 5.5 minutes and 11 minutes	Smartphone for recording interview	*Interviewer and recording taker

It was of essence to define the following for the data collection process: the data collection strategies, the number of participants determining the sample size, sites used, and the dates in which these sites were accessed, the duration of the data collection process, the research

instrument employed, and the role the researcher undertook in a particular data collection process.

The data collection process was motivated by the following five steps of a data collection process, as motivated by Creswell (2012):

1. The researcher needs to identify the participants and sites;
2. The researcher needs to gain access to participants and sites;
3. The researcher needs to identify the types of data to collect;
4. The researcher needs to develop data collection forms; and
5. The researcher needs to administer the process in an ethical manner.

These steps formed a cornerstone for the data collection process. As pointed out, the research opted for a case study strategy for the data collection, as motivated in Subsection 5.4.3. The application of the five steps of the data collection process is outlined from Subsections 5.5.1 to 5.5.4, and also in Subsection 5.7. During the data collection process, care was taken to focus on collecting data that are relevant to the study, as this practise is generally aligned with good ethical research practices (Creswell, 2013).

5-5-1. Site and participant identification

Having been granted access to the sites used by the ICT4E project, the researcher identified a cluster in the Limpopo Province as convenient and having the attributes of a RCE, which is the context of the research. The cluster is in a rural environment, which potentially had scarcity in a number of resources, with roads and running water being the most evident ones.

Cluster 10 was selected; it contains the following schools: Primary School P_1, Primary School P_2, and Mohlapetsi Secondary School. The schools are located in the Capricorn district, Polokwane municipality, Perskebult town (also known as Mmotong wa Perekisi) under the Seshego Circuit in the Limpopo Province of South Africa (Maremi et al., 2016). The series of maps below shows the location of the cluster:

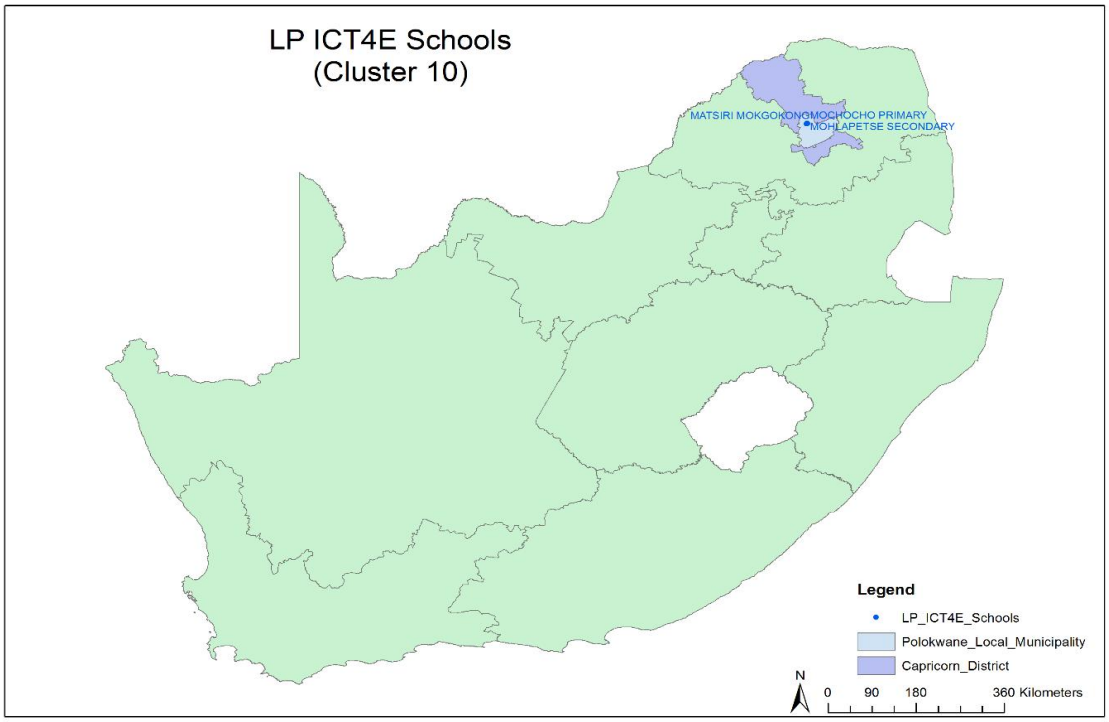


Figure 5-7: The location of Cluster 10 in South Africa (Maremi et al., 2016)

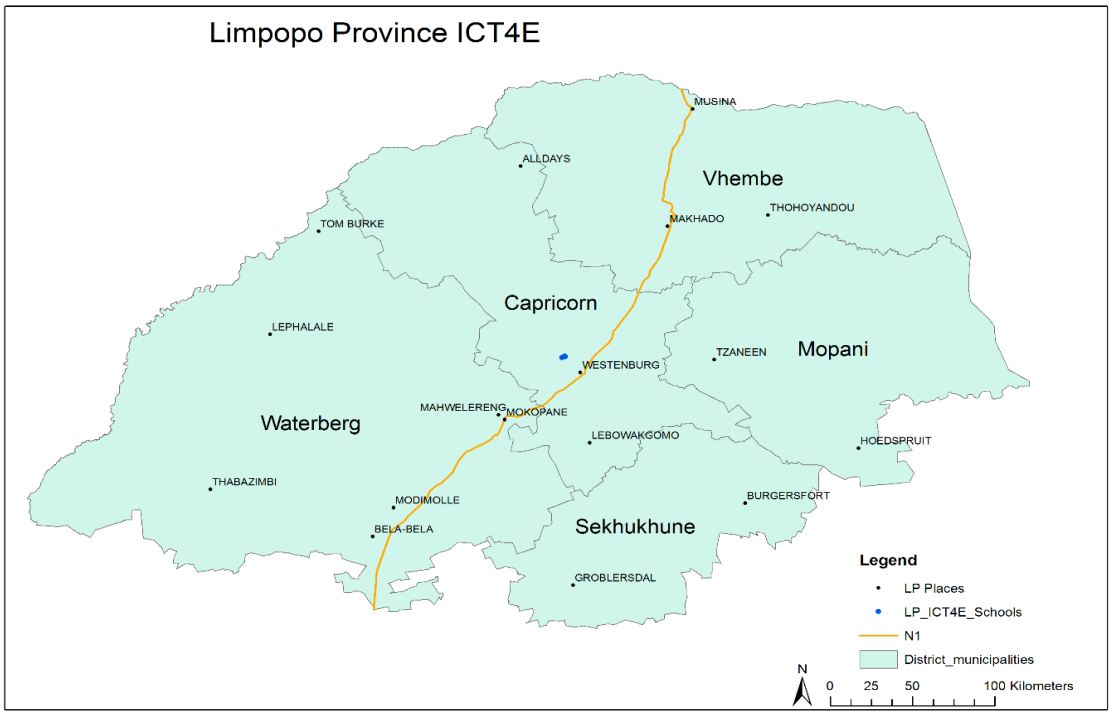


Figure 5-8: The Limpopo province, Capricorn district which participated in the ICT4E project (Maremi et al., 2016)

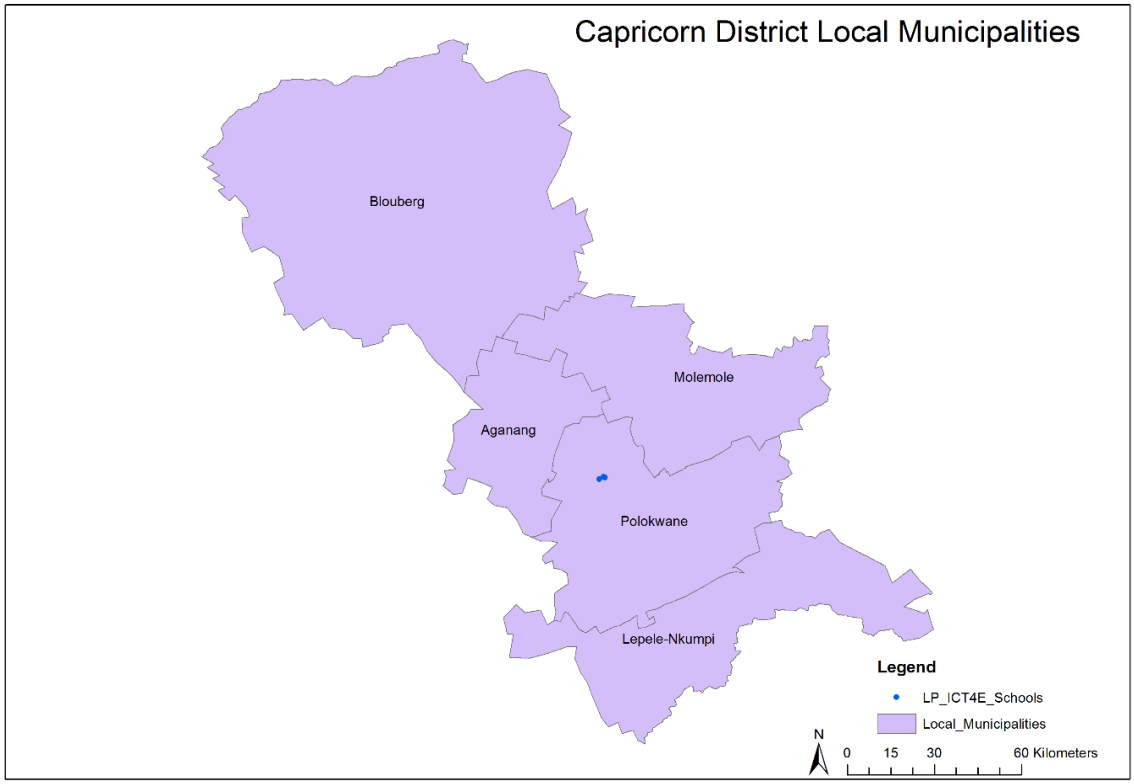


Figure 5-9: The municipalities of the Capricorn district including the Polokwane municipality which contained the three schools used in the research (Maremi et al., 2016)

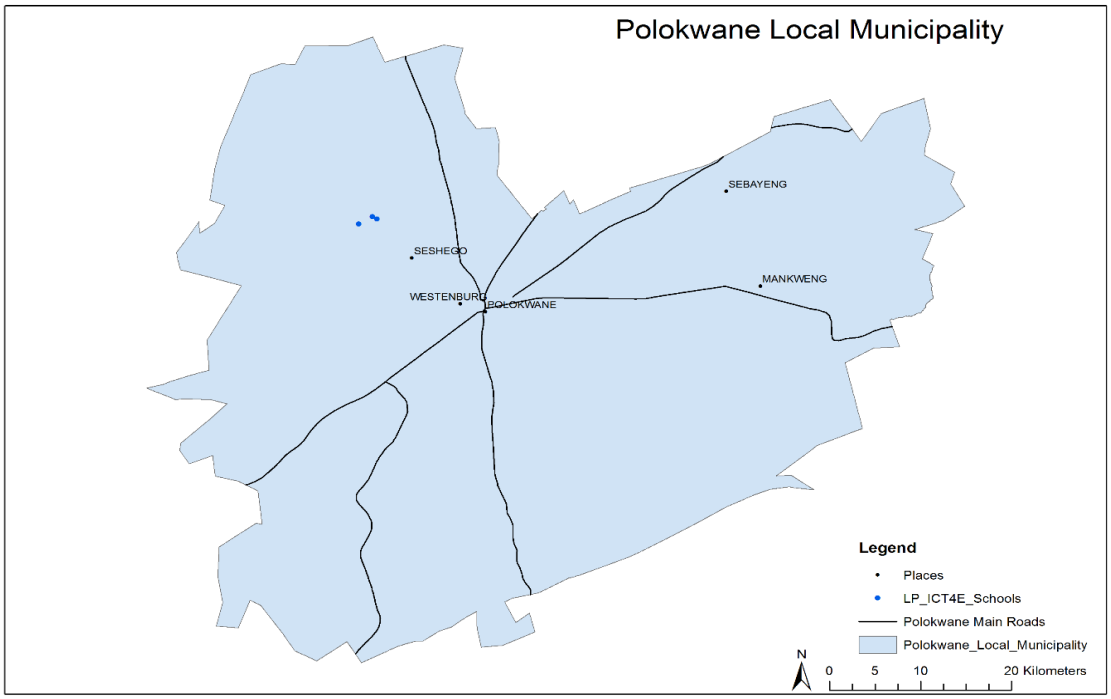


Figure 5-2 The Polokwane Local Municipality showing the 3 schools selected for the ICT4E project and the current research (Maremi et al., 2016)

The teachers involved in the ICT4E project were identified as research participants. These teachers were selected by the principals of the respective schools to take part in the project. As was motivated in Subsection 5.4.6.1.2, the sampling technique of purposeful sampling was adopted to identify and select participants with the most value for the research process. According to Morse (1991), participants selected through purposeful sampling need to be knowledgeable about concepts associated with the research, and also be willing and available to participate in the research.

The teachers sampled for the research were purposefully selected based on the following attributes: accessibility, convenience, availability, and the fact that they were not part of vulnerable groups (Bracken-Roche et al., 2017), were in the age of majority (see Table 1-1) and no longer minors, and were further willing to participate in the study. Other attributes that motivated the selection of teachers were as follows: professionalism and potential agents of development in communities and society. The involvement of these teachers in the ICT4E project implied that they were actively involved in technology adoption and potentially improving and enhancing their digital literacy. Based on their demographic information and educational background, most of these teachers had adequate teaching experience but limited digital literacy. As part of the project, the teachers were required to undergo training involving ICT, thus improving their digital literacy. The ICT4E project involved the introduction of tablets to the pedagogy of learners in rural areas (Maremi et al., 2016). The teachers further required training in order to be familiar with the best practises of technology use, particularly towards their learners and in collaboration with fellow teachers – core attributes to digital literacy.

As reiterated by Ritchie et al. (2013), the sampling units in purposeful sampling contain attributes of interest to the researcher, which can facilitate the detailed exploration of central themes to the research. Consequently, the site and participants identified in the research project were ideal candidates and had the sufficient and necessary attributes for selection.

5-5-2. Access to sites and participants

Access to the site was facilitated by funding from the CSIR. Time, transportation, and accommodation in Limpopo for the researcher were supported through this fund. The request by the researcher to be part of the ICT4E project provided access to potential research participants. This request was made to the CSIR and facilitators from the UFS. No direct request for permission was made to DRDLR, and this was done indirectly through the CSIR.

The requests were granted successfully. Further permissions were necessary for completing the field work (see Section 5.7).

The teachers who were to be observed and interviewed were requested in advance to participate in the research. The associated ethical considerations are outlined in Section 5.7. Further, the researcher explained the contents of all the forms in a combination of English and the local language before handing them to each of the potential participants. The local language spoken in the area is Sepedi, one of the official languages in South Africa.

5-5-3. The type of data to be collected

According to Creswell (2012), the type of data to be collected needs to represent the information that will best answer the research questions. In the case of the research, the collected data addressed concepts of technology adoption, digital literacy, and RCEs. The chosen site complied with criteria of being an RCE, and the rural area of Perskebult fits this profile.

The type of data to be collected was determined by the instruments adopted in the research. In Section 5.4.6, Table 5.6, the type of data as well as the research approach addressed for each data collection tool was outlined. The categorisation of the research instruments, based on their contribution to the research concepts and the collected data, is outlined in Table 5-9:

Table 5-9: Data collection tools based on contribution to research concepts and to model characteristics

Data collection tool	Data to be collected
Document review	Context information (location) – RCEs. High level information about the participants and location.
Survey using a questionnaire	Questionnaire responses based on the following themes: • Technology adoption (social influence, performance expectancy, effort expectancy, facilitating conditions); and • Digital literacy (technical, cognitive, socio-emotional dimensions).
Participant observation	Anecdotal records and field notes based on teacher training observation and class observations. These observations were centred on general attributes of technology adoption and digital literacy.
Semi-structured one-	Voice recordings for all the interviews. The following concepts were covered in

on-on interviews	the interviews: technology adoption (UTAUT), digital literacy, and RCEs.

From Table 5-9, it is evident that the data collection tools contributed to all the constructs of technology adoption and all the dimensions of digital literacy. This meant that these instruments facilitated the capturing of data that would facilitate investigation of the characteristics of the model for digital literacy through technology adoption in RCEs. This proved that data collection tools were relevant for collecting data that would be able to answer the sub-research questions as well as the main research question.

The researcher adopted a role of ***complete observer*** during all the participant observation sessions. This choice was motivated by Saunders et al. (2016) typology of participant observation researcher roles, where the researcher reveals his identity and observes the participant's activity. The participation observation information was categorised as follows: context information, learning environment, classroom management, teaching and learning material, teacher methodology, assessment, general information. The interview protocol addressed the following categories: demographic information, educational background, RCEs, digital literacy (technical, cognitive and socio-emotional dimensions), and UTAUT (performance expectancy, effort expectancy, social influence, facilitating conditions).

The data collected using these instruments was clearly in line with capturing information on the attributes related to the concepts of technology adoption, digital literacy, and RCEs – in line with investigating the characteristics of the developed model. The questionnaire-based survey instrument and the semi-structured one-on-one interviews directly captured the information, while participant observation and even the document reviews indirectly captured information that was essential to the research process.

5-5-4. The data collection forms

The data collection forms used in the research were as follows: open-ended questionnaire, which included the teacher baseline information for the ICT4E project (Appendix A), observational protocol, and interview protocol (Appendix C). All the questions in the open-ended questionnaire (see Appendix A) were designed by the researcher with the aim of capturing information related specifically to technology adoption and digital literacy. The research identified themes for the interviews, based on the theoretical grounding of the research and elicited through the literature reviews that guided the design of the interview

protocol. The different sections (which reflect the themes) and the purposes associated with these themes are shown in Table 5-10:

Table 5-10: Interview protocol sections and purposes

Section	***Purpose***
Salutations	Greetings were used to get the candidates to relax and be at ease
Demographic information	Information was used to assess the following: • Verifying the professional career of candidate; and • The maturity, experience, and gender of the candidate.
Educational background	Assessment of the competency credentials of the candidate.
Resource – constrained environment	
Running water	Information was used to determine the availability of each of these key resources in determining resource-constrained environments. The telecommunication infrastructure was further used to determine the support for ICT in the area available to the participant, of which the participant was aware.
Electricity	
Road infrastructure	
Telecommunication infrastructure	
Dimensions of digital literacy	
Technical, cognitive, and socio-emotional	Information was used to determine the level of familiarity of the candidate to technical, cognitive, and socio-emotional dimensions of digital literacy.
Attributes of UTAUT – Technology adoption	
Performance expectancy, effort expectancy, social influence, and facilitating conditions	The information was used to determine to what extent the candidates supported UTAUT through the support of key attributes of the technology adoption model.

From Table 5-10, resource-constrained environments, the dimensions of digital literacy, and the attributes of UTAUT were the key focus areas of the interview process as they contained the theoretical foundations as well as the context of the research. The other sections, namely, salutations, demographic information, and educational background, were less significant and received less in-depth analysis.

Finally, the observational protocol was designed as provided in Table 5-11:

Table 5-11: Participant Observation protocol

Classroom Observation Tool

Part A: Researcher and context information

Observation Date: _____/_____/__	
Name of School	
Duration	
Name of teacher observed	
Grade and class of learners (e.g., 5A)	
Learning area / Subject observed	
Topic addressed in class	
Number of learners in class	

	Are there any tablets used in class? (If yes, how many?)	**Notes**

Part B: Observation

Learning environment

Is the classroom organized in a way conducive to the type of lesson being presented? (group work, teacher-directed)	**Notes**
Can the classroom comfortably accommodate all the learners?	**Notes**
Are the science lab / computers / practical equipment available in class today? (Comment on the way in which it is used, if applicable)	
Are the teacher's tablet / mobikit / learner tablets / projector / headphones etc. available in class today? (Comment on way in which it is used, if applicable)	**Notes**
Is there anything outstandingly noteworthy about the learning environment? (either positive or negative)	**Comments**
Do you have recommendations for improvement?	**Notes / Comments**

Classroom management

Does the session start without any unnecessary delays?	**Notes**
Is the session free from any disruption / interruption?	**Notes**
Does the session continue for as long as it is intended?	**Notes**
Is the level of noise outside and inside the classroom conducive to learning?	**Notes**
Is the level of learner interaction conducive to learning?	**Notes**
Does the teacher maintain firm yet appropriate discipline in class?	**Notes**
Does the teacher encourage all learners to freely participate and share?	**Notes**

Please comment on anything outstandingly noteworthy about the classroom management (either positive or negative)	**Comments**
Was technology used in any way to improve classroom management? (If Yes, how?)	**Notes**
Do you have recommendations for improvement?	**Comments**

Teaching and learning material

Does the educator make use of appropriate instructional aids?	**Notes**
Are there enough learning materials for the learners?	**Comments**
Is ICT at all incorporated as teaching and learning material in the class? (If Yes, how?)	**Notes**
Do you see opportunities for the incorporation of technology that was not utilized? (If Yes, what was the missed opportunity?)	**Notes**
Is there anything outstandingly noteworthy about the use of Learning and Teaching Support Material (LTSM)? (either positive or negative)	**Comments**
Do you have recommendations for improvement?	**Notes/Comments**

Teacher's teaching methodology

Does the teacher pitch the lesson at the right level for all learners?	**Notes**
Is the pace appropriate to most learners – i.e., not frustrating to those who can't keep up or those who are bored?	**Notes**
Is there an appropriate mix of lecture, group work, and individual work in class?	**Notes**
Does the teacher include interaction with the learners (questions, etc.) to gauge their understanding?	**Notes**
Does the teacher use vivid examples and images to convey the learning material?	**Notes**
Does the teacher explain concepts until all learners understand / provide help where needed?	**Notes**
Does the teacher pay sufficient attention to vocabulary / definition issues?	**Notes**
Does the teacher make provision for learners at different levels?	**Notes**
Was technology used in any way to improve or detract from the teacher's teaching methodology?	**Notes**
What works really well?	**Notes**
Do you have recommendations for improvement?	**Notes/Comments**

Assessment

Is appropriate continuous assessment incorporated into the lesson?	**Notes**
Is assessment criteria given to learners when a task is introduced?	**Notes**
Is technology used in any way to improve or detract from the assessment in class?	**Notes**
What works really well?	**Notes**
Do you have recommendations for improvement?	**Notes**

General

Provide any comments about positive or negative aspects that you noticed in the class that you were not able to capture / explain elsewhere _____

The aim of the observation protocol was to capture key pedagogical aspects of a lesson, teacher training or classroom session, as well as the use of ICT during the observation sessions. This information contributed to technology adoption and, in turn, the evaluation of teacher digital literacy levels.

5-6. *Data analysis process*

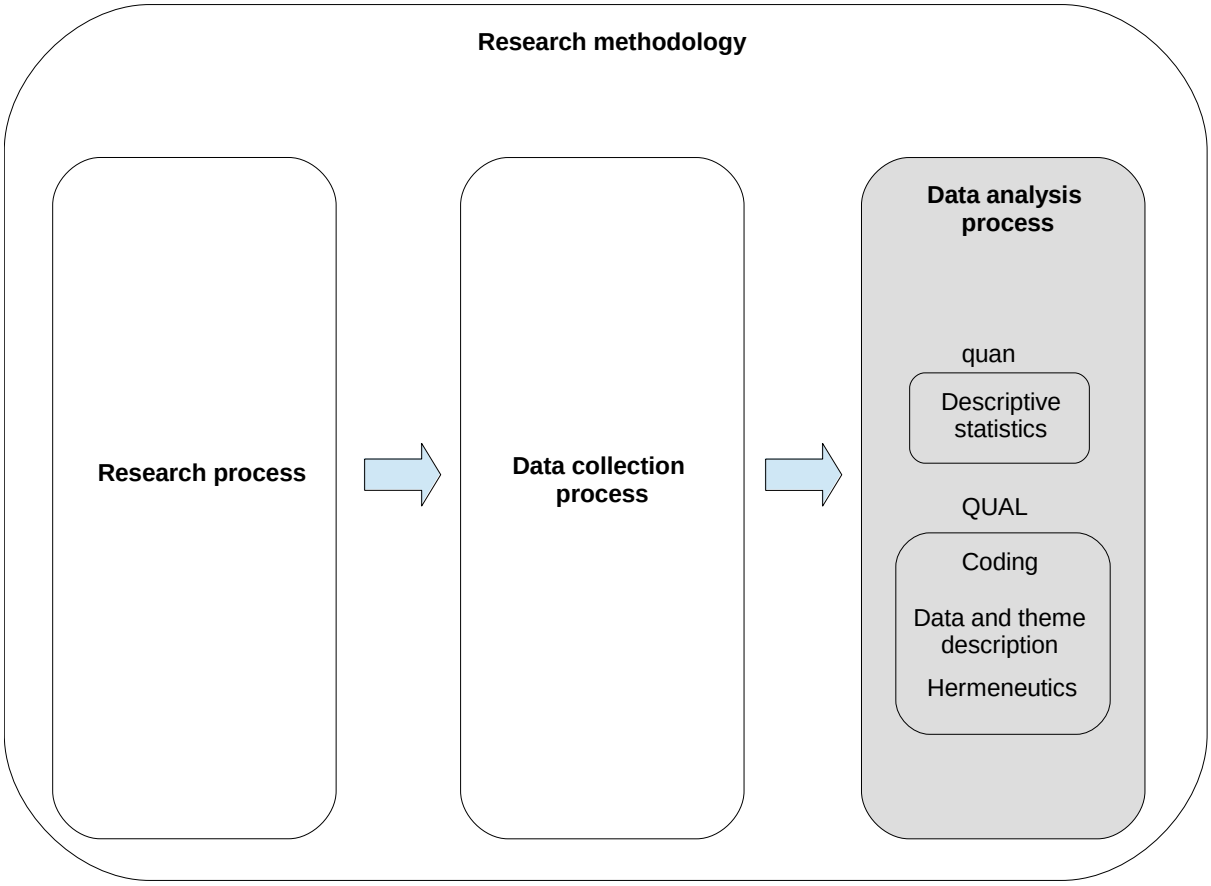


Figure 5-3: The data analysis process

The data analysis process was informed by the mixed method research choice. This meant that the research undertook quantitative and qualitative data analysis processes. As pointed out in Subsection 5.4.4.2, priority is on the qualitative rather than the quantitative data analysis, and integration took place at the interpretation phase.

5-6-1. Quantitative data analysis process

The quantitative data analysis process was undertaken using descriptive statistics. Descriptive statistics and distributions (of participant responses) are undertaken using averages and standard deviations (Salkind, 2016). According to Ibe (2014) and Salkind (2016), descriptive statistics deal with collecting, grouping, organizing, describing, and presenting data in a way that can be easily understood using measures of central tendency and measures of variability (Ibe, 2014; Salkind, 2012; Salkind, 2016). According to Salkind (2012), there are three types of measures of central tendency, namely, the mean, the median, and the mode; measures of variability include the range, standard deviation, variance, kurtosis, and skewness (Ibe, 2014; Salkind, 2016). For the calculation of measures of central tendency, the mode and the median

were irrelevant to this study, since the participant responses were not numeric; hence, only the mean was used. Further, only the standard deviation was used as measure of variability.

The survey results were mirrored against the dimensions of digital literacy and the constructs of the UTAUT. The mean and standard deviation were then calculated on these dimensions and constructs. Standard statistics formulas were used. Questions on RCEs were omitted, since the participants were from a rural area and RCEs were implied. Table 5-12 illustrates:

Table 5-12: Addressing research concepts based on research questions

Research concept	Dimensions/ Constructs	Total questions	Application of descriptive statistics
Digital literacy	Technical	7	✓
	Cognitive	2	✓
	Socio-emotional	2	✓
	-	1	✓
UTAUT	Performance expectancy	3	✓
	Continuance intention	3	✓
	Effort expectancy	3	✓
	Performance	2	✓
	Facilitating conditions	8	✓

5-6-2. Qualitative data analysis

The qualitative data analysis involved the process of linking data with theoretical concepts, as well as the actual qualitative data analysis process. The process of linking data with theoretical concepts explored analytic strategies that could align the results of the qualitative data collection process with theoretical concepts on digital literacy, UTAUT, and RCEs. Despite UTAUT being a quantitative model (Dwivedi et al., 2011), the study used in qualitatively in order to gain a richer evaluation of the associated constructs in the context of the study (Trimmer, Beachboard, Wiggins, & Woodhouse, 2008). The qualitative data analysis process adopted a framework that guided the process.

5-6-2-1 Linking data with theoretical concepts

The multiple data collection tools used facilitated the generation of textual and non-textual data, which required categorisation for analysis and interpretation. Of essence to conducting case study analysis was a general analytic strategy that facilitated the linking of data with theoretical concepts (Yin, 2017). The general analytic strategy of the research was motivated by Yin (2017), who provided three strategies for qualitative data analysis, namely, relying on theoretical propositions, rival explanations, and case descriptions. The research opted for the analytic strategy that relied on theoretical propositions, since the case study was used to evaluate and validate the conceptual model that was elicited through the theoretical underpinnings of technology adoption and digital literacy in the context of RCEs from literature.

However, Kelle (2013) notes that there are preconditions that need to be met before associating theory and empirical data. According to Kelle (2013), three questions need be addressed before the relationship between theory and data can be clarified, namely: what is a theory and what are its crucial elements; how are theories and empirical data related to each other; and what different functions can theories perform in qualitative data analysis. Table 5-13 illustrates:

Table 5-13: Preconditions of theory and their associated grounding

Precondition	Grounding
What is a theory and what are its crucial elements?	According to Grbich (2012), theory is abstract knowledge that is used to explain phenomena. This theory is derived from the exploration of phenomena using the associated concepts, where the interrelationships between these concepts facilitate the development of an exploratory framework for the empirical findings of the research (Grbich, 2012).
How are theories and empirical data related to each other?	A relationship (if any) needs to be established between the collected qualitative data and the theory associated with digital literacy and UTAUT in light of RCEs. First, the research collated a summary of the findings of the case study research strategy as employed in the qualitative research. This meant that the findings from the observation and interview data collection tools will be presented. These findings are presented in Section 6.7.
What different functions can theories perform in qualitative data analysis?	According to Bradley, Curry, and Devers (2007), data can facilitate the establishment of relationships between different concepts, which can further facilitate the generation of, and reporting on, theory. The coding in Subsection 5.2.2.1 illustrates the process as it is undertaken in the research.

5-6-2-2 Qualitative data analysis process

The qualitative data analysis process consists of the coding process and the data and theme description process. Qualitative data analysis was applied to the observation and interview instruments. This qualitative data analysis process was guided by a framework of the following six steps involved when analysing and interpreting qualitative data, as motivated by Creswell (2012): preparing and organising the data; exploring and coding the database; describing the findings and forming themes; representing and reporting findings; interpreting the meaning of findings; and validating the accuracy of findings. The framework was applied to the results of the qualitative data collection process based on the dimensions of digital literacy, applicable constructs of UTAUT, and attributes of RCEs. Table 5-14 illustrates:

Table 5-14: The six steps of qualitative data analysis (adapted from Creswell (2012))

Step	**Motivation**
Preparing and organising the data	Three types of data were collected for the research, as follows: • Images for the surroundings of the schools, the teacher training, and class observations; • Anecdotal records and field notes for the each of the two training sessions and for each of the eleven (11) class observations; and • Voice recordings for each of the twenty-one (21) interviews. The images were taken using a smartphone and were given a timestamp. This enabled categorisation with little effort, based on a particular school and a particular observation session. The field notes for the observations were labelled based on the particular observation that was undertaken. An observation protocol was later used to standardise them based on the type of observation being undertaken, that is, training observation or class observation. The voice recordings of the interviews were also given a timestamp and, where necessary, a label. These were later transcribed by the researcher based on the interview protocol. The researcher listened to the interviews several times to decipher them and accurately transcribe them for later processing. Once the transcription was completed, it was directly validated with the associated recording and updated where necessary. All the textual data were finally categorised into folders on a computer, based on the instrument used to collect it. The collected textual data were then read several times so that the researcher could re-familiarise with it. These were further categorised based on their source, that is, the school and session from which it was captured for the purpose of summarising them.

	Subsequently, notes that were taken informed the initial list of themes that was identified. Finally, the data were uploaded into the *QDA Miner lite* software tool for further analysis. The software was found cumbersome and non-intuitive. However, it played a vital role in eliminating duplicate codes and streamlining the themes.
Exploring and coding the database	The coding of the database was undertaken in Chapter 7, during the qualitative data analysis phase of the research. The database, which comprised the transcribed interviews and field notes for the observations, were less than 50 pages; this prompted a combination of hand and software analysis (Creswell, 2012).
Describing the findings and forming themes	The findings are described in Chapter 5; the themes were incepted from the coding process and presented in Chapter 6.
Representing and reporting findings	Chapter 6 represents and reports on the findings. The chapter presents the results for participant observations and for interviews.
Interpreting the meaning of findings	The interpretation of the meaning of findings, and alignment of the findings to the sub-research questions and the main research question, is undertaken in Chapter 6.
Validating the accuracy of findings	Validation of the accuracy of the findings is undertaken in the current chapter as part of the interpretation process.

The six-step process can be summarised as in Figure 5-13:

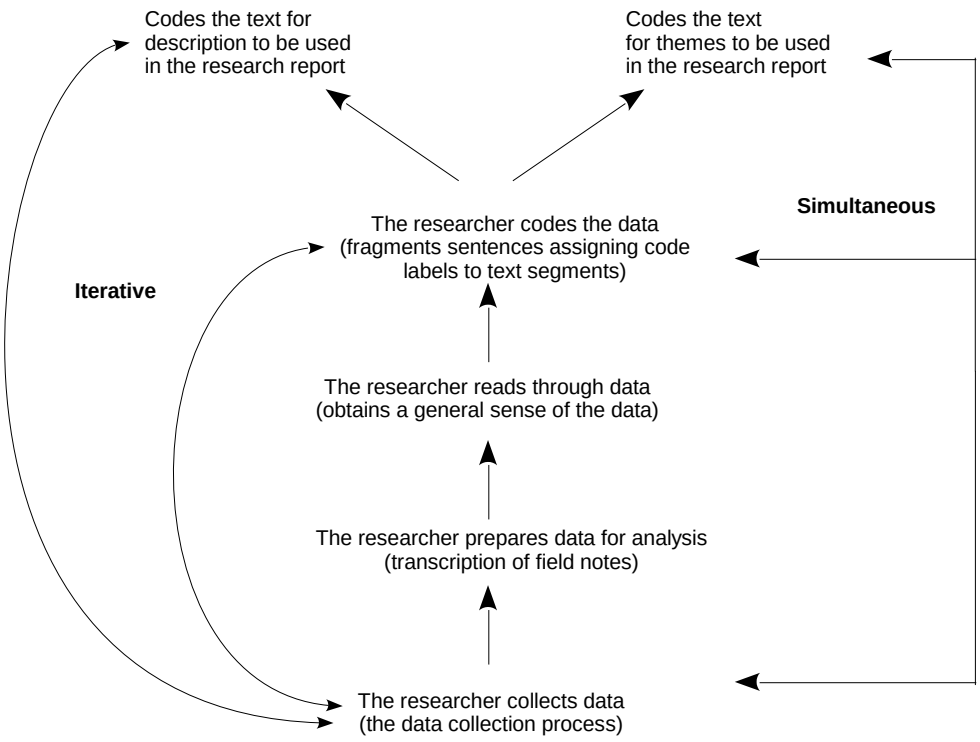


Figure 5-4: The qualitative data analysis process (adapted from Creswell (2012))

In line with the six steps, the analysis process was preceded by the data collection process and the presentation of the results; the latter comprised preparation of the data for textual representation – especially the transcription of audio interview data to textual data. The field notes from the different observations were not transcribed, as they were minimalistic. As a result, coding and theme identification was not undertaken for the participant observation sessions, and only descriptions were provided. Key outcomes of participant observations are presented in Chapter 6, Subsection 6.6.1.

The significance of transcribing the data is highlighted by Creswell (2012), who points out that data transcription facilitates data analysis through converting spoken words and visual data into written words. In this way, data could be coded and uploaded into the software for coding processes and for the elicitation of data descriptions and themes for interpretation. The interpretation of the collected data was undertaken using hermeneutics, and is described in Section 6.9.

The data organisation and transcribing processes, as well as the coding software used, is described extensively in Table 5-14. The next subsection presents the coding process followed in the research. Subsection 5.6.2.2.2 outlines the process of constructing data

descriptions and themes. The coding process, description of data, and the process of identifying themes was influenced by Sutton and Austin (2015).

5-6-2-2-1 Coding

According to Sutton and Austin (2015, p. 228), "Coding refers to the identification of topics, issues, similarities, and differences that are revealed through the participants' narratives and interpreted by the researcher". Similarly, Creswell (2012) points out that coding is the process of deconstructing textual data to form descriptions and broad themes. Miles et al. (2013) further point out that coding was analysis that is based on the deep reflection, analysis, and interpretation of the meaning of the data.

Coding plays an important role in qualitative data analysis (Saldaña, 2015). The coding undertaken in the research is discussed in Subsection 7.3.2.1. The results from the data collection process for the interview were analysed using both open and focused coding, as motivated by Given (2008). These coding strategies were adopted due to the strength of open coding in facilitating the identification of ideas and concepts without establishing their relationship, and the strength of focused coding in facilitating the thorough and systematic review of data in an effort to refine existing codes, prompting more reassessment of existing or newly introduced data (Given, 2008).

During the open coding process, a set of codes were identified from the interview transcripts and categorised based on the sequence of the interview questions. This initial set of codes comprised approximately eighty (80) items. Duplicates within questions and across questions were removed where necessary. Focused coding was then undertaken.

The focused coding concentrated on thoroughly and systematically reviewing data based on the concepts with specific categories in mind – mainly the attributes of digital literacy and technology adoption (Given, 2008). These in turn influenced the themes and assertions made in the research based on the research questions. The coding process followed the code-to-theory model advocated by Saldaña (2015), which facilitated the streamlining of textual field data captured by the research to theoretical assertions captured in the core concepts of the research. Figure 5-14 outlines the code-to-theory model:

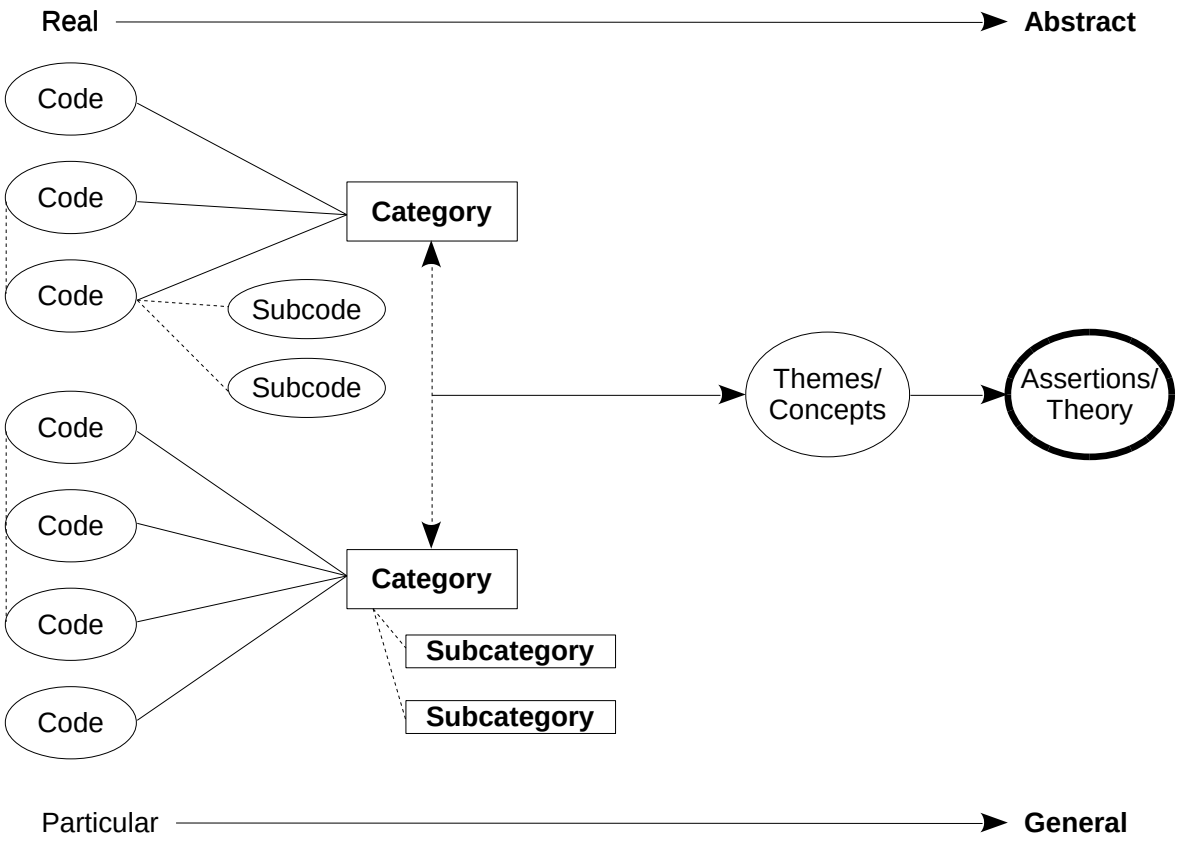


Figure 5-5: The streamlined codes-to-theory model for qualitative enquiry (Saldaña (2015))

The application of the codes-to-theory model resulted in the reduced set of thirteen (13) items from the initial set of eighty codes. The definition of the codes as advised by Creswell (2012) was omitted, as the codes were self-explanatory. Lastly, the final list of codes was linked to the initial interview questions to minimise possible loss of data. The interview questions captured the theoretical grounding of the research and the assertions made in the research (Saldaña, 2015).

5-6-2-2-2 Data and theme description

According to Sutton and Austin (2015, p. 229), "Theming refers to the drawing together of codes from one or more transcripts to present the findings of qualitative research in a coherent and meaningful way". This is more clearly articulated by Creswell (2012) in pointing out that themes are similar codes aggregated together to form a major idea in the database. As a result, the significance of themes in qualitative data analysis is stressed (Creswell, 2012).

The data and theme description undertaken in the research is outlined in Subsection 7.3.2.2. The qualitative database with similar codes and themes entailed the transcriptions of

interviews and anecdotal and field notes related to both the classroom and the learner observations. This database with the entire empirical evidence was less than 50 pages long, thus prompting a combination of hand and computer-based analysis.

The significance of themes is further highlighted by Langenhoven (2016), who points out that themes may encapsulate significant attributes of the data, thus relating it back to the research question(s) and aligning themes closer with the interpretation process.

5-6-2-3 Interpretation

In light of the sequential explanatory mixed method design that was adopted, the integration for the research takes place during the interpretation stage. It involves the combination of quantitative and qualitative research findings towards addressing the research questions and objectives.

Flick (2009) points out that interpretation plays a significant role in the analysis of qualitative data. It involves giving meaning to meaningful engagements with subjects to gain deeper insight into social and psychological processes (Willig, 2017). According to Willig (2017), even qualitative data require allocation of meaning by the researcher. Some of the noted tools of case study analysis are qualitative content analysis and hermeneutics. Despite both tools being interpretation methods for the analysis of textual data, as well as the strengths of qualitative data analysis (Kohlbacher, 2006), this study adopted hermeneutics. The motivation of this choice is provided next.

5-6-2-4 Hermeneutics

According to Myers (1997) hermeneutics provides a philosophical grounding for interpretivism when treated as a philosophical approach to human understanding. As motivated by Boland (2002) and Gill and Johnson (2010), hermeneutics is a study of text-related interpretation that explains meaningful human behaviour. The interpretation of text is considered an important part of searching for meaning and the essence of experience (Walsham, 2009). The research considered hermeneutics for the categorisation and interpretation of the textual data. The data collected using observations and interviews was eventually analysed as textual data. The fact that hermeneutics may transcend linguistic and textual forms of interpretation (Palmer, 1969) was acknowledged; however, for the purposes of the current research, it was relegated to mainly text and possibly images as well. In light of

the significance of hermeneutics, the research adopted this approach for the case study analysis when dealing with textual data.

The significance of hermeneutics when dealing with numerous textual data is highlighted in literature. According to Palmer (1969), the focus of hermeneutics was the deciphering and understanding of the meaning of a work (associated with human or God), and text was an instance of such a work. Myers (1997) further pointed out that hermeneutics was mainly concerned with text or information about a phenomenon that the researcher came to understand through interpreted text related to that phenomenon. According to Cohen et al. (2007), hermeneutics involves recapturing the interaction between the researcher and the participants and potentially understanding the interaction of participants with other participants in a situation. This was generally captured in textual accounts. It is noted that hermeneutics extends beyond simply a textual understanding to understanding as a fundamental principle of human action and day-to-day life encounters (Wernet, 2013).

The principles that apply to conducting the hermeneutic interpretive research (Klein & Myers, 1999) are as follows: hermeneutic cycle, contextualization, interaction, abstraction and generalization, diagonal reasoning, multiple interpretations, and suspicion. These principles are applied to the research during results synthesis and interpretation in Chapter 7.

In light of the significance of hermeneutics in interpreting textual data, the research incorporated this research philosophy into its processes.

5-7. Ethics

The ethical consideration undertaken in the data collection process was driven by the general ethical consideration of the research as outlined in Section 1.7.2. This supports Creswell (2013), who pointed out that attention needs to be directed to ethical considerations throughout the research process, and particularly during data collection and analysis, storage, reporting, and dissemination. Over and above these considerations, the study was granted permission as outlined in Table 5-15:

Table 5-15: Permission granted based on stakeholders of the ICT4E project

Stakeholder	**Permission granted**
CSIR	Access to use the cluster 10 site and to involve the associated participants.

UFS and CSIR	Access to use the cluster 10 site and involve the associated participants during the training sessions of the ICT4E project.
School principal or Vice principal	Access to the school premises and to interact with teachers, supporting staff and, where absolutely necessary, with learners.
UFS[1]	Permission to perform participant observation during training sessions.
Participant (School principal, vice principal or teacher)	• Permission to observe participants during class observations; and • Permission to conduct semi-structured one-on-one interviews.

[1]*Facilitators from the University of Free State involved in the ICT4E project*

Further, participants were provided with information sheets for interview sessions; these explained the purpose of the research and consent forms (Saunders et al., 2016). These documents were in English, a language all the participants were familiar with despite their mother tongue being different from English. These information sheets are outlined in Appendix E. The researcher requested informed consent from each of the participants involved in the interview sessions. These participants were in the following categories: management (school principal, vice principal, or supporting staff) and teachers. Consent was outlined in the participant consent form (see Appendix D).

All participants were made aware that they were participating voluntarily, and that they could revoke consent at any time they so wished (Morrow, 2009; Saunders et al., 2016). Finally, pseudo names in the form of numeric identifiers were used to identify the responses of individual participants and to protect and suppress their true identities. The participants' identities were not necessary for the purposes of the research.

The research summary follows in the next section.

5-8. Summary

The chapter presented the research methodology of the study. The methodology was broken down into the research process, data collection process, and data analysis process, and represented a systematic approach to the research.

The chapter set out to do the empirical validation of the model for the attainment and enhancement of digital literacy through technology adoption for individuals in RCEs to facilitate ICT use. The research adopted the interpretive paradigm due to the phenomenon under study and the need to interpret the views of the participants. Having adopted this

research paradigm, the qualitative case study research methodology was adopted based on the qualitative research approach that was facilitated by the interpretive paradigm.

The research methodology informed the research design which, in turn, outlined the research strategy, research methods, and data collection tools available for the research in investigating the phenomenon under study. A case study research strategy was adopted based on the complex nature of the research, with the aim of providing an in-depth treatment of the key concepts of the research, namely, digital literacy and technology adoption. The case study facilitated the adoption of multiple data collection tools to provide the research with multiple perspectives and facilitated validation through triangulation. Ethical considerations formed a pivotal aspect of the data collection process, particularly when related to the selection of the location of the empirical study and sampling considerations.

For the data collection process, a survey was quantitatively employed as a pilot to investigate the viability of undertaking the qualitative investigation. The results of the quantitative enquiry were explained through descriptive statistics, and supported the undertaking of the qualitative enquiry. The results and findings of the qualitative enquiry supported the significance of the attributes of the model for ICT use, particularly in RCEs, using the attainment and enhancement of digital literacy through technology adoption. After the data collection process for the empirical enquiry, these results and findings are analysed and interpreted in subsequent chapters.

Chapter 6 *Research results*

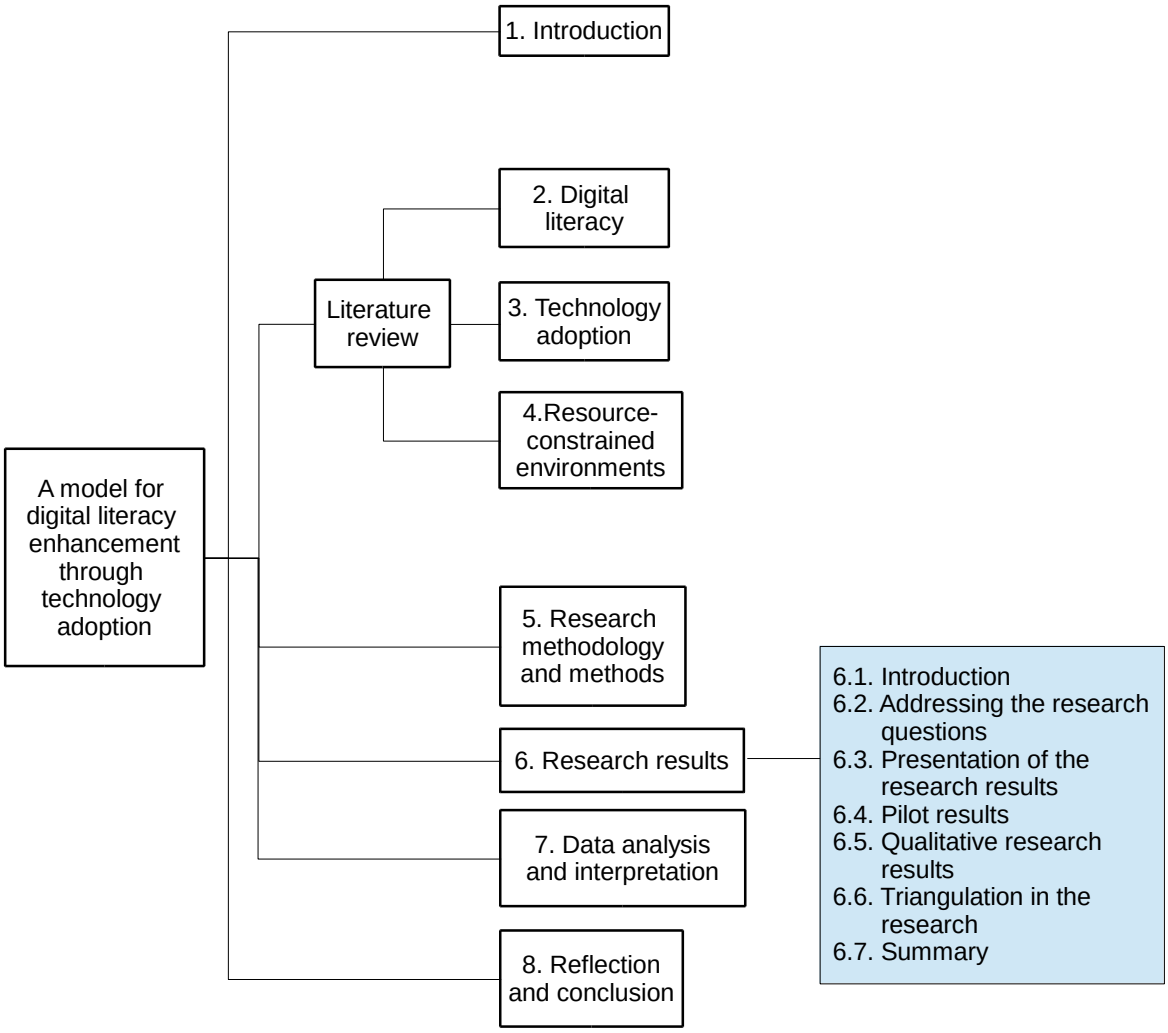


Figure 6-1: Research outline with emphasis on qualitative data analysis and interpretation

From the diagram, the chapter outline is presented. The aim of this chapter is to present the quantitative and qualitative results of the research (see Section 6.1). The mixed method research choice facilitated the presentation of the results.

6-1. Introduction

The research methodology addressed in Chapter 5. This chapter presents the research results. Since mixed methods research choices were adopted, the quantitative research results will be presented first, followed by the qualitative research results. The approach to triangulation in the research will also be motivated.

6-2. Addressing the research questions

The literature review outlined in Chapters 2, 3, and 4 provided answers to the three sub-research questions from theory. The case study adopted in the methodology chapter aims to answer these sub-research questions empirically and further contribute towards answering the main research question.

Each of the three data collection tools also aimed to provide answers to these sub-research questions and the main research question. The pilot and observations will yield results aimed at addressing two of the sub-research questions, and interviews will generate results aimed at answering all three sub-research questions. The motivation presented by triangulation will further confirm and corroborate the results towards validation of the findings, which are presented in the next chapter.

6-3. Presentation of the research results

The data collection process employed a survey, participant observation, and semi-structured one-on-one interviews. The documents associated with these data collection tools are outlined in Appendixes A and C for the survey instrument and interview protocol, respectively, and the observation protocol is depicted in Figure 5.10.

In line with the adopted sequential explanatory design mixed method research choice, the quantitative results will be presented first followed by the qualitative results. Priority is placed on the qualitative rather than the quantitative results:

quan -> QUAL

The quantitative results are from the pilot (survey) study, and the qualitative results are from the observation and interview instruments.

6-4. Pilot results

The questionnaire collected data on the dimensions of digital literacy and the key constructs of UTAUT. The context of RCEs was implied, as the data collection took place in a rural area that reflected attributes of RCE. These results are presented from Subsection 6.4.1.1 to 6.4.1.6. Subsections 6.4.1.1 to 6.4.1.4 present responses on digital literacy, and Subsections 6.4.1.5 to 6.4.1.6 present responses on technology adoption (UTAUT). For each of the attributes being investigated, the number of responses per option in a question is provided, as are the statistical mean and standard deviation. Figure 6-2 illustrates:

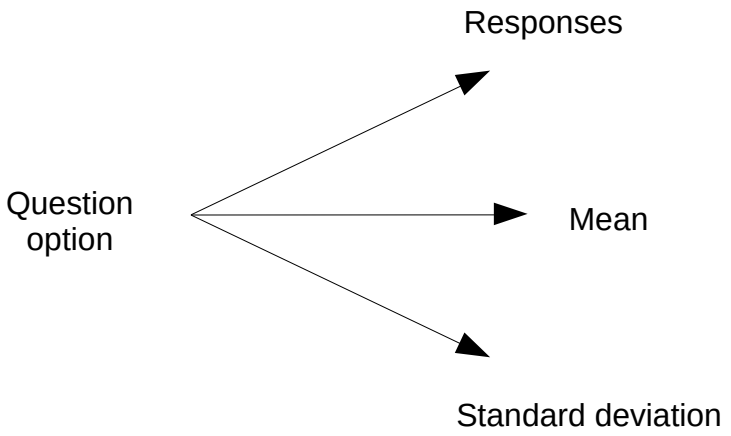


Figure 6-2: Responses, mean, and standard deviation per question option

The mean and the standard deviation are used in Section 7.2 for the quantitative data analysis. The summary of responses per question as a percentage was then plotted in a graph and presented. All the percentages add up to 100 percent.

6-4-1-1 Technical dimension

The collation of the results of the technical dimension is presented in Table 6-1:

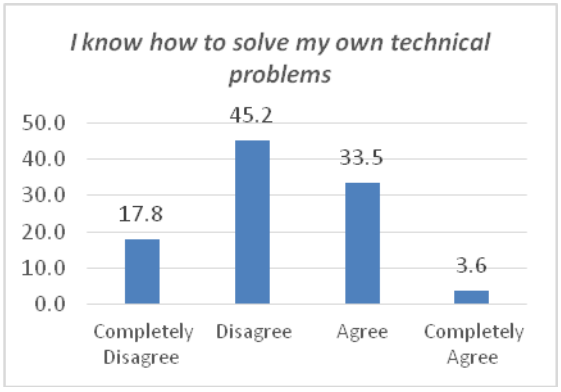
Table 6-1: Technical dimension responses and measures of central tendency and variability

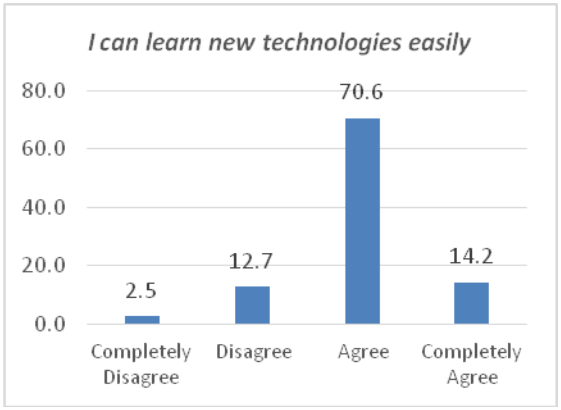
Statistical Measure	Responses	Mean	Standard deviation
I know how to solve my own technical problems*			
Completely Disagree	5	0.20	0.98
Disagree	11	0.44	2.16
Agree	8	0.32	1.57
Completely Agree	1	0.04	0.20
I can learn new technologies easily*			
Completely Disagree	1	0.04	0.20
Disagree	3	0.12	0.59
Agree	18	0.72	3.53
Completely Agree	3	0.12	0.59
I keep up with important new technologies*			
Completely Disagree	1	0.04	0.20
Disagree	7	0.28	1.37
Agree	15	0.60	2.94
Completely Agree	2	0.08	0.39
I know about a lot of different technologies			
Completely Disagree	2	0.08	0.39
Disagree	11	0.44	2.16
Agree	11	0.44	2.16
Completely Agree	1	0.04	0.20
I can teach my students to select appropriate software to use in their projects*			
Completely Disagree	1	0.04	0.20
Disagree	8	0.32	1.57
Agree	14	0.56	2.74

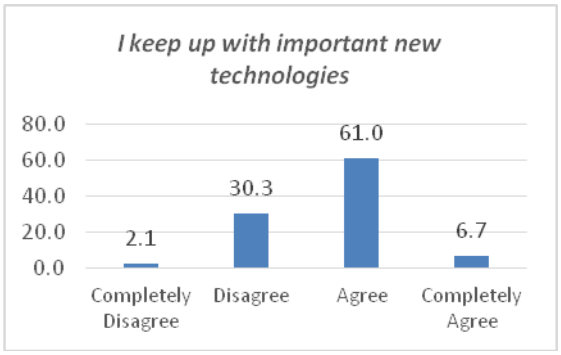
Completely Agree	2	0.08	0.39
I have the technical skills I need to use ICT for learning and to create artefacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt			
Completely Disagree	2	0.08	0.39
Disagree	11	0.44	2.16
Agree	11	0.44	2.16
Completely Agree	1	0.04	0.20

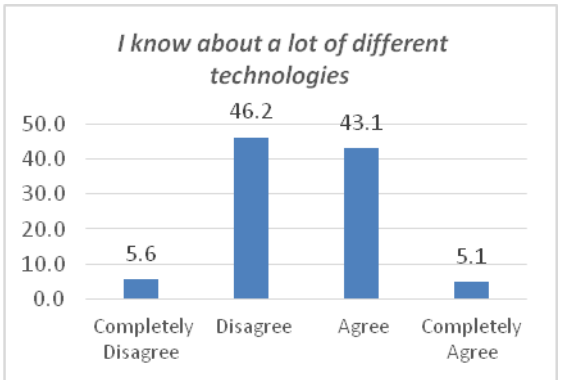
I have good ICT skills			
Completely Disagree	2	0.08	0.39
Disagree	12	0.48	2.35
Agree	10	0.40	1.96
Completely Agree	1	0.04	0.20

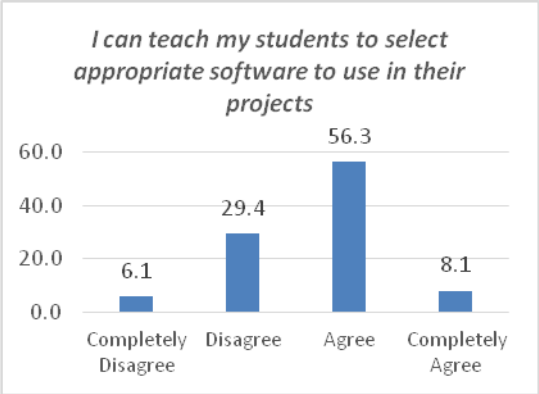
The summaries of these results, based on each of the answered questions, are presented in the figures below:

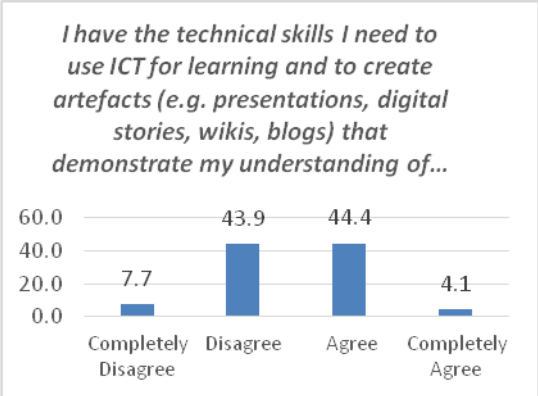


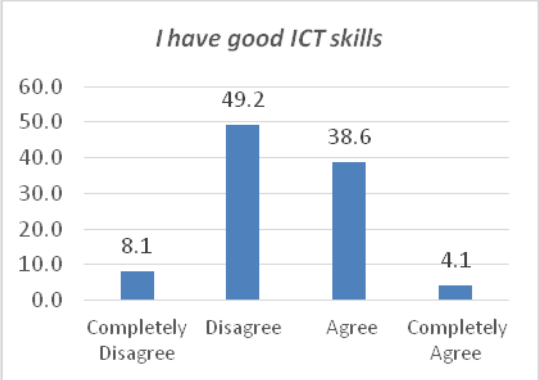












The figures above present the percentage of responses in each response category for the technical dimension questions.

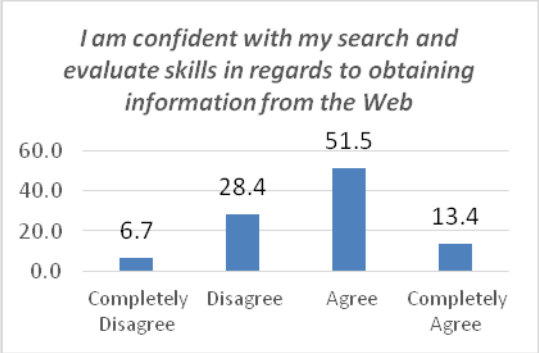
6-4-1-2 Cognitive dimension

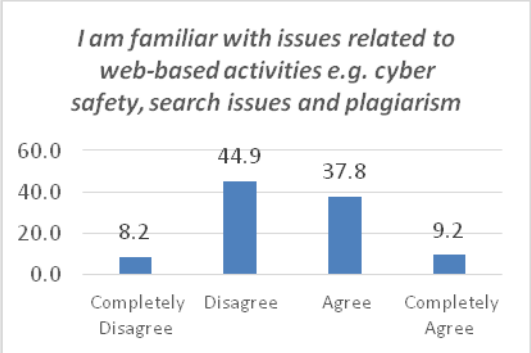
The responses of the cognitive dimensions are presented in Table 6-2:

Table 6-2: Cognitive dimension responses and measures of central tendency and variability

Statistical Measure	Responses	Mean	Standard deviation
I am confident with my search and evaluate skills in regards to obtaining information from the Web*			
Completely Disagree	0	0	0
Disagree	8	0.32	1.57
Agree	15	0.60	2.94
Completely	2	0.08	0.39
Agree			
I am familiar with issues related to web-based activities, for example, cyber safety, search issues, and plagiarism*			
Completely Disagree	2	0.08	0.39
Disagree	11	0.44	2.16
Agree	10	0.40	1.96
Completely Agree	2	0.08	0.39

The figures below summarise the percentage of responses in each response category:





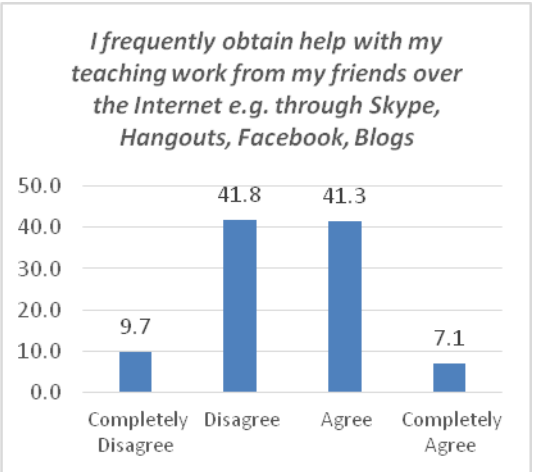
6-4-1-3 Socio-emotional dimension

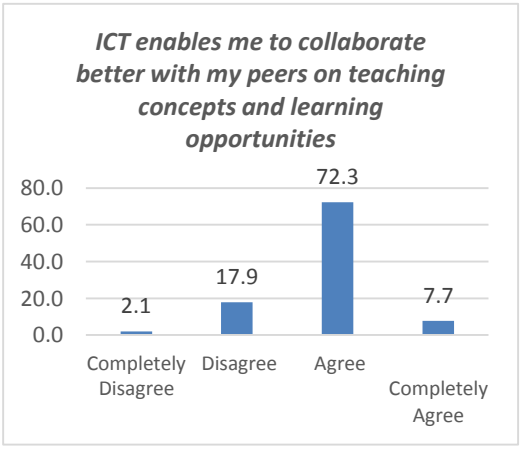
The responses to the socio-emotional dimensions are presented in Table 6-3:

Table 6-3: Socio-emotional dimension responses and measures of central tendency and variability

Statistical Measure	Responses	Mean	Standard deviation
I frequently obtain help with my teaching work from my friends over the Internet, for example, through Skype, Hangouts, Facebook, Blogs*			
Completely Disagree	2	0.08	0.39
Disagree	11	0.44	2.16
Agree	10	0.40	1.96
Completely Agree	2	0.08	0.39
ICT enables me to collaborate better with my peers on teaching concepts and learning opportunities*			
Completely Disagree	1	0.04	0.20
Disagree	4	0.16	0.78
Agree	18	0.72	3.53
Completely Agree	2	0.08	0.39

The responses are summarised in the figures below, indicating the percentage of responses in each response category:





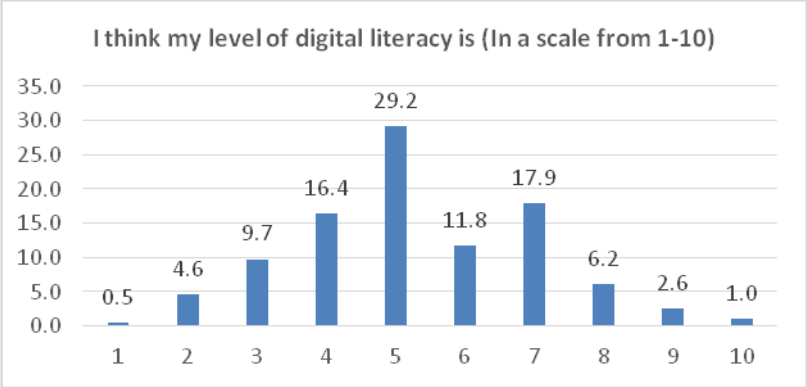
6-4-1-4 Perceived level of digital literacy

An outline of the results of the perceived level of digital literacy follows in Table 6-4.

Table 6-4: Perceived level of digital literacy responses and measures of central tendency and variability

Statistical Measure	Responses	Mean	Standard deviation
I know how to solve my own technical problems* (Scale of 1-10; 1 – Very Low and 10 Very High)			
1 (Very low)	0	0	0
2	1	0.04	0.20
3	3	0.12	0.59
4	4	0.16	0.78
5	7	0.28	1.37
6	3	0.12	0.59
7	5	0.20	0.98
8	2	0.08	0.39
9	0	0	0
10 (Very high)	0	0	0

The figure below summarises the percentage of responses per response category:



6-4-1-5 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The responses of UTAUT questions are presented in Table 6-5:

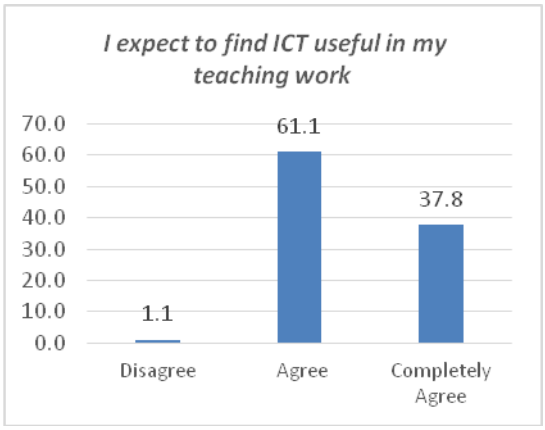
Table 6-5: UTAUT responses and measures of central tendency and variability

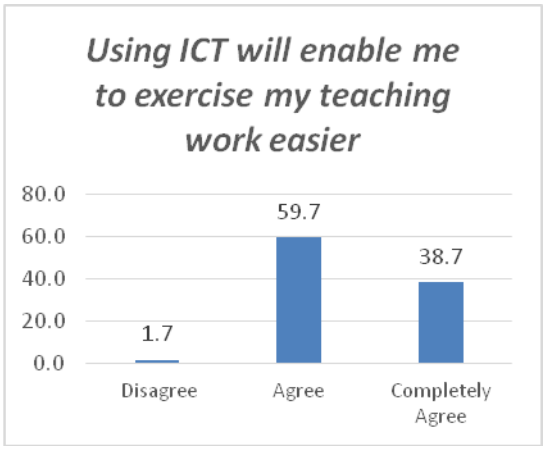
Statistical Measure	Responses	Mean	Standard deviation
(PE) I expect to find ICT useful in my teaching work*			
Completely Disagree	0	0	0
Disagree	1	0.04	0.20
Agree	15	0.60	2.94
Completely Agree	9	0.36	1.76
Using ICT will enable me to exercise my teaching work easier			
Completely Disagree	0	0	0
Disagree	0	0	0
Agree	15	0.60	2.94
Completely Agree	10	0.40	1.96
Using ICT will enable me to positively teach more learners*			
Completely Disagree	0	0	0
Disagree	0	0	0
Agree	15	0.60	2.94
Completely	10	0.40	1.96

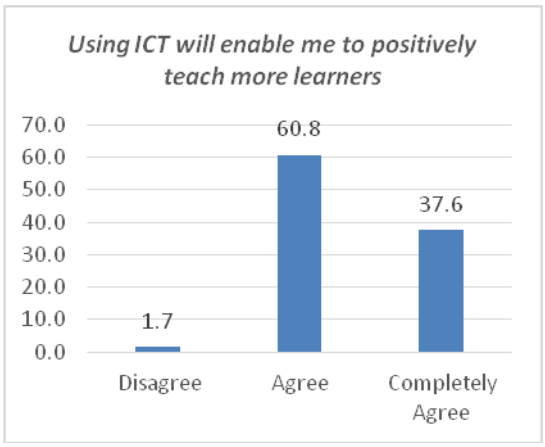
Agree			
(CI) I intend to continue using ICT for my teaching rather than discontinue using it*			
Completely Disagree	0	0	0
Disagree	0	0	0
Agree	15	0.60	2.94
Completely Agree	10	0.40	1.96
My intentions are to continue using ICT for teaching rather than traditional teaching			
Completely Disagree	0	0	0
Disagree	2	0.08	0.39
Agree	14	0.56	2.74
Completely Agree	9	0.36	1.76
I would like to discontinue using ICT for teaching			
Completely Disagree	11	0.44	2.16
Disagree	11	0.44	2.16
Agree	2	0.08	0.39
Completely Agree	1	0.04	0.20
(EE) ICT use for teaching is clear and understandable*			
Completely Disagree	0	0	0
Disagree	1	0.04	0.20
Agree	18	0.72	3.53
Completely Agree	6	0.24	1.18

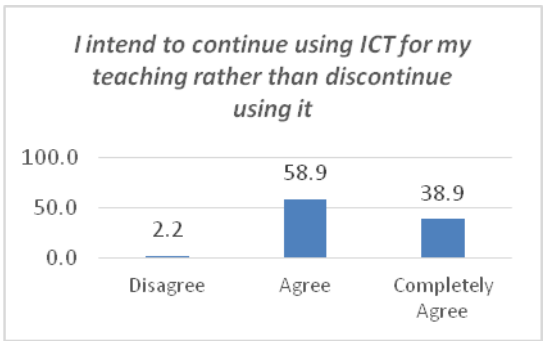
Teaching using ICT will be easy and I believe my learners will experience little challenges with it			
Completely Disagree	0	0	0
Disagree	1	0.04	0.20
Agree	18	0.72	3.53
Completely Agree	6	0.24	1.18
ICT will introduce challenges to teaching learners			
Completely Disagree	2	0.08	0.39
Disagree	6	0.24	1.18
Agree	14	0.56	2.74
Completely Agree	3	0.12	0.59
(Perf.) I anticipate learners to be motivated in learning with ICT methods*			
Completely Disagree	0	0	0
Disagree	1	0.04	0.20
Agree	16	0.64	3.14
Completely Agree	8	0.32	1.57
I believe that my learners will not progress when learning using ICT			
Completely Disagree	11	0.44	2.16
Disagree	12	0.48	2.35
Agree	2	0.08	0.39
Completely Agree	0	0	0

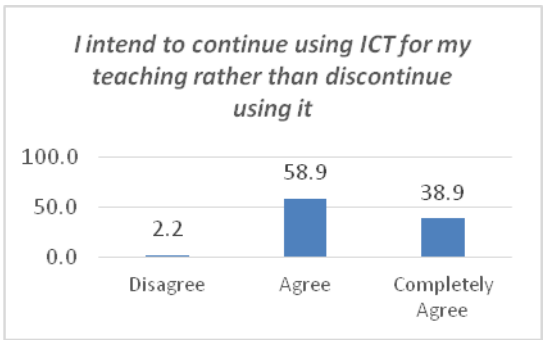
The figures below summarise the percentage of responses in each response category:

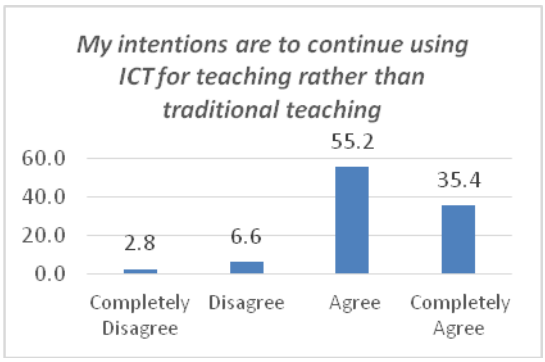

I expect to find ICT useful in my teaching work
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1.1
61.1
37.8
Disagree
Agree
Completely Agree

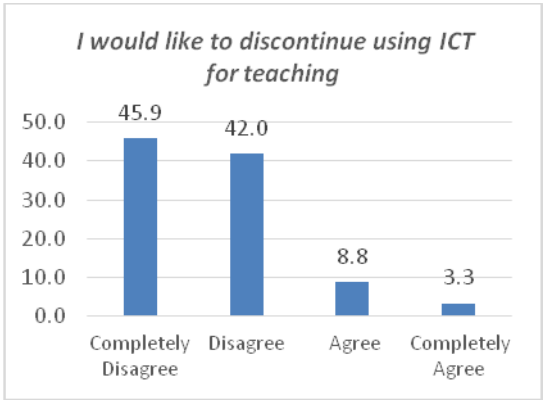

Using ICT will enable me to exercise my teaching work easier
80.0
60.0
40.0
20.0
0.0
1.7
59.7
38.7
Disagree
Agree
Completely Agree

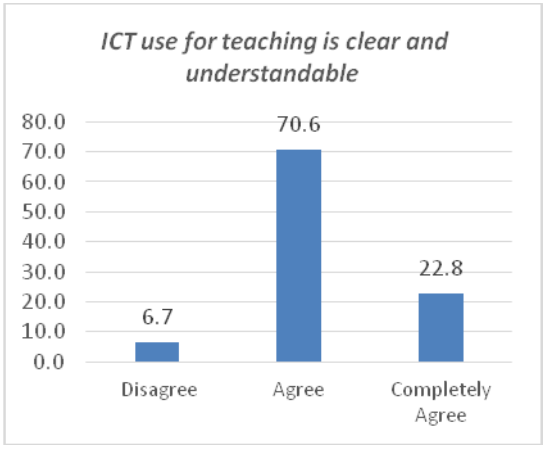

Using ICT will enable me to positively teach more learners
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1.7
60.8
37.6
Disagree
Agree
Completely Agree

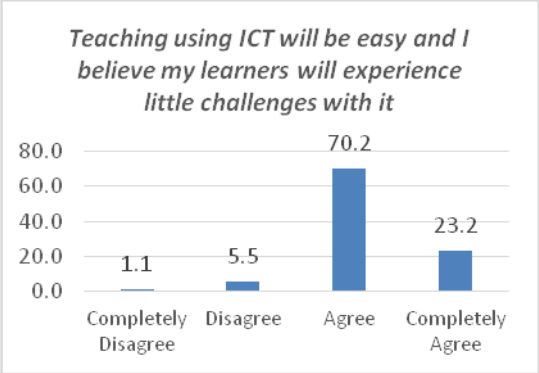

I intend to continue using ICT for my teaching rather than discontinue using it
100.0
50.0
0.0
2.2
58.9
38.9
Disagree
Agree
Completely Agree

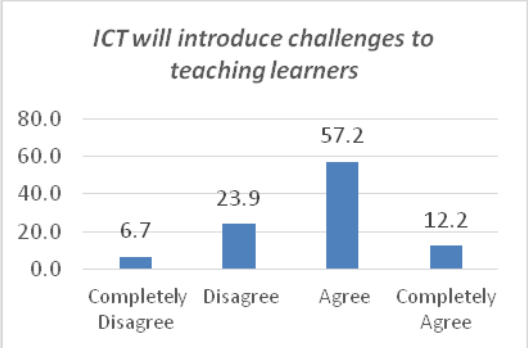

I intend to continue using ICT for my teaching rather than discontinue using it
100.0
50.0
0.0
2.2
58.9
38.9
Disagree
Agree
Completely Agree

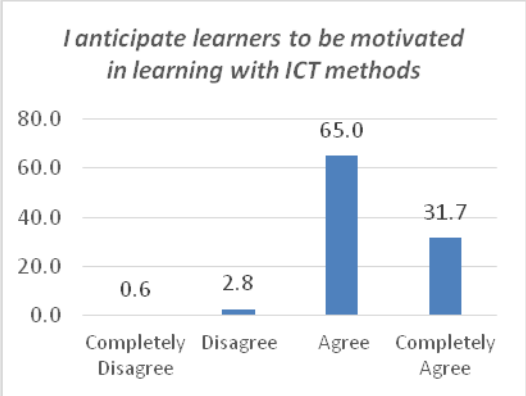

My intentions are to continue using ICT for teaching rather than traditional teaching
60.0
40.0
20.0
0.0
2.8
6.6
55.2
35.4
Completely Disagree
Disagree
Agree
Completely Agree

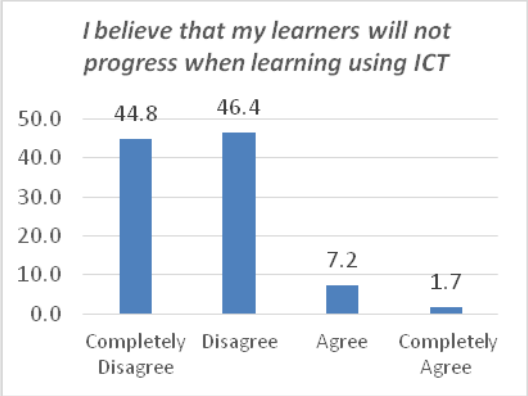

I would like to discontinue using ICT for teaching
50.0
40.0
30.0
20.0
10.0
0.0
45.9
42.0
8.8
3.3
Completely Disagree
Disagree
Agree
Completely Agree


ICT use for teaching is clear and understandable
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
6.7
70.6
22.8
Disagree
Agree
Completely Agree









6-4-1-6 Facilitating conditions

The responses of facilitating conditions are presented in Table 6-6:

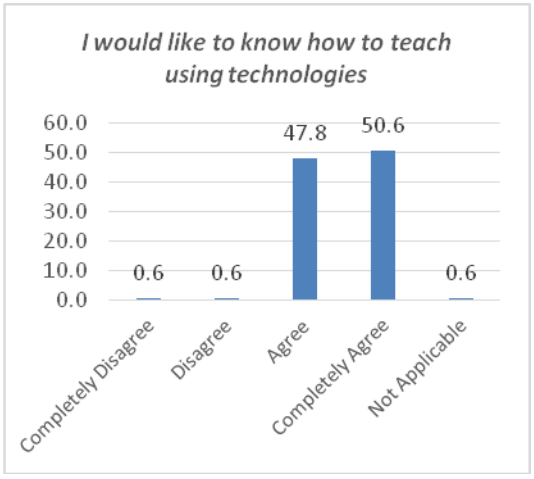
Table 6-6: Facilitating condition responses and measures of central tendency and variability

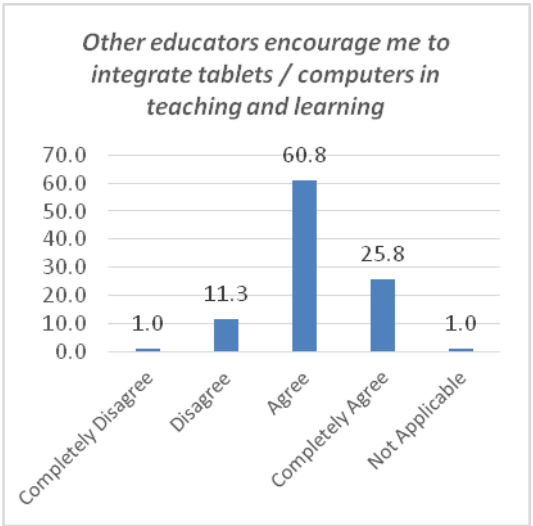
Statistical Measure	Responses	Mean	Standard deviation
I would like to know how to teach using technologies*			
Completely Disagree	1	0.04	0.20
Disagree	1	0.04	0.20
Agree	13	0.52	2.55
Completely Agree	9	0.36	1.76
Not Applicable	1	0.04	0.20
Other educators encourage me to integrate tablets / computers in teaching and learning			
Completely Disagree	0	0	0
Disagree	3	0.12	0.59
Agree	15	0.60	2.94
Completely Agree	7	0.28	1.37
Not Applicable	0	0	0
I would like to teach using ICT's			
Completely Disagree	0	0	0
Disagree	0	0	0
Agree	15	0.60	2.94
Completely Agree	10	0.40	1.96
Not Applicable	0	0	0
The school's ICT coordinator or committee encourages me to integrate tablets / computers in teaching and learning*			
Completely Disagree	2	0.08	0.39
Disagree	2	0.08	0.39

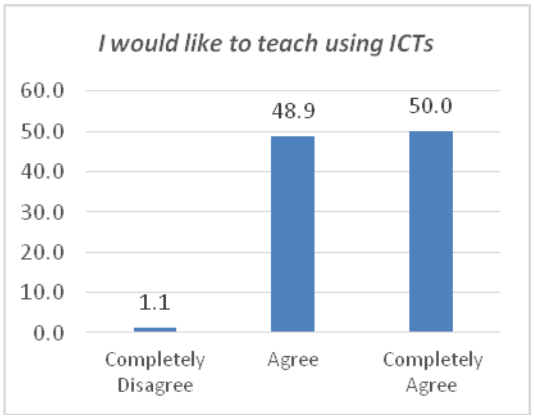
Agree	13	0.52	2.55
Completely Agree	6	0.24	1.18
Not Applicable	2	0.08	0.39
The principal encourages me to integrate tablets / computers in teaching and learning			
Completely Disagree	1	0.04	0.20
Disagree	3	0.12	0.59
Agree	13	0.52	2.55
Completely Agree	7	0.28	1.37
Not Applicable	1	0.04	0.20
The technical support in my school is adequate*			
Completely Disagree	1	0.04	0.20
Disagree	11	0.44	2.16
Agree	13	0.52	2.55
Completely Agree	3	0.12	0.59
Not Applicable	1	0.04	0.20

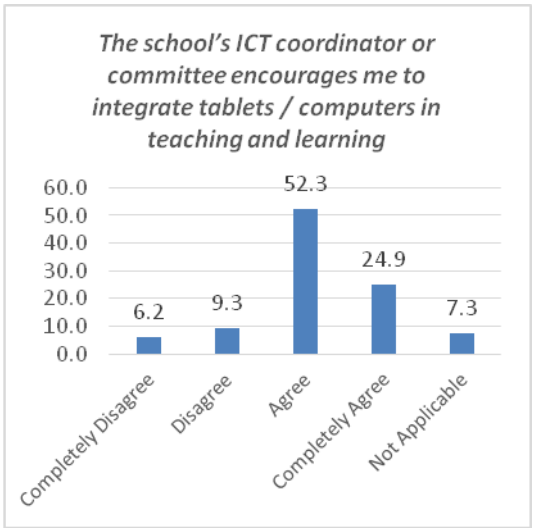
The instructional support (i.e. support provided by the HOD or principal to guide teaching and learning) in my school is adequate			
Completely Disagree	1	0.04	0.20
Disagree	7	0.28	1.37
Agree	13	0.52	2.55
Completely Agree	3	0.12	0.59
Not Applicable	1	0.04	0.20
The technical infrastructure in my school is adequate			
Completely Disagree	2	0.08	0.39
Disagree	11	0.44	2.16
Agree	9	0.36	1.76
Completely Agree	2	0.08	0.39
Not Applicable	1	0.04	0.20

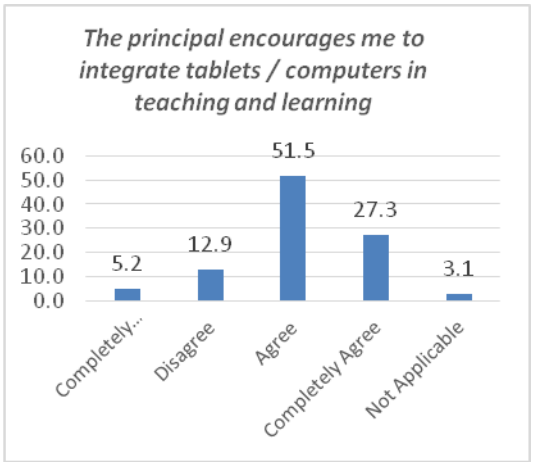
The summary of these responses in percentages are presented in the figures below:

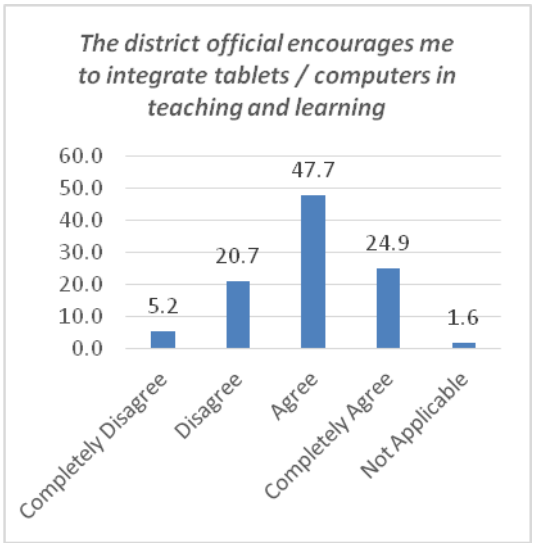


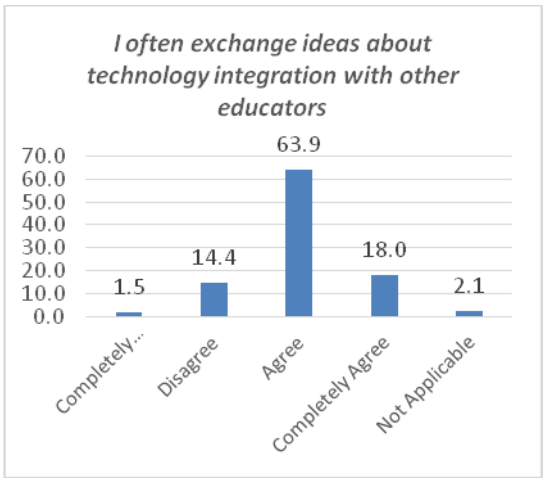


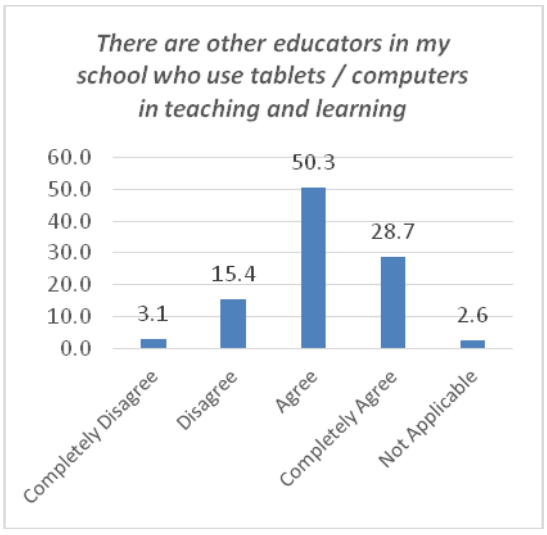

I would like to teach using ICTs
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1.1
48.9
50.0
Completely Disagree
Agree
Completely Agree

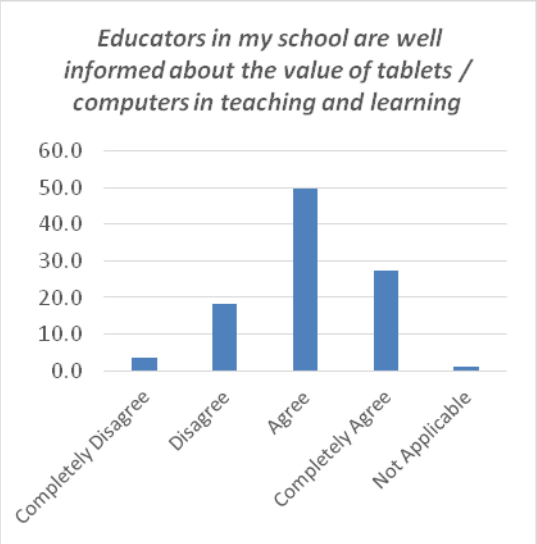

The school's ICT coordinator or committee encourages me to integrate tablets / computers in teaching and learning
60.0
50.0
40.0
30.0
20.0
10.0
0.0
6.2
9.3
52.3
24.9
7.3
Completely Disagree
Disagree
Agree
Completely Agree
Not Applicable

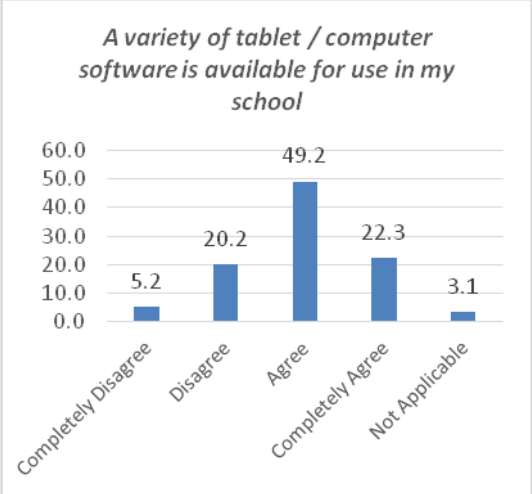

The principal encourages me to integrate tablets / computers in teaching and learning
60.0
50.0
40.0
30.0
20.0
10.0
0.0
5.2
12.9
51.5
27.3
3.1
Completely...
Disagree
Agree
Completely Agree
Not Applicable

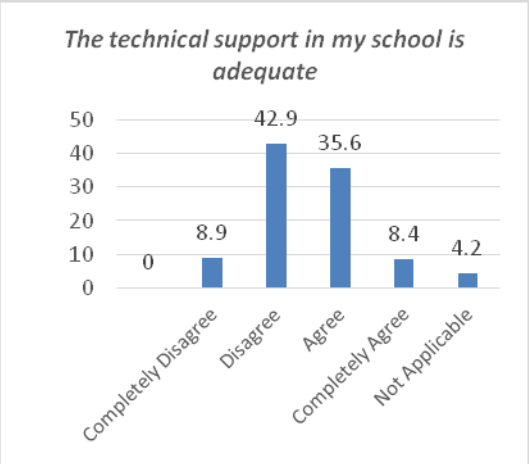

The district official encourages me to integrate tablets / computers in teaching and learning
60.0
50.0
40.0
30.0
20.0
10.0
0.0
5.2
20.7
47.7
24.9
1.6
Completely Disagree
Disagree
Agree
Completely Agree
Not Applicable

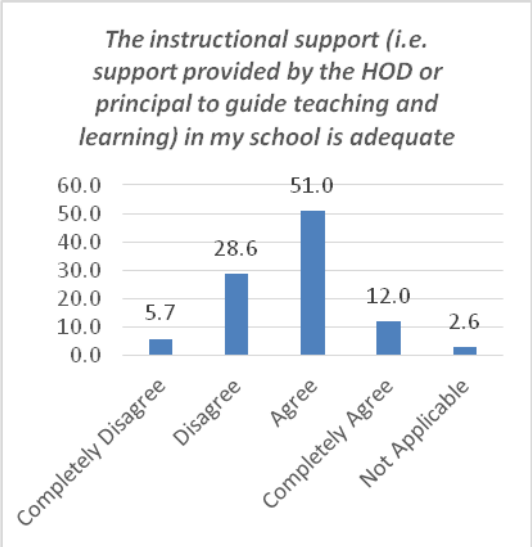

I often exchange ideas about technology integration with other educators
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1.5
14.4
63.9
18.0
2.1
Completely...
Disagree
Agree
Completely Agree
Not Applicable

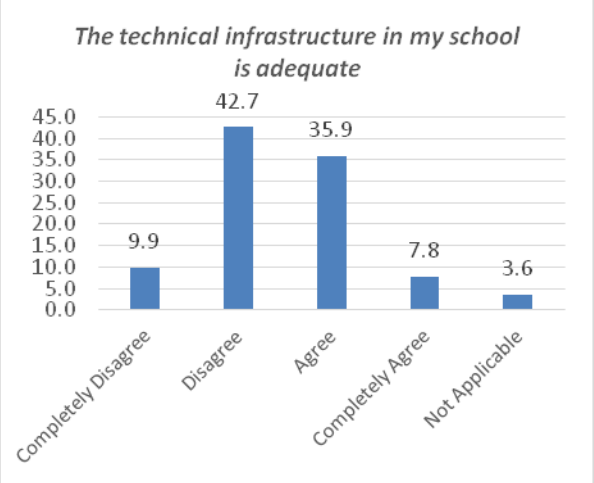

There are other educators in my school who use tablets / computers in teaching and learning
60.0
50.0
40.0
30.0
20.0
10.0
0.0
3.1
15.4
50.3
28.7
2.6
Completely Disagree
Disagree
Agree
Completely Agree
Not Applicable











Having presented the survey results based on the participants' responses, the researcher notes that there is a correlation between the dimensions of digital literacy and constructs of

UTAUT and ICT use in RCEs. The quantitative data analysis in Chapter 7 aims to establish the exact nature of this correlation.

6-4-1-7 Pilot results synthesis and summaries

The pilot results were synthesised and summarised using descriptive statistics. The synthesis and summary processes were based on the attributes of technology adoption and digital literacy. Table 6-7 presents the pilot result synthesis and summaries:

Table 6-7: Pilot result synthesis and summary

Pilot (survey instrument)	
Research concept	**Synthesis and summary**
Digital literacy	• The majority[1] of the participants showed weak ***technical dimensions***. Participants mainly possessed positive attributes of the technical dimension that were below the median,[2] and negative attributes towards the technical dimension that were above the median (*See*: Subsection 6.4.1.1). • Participants showed even ***cognitive dimensions***. Despite experiencing challenges with some attributes related to cognitive dimensions, they also showed strong familiarity with other attributes of cognitive dimensions (see Subsection 6.4.1.2). • Participants showed even ***socio-emotional dimensions***. Despite experiencing challenges with some aspects related to socio-emotional dimensions, they also showed strong familiarity with others (see Subsection 6.4.1.3). • The majority[1] of the participants were not comfortable with their own ***digital literacy*** skills (see Subsection 6.4.1.4).
Technology adoption	• (***PE***) The majority of the participants showed strong **performance expectancy**. Less than 2% of the participants anticipated ICT to form barriers to progress. • (***EE***) The majority of the participants showed strong **effort expectancy** through acknowledging challenges. More than 90% of the participants possessed positive attributes to effort expectancy, despite seventy percent acknowledging potential challenges to ICT use. • (***SI***) Despite social influence not captured, it was assumed that this applies to the research, as teachers participating in the ICT4E training attended with their peers as teams. • (***FC***) Participants showed even ***facilitating conditions***. Participants showed strong facilitating conditions towards the learners and

	acknowledge challenges with general support, both technically and socially. • Effective use (***Perf.***) and continuance intention (***CI***) of use were constructs captured to measure the direct use of ICT; these were not part of UTAUT.

Key:
[1]Majority – more than 50% of the participants
[2]Median – Total rounds off to 100, so median is 50

Having presented the synthesis and summaries of the pilot study, the next section presents the qualitative research results. The qualitative research was informed by the outcomes of the quantitative pilot study.

6-5. Qualitative research results

Two instruments were used for the qualitative data collection processes, namely, participant observation and semi-structured one-on-one interviews. The associated results are presented in Subsections 6.5.1 and 6.5.2, respectively.

6-5-1. Participant observations

Two types of participant observations were conducted, namely, teacher training and classroom observation. A total of thirteen (13) participant observation sessions were undertaken in the research. Two teacher training observations and eleven classroom observations were undertaken.

The ***teacher training participant observation*** entailed two intensive training sessions of three hours each held at Primary School P_1. The training sessions involved participation by all the teachers in the ICT4E project from all three schools, and were conducted by facilitators from the University of Free State (UFS). The purpose of the training sessions was to familiarise teachers with ICT and extend ICT to their pedagogy in a structured manner.

The ***classroom participant observation*** entailed classroom sessions involving teachers and their learners using ICT to undertake class lessons. Two of the three schools participated in classroom participant observations. The third school was unprepared and did not participate. These sessions were also part of the ICT4E project, and served as a pilot for conducting teaching and learning in rural schools using ICT. The purpose of these sessions was to introduce ICT to learners and use it in a structured manner with a focus on pedagogy and the benefits of using ICT in the classroom.

The results of the teacher training observation are provided next, followed by the results of the classroom observation. These results were formulated based on the observation protocol used in the research process, as outlined in Subsection 5.5.4.

6-5-1-1 Teacher training observation

The main points that characterise this participant observation are presented as follows:

- The observed teacher training was conducted by facilitators from the UFS, and was called Teacher Professional Development for Digital Mobile Learning.
- A principal of at least one of the schools was directly involved in the training programme. In some other schools, deputy principals or other senior members of the school were involved.
- Two three-hour observation sessions were undertaken over two days.
- Teacher tablets contained information about the activities to be undertaken during the training.
- These activities were uploaded by the facilitators.
- Teachers were given activities that enabled them to be familiar with ICT concepts, and were expected to extend these concepts to learners and fellow teachers through teaching and collaboration, respectively.
- Despite each teacher having a tablet, group work was highly encouraged.
- Teachers reported their progress through mobile applications called Memoirs and Reflective Journals.
- Participants were awarded different badges based on the duration of their participation, their skill level, and their collaboration with their peers.
- Each school had an ICT champion who assisted the other teachers within the school with their ICT challenges – mainly their technical challenges.
- The ICT champion had access to a laptop that could be used to extend content for teachers to use in their different subjects and topics.
- Content was extended through the generation of new content or the uploading of existing content.
- Teachers formed a Professional Learning Community (PLC) that facilitated collaboration within a school or a cluster, or even with other clusters throughout the country.
- Teachers were encouraged to reflect on their training and explore alignment with their lessons.
- Facilitators communicated with teachers and school principals to source a wider variety of ICT-based teaching and learning material for extending content to as many subjects and topics as possible.

- Not all the teachers in each of the schools participated in the pilot. The participating teachers were encouraged to involve non-participating teachers.
- Figures 6-3 to 6-5 represent some of the images taken during the two sessions of teacher training:

Figure 6-3: Facilitator

Figure 6-4: Group presentation

Figure 6-5: Teacher group activities

6-5-1-2 Classroom observation

The following main points characterise this participant observation:

- Teachers were conducting their lessons based on a standardised work plan designed by facilitators from the UFS. The work plan involved the following concepts: content, pedagogy, and technology.
- The content entailed attributes describing the class, which were as follows: the teacher, the grade, the subject covered (including the actual content) and, finally, the lesson objectives.
- The pedagogy entailed the following: teaching and learning strategies; learner's objectives; teacher obligations to assist learner to achieve their objectives; the technology adopted for the lesson; and the benefits of the technology in the lesson.
- Teacher-oriented tablets and learner-oriented tablets were used to facilitate the lesson.
- Learner tablets contained the lesson conducted in class for a session.
- Lessons were uploaded by the teachers.
- Learner tablets were used at two different levels. First, they were used at the individual level, where each learner had access to a tablet; second, at the group level, learners were split into groups, with each group having access to a tablet.
- Primary School P_1 used the tablets at the individual level, and six (6) classes in total were observed.
- Secondary School S_1 used the tablets at the group level, and five (5) classes in total were observed.
- No observations were undertaken in Primary School P_2, since the teachers and learners were unprepared.
- At both levels, facilitators were available to oversee and observe the lessons.
- Each of the teachers had access to learner tablets for monitoring and assessment purposes.
- At group level, learners were given a task that they were to complete as a group. Additional notes were occasionally provided for completing the task. The teacher timed the learner's activity by moving around to assess progress and provide assistance. Upon completion, pictures of the learners in the group were taken, possibly for later grading as part of the group assessment. A lead learner then presented the solution of the group in front of the class.
- Classes at group level were relatively large, with an average in excess of 50 learners, while those at individual level were small with typically 10 learners per class.
- Learners at both group and individual levels showed extensive focus on learning, and were not diverted by the technology.

- Teachers generally provided learners with the opportunity to explore other aspects of the technology at the end of the lesson by encouraging them to make multimedia recordings of class activities or use mobile applications outside of their lessons.

- Below are some of the images taken during the learner observations:

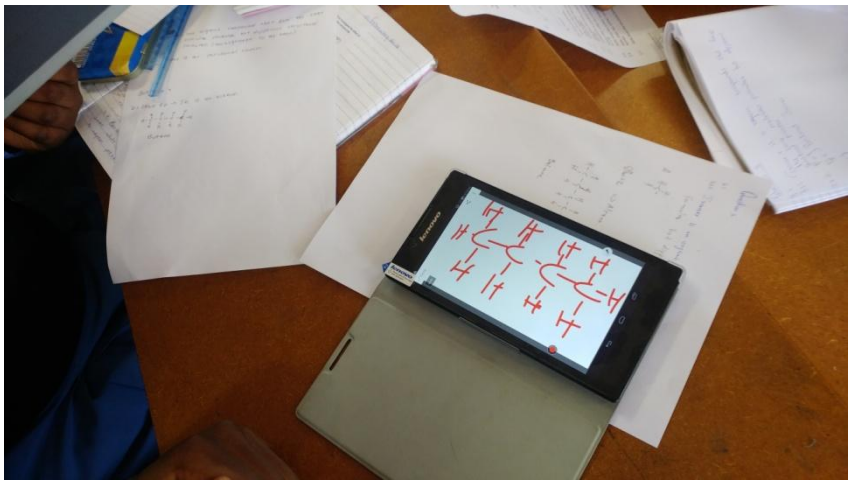


Figure 6-6: Learner tablet – organic chemistry (Grade 12)

Figure 6-7: Learners sharing a tablet – teacher supervising

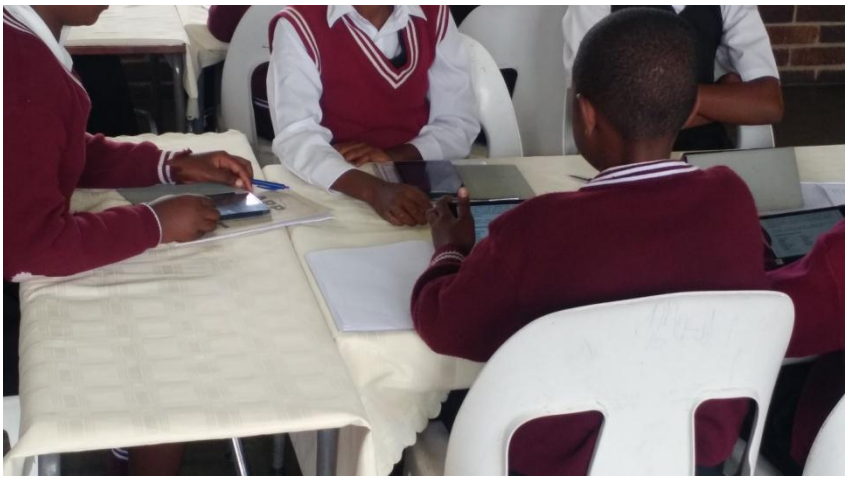


Figure 6-8: Primary school learners using tablets individually

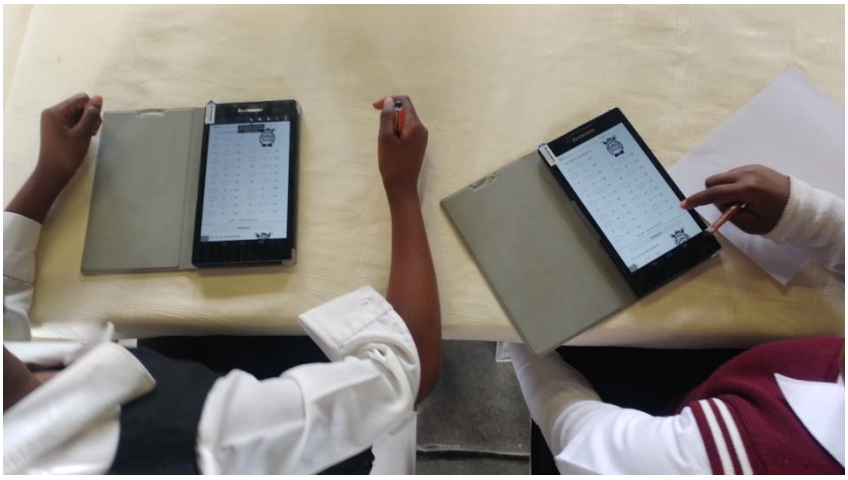


Figure 6-9: Two primary school learners doing arithmetic tables

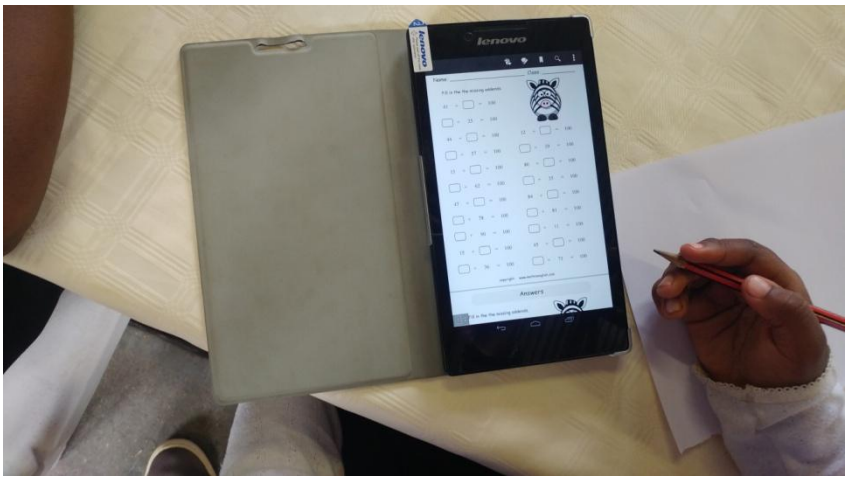


Figure 6-10: Primary school learner doing arithmetic tables

The following images illustrate the three schools in cluster 10 that participated in the research:

Figure 6-11: Primary School P_2

Figure 6-12: Primary School P_1

Figure 6-13: Secondary School S_1

Having presented the participant observation results, including key points from the researcher field notes, the next subsection presents the synthesis and summary of these results in line

with digital literacy and technology adoption. The attributes of RCEs are implied, due to the location considerations outlined in Section 5.5.

6-5-1-3 Participant observation synthesis

As pointed out in Subsection 5.5.4, the participant observation instrument captured the pedagogical aspects of a lesson, teacher training, and classroom sessions as well as ICT use. These contributed to digital literacy and technology adoption. Where an observation outcome maps to at least one of these factors it is labelled green and associated with the constructs of UTAUT, and where applicable, the dimensions of digital literacy. Otherwise the observation outcome is labelled red. Table 6-8 summarises:

Table 6-8: Observation result synthesis

Teacher training observation	
The teacher training that was observed was conducted by facilitators from the UFS and was called Teacher Professional Development for Digital Mobile Learning (***None***).	None
A principal of at least one of the schools was directly involved in the training programme. In some other schools deputy principals or other senior members of the school were involved (***Teacher training***).	Facilitating conditions (UTAUT)
Two observation sessions were undertaken over two days. Each observation session lasted three hours (***None***).	None
Teacher tablets contained information about the activities to be undertaken during the training (***None***).	None
Despite each teacher having a tablet, group work was highly encouraged (***None***).	None
Teachers were to report their mobile applications called Memoirs and Reflective Journals (***None***).	None
Participation was encouraged through a reward programme facilitated by the badge system (***Teacher training***).	Effort expectancy and Social influence (UTAUT); Technical and Cognitive dimensions (DL)
Participants were awarded different badges based on the duration of their participation, their skill level, and their collaboration with their peers (***Teacher training***).	Effort expectancy (UTAUT); Technical and Cognitive dimensions (DL)
Each school had an ICT champion who assisted the other teachers within the school with their ICT challenges, mainly their technical	Technical and Cognitive dimensions (DL)

challenges (***ICT use***).	
The ICT champion had access to a laptop that could be used to extend content for teachers to use in their different subjects and topics that they offer to learners (***ICT use***).	Effort expectancy (UTAUT); Cognitive dimensions (DL)
Content was extended through the generation of new content or the uploading of existing content (***ICT use***).	Effort expectancy (UTAUT); Cognitive dimensions (DL)
Teachers formed a Professional Learning Community (PLC), which facilitated collaboration within a school or a cluster, or even with other clusters throughout the country (***Teacher training***).	Continuance expectancy (UTAUT)
Teachers were encouraged to reflect on their training and explore how they can align it with their lessons ***Teacher training***).	Cognitive dimension (DL)
Facilitators communicated with teachers and school principals to source a wider variety of ICT-based teaching and learning material for extension to as many subjects and topics as possible. Teaching material was sourced for even some of the subjects that are not generally associated with ICT like languages (***None***).	None
Not all the teachers in each of the schools participated in the pilot. The participating teachers were encouraged to involve non-participating teachers as well (***Teacher training***).	Social influence (UTAUT)
Classroom observation	
Teachers were conducting their lessons based on a standardised work plan designed by facilitators from the UFS. The work plan involved the following concepts: content, pedagogy, and technology (***Teacher training***).	Effort expectancy (UTAUT); Technical dimension (DL)
The following class attributes were considered within the content: the teacher, the grade, the subject covered (including the actual content covered) and, finally, the lesson objectives (***None***).	None
The pedagogy entailed the following: teaching and learning strategies; learners' objectives; teachers' obligations to assist learners to achieve their objectives; the technology adopted for the lesson; and the benefits of the technology in the lesson (***None***).	None
The technology used in the classroom was tablet computers. Teacher-oriented tablets and learner-oriented tablets were used to facilitate the lesson (***None***).	None
Learner tablets further contained information about the lesson that was to be conducted in class for the session (***None***).	None

These lessons were uploaded by the teachers (***Teacher training***).	Performance expectancy (UTAUT); Technical and Cognitive dimensions (DL)
Learner tablets were used at two different levels. First, they were used at the individual leves where each learner had access to a tablet; second, they were used at the group level, where learners were split into groups, with each group having access to a tablet (***None***).	None
Primary School P_1 used the tablets at the individual level, and six (6) classes in total were observed (***Classroom session***).	Performance expectancy (UTAUT); Technical and Cognitive dimensions (DL)
Secondary School S_1 used the tablets at the group level, and five (5) classes in total were observed (***Classroom session***).	Performance expectancy (UTAUT); Technical and Cognitive dimensions (DL)
No observations were undertaken at Primary School P_2, since the teachers and learners were unprepared (***None***).	None
At both levels, facilitators were available to oversee and observe the lessons (***None***).	None
Each of the teachers had access to learner tablets for monitoring and assessment purposes (***Classroom session***).	Performance expectancy (UTAUT); Cognitive dimensions (DL)
At group level, learners were given a task to complete. Additional notes were provided for completing the task. The teacher timed the learners' activity by moving around to assess progress and provide assistance. Upon completion, pictures of the learners in the group were taken. A lead learner then presented the solution (***Classroom session***).	Performance expectancy (UTAUT); Cognitive dimensions (DL)
Classes at group level were large, with an average in excess of 50 learners. Those at individual level were small, with typically 10 learners per class (***None***).	None
Learners at both the group and individual levels showed extensive focus on learning, and were not diverted by the technology (***Classroom session***)	Cognitive dimension (DL)
Teachers generally provided learners with the opportunity to explore other aspects of the technology at the end of the lesson (***Classroom session***).	Performance expectancy (UTAUT); Cognitive dimension (DL)

Having presented the summaries of the participation observation results, the interview results are presented in the next section.

6-5-2. Semi-structured one-on-one interviews

From Table 5.8 it is noted that a total of twenty one (21) semi-structured one-on-one interviews were conducted across the three participating schools. The breakdown of the interviews per participating school is outlined in Table 6-9:

Table 6-9: Breakdown of interviews per school

School	Number of interviews undertaken	Date
Primary School P_2	5	01 March 2018
Primary School P_1	6	28 February 2018
Mohlapetsi Secondary School	10	28 February 2018

Of the interviews, 52% were conducted in primary schools and 48% were done in the secondary school over a sample of 21 individuals. The interviews were voice-recorded to free the researcher to focus on the interview and not take notes. The recordings were transcribed into a total of 21 documents. An illustration of a transcribed interview document is as follows:

Matsiri Teacher 1

Salutations

1: Good day Sir.

2: Good day.

1: How are you?

2: Fine

Demographic information:

Professional career?	I'm a teacher			
Age group 0-18	19-25	26-40	40+	
Years in the profession?	26		Yes	
Marital status	Married			
Gender	Male			

Educational background

Highest qualification	Grade 1-12	3 year qualification	Yes	4 year + qualification
Type of qualification	University of Technology degree		University degree	
		Yes		

Resource constrained environment

Resource challenges in your area	Running water (sufficient)		Electricity (sufficient)		Road infrastructure (sufficient)		Telecommunication infrastructure (sufficient)	
	No	Yes		No		No		

- Firstly we don't have libraries and also we are lacking the tablets also.
- Not enough teachers to cater for learners

Dimensions of digital literacy

Technical	
What are technical challenges	If you're not technically advanced
Do you know how to solve your technical problems	No. I give it to somebody

Can you teach your learners how to do their lesson on the tablet?	Yes
Can you create your own teaching material for your learners? If not, are you interested in knowing?	No. I use secondary material. Yes, I am interested in knowing
Describe the level of your ICT skills on a day to day basis	Mainly WhatsApp. I am part of a WhatsApp group with my colleagues
Cognitive	
Do you believe using ICT is mentally demanding?	No.
What do you think of the validity of the information from the Internet?	
What do you know about cybersecurity, search and plagiarism?	
Socio-emotional	
Do you believe you have to be careful on the Internet? Please explain.	
Explain with your interaction with colleagues regarding challenges you experience with teaching using ICT and in general	The thing is they were born before technology, that they find it difficult you know.
Do you collaborate with your colleagues using ICT? Briefly explain.	Yes. When I experience problems with ICT I ask my colleagues

Attributes of UTAUT – Technology adoption

Performance expectancy	
Do you believe ICT can assist you in improving your work? Please explain.	Yes. Because it makes learners to learn faster and when coming to controlling the learners work.
Effort expectancy	
Do you believe ICT can be used effortlessly? Explain	Yes, but it requires a little bit of effort.
Social influence	
Do you think your colleagues would like you to use ICT with your learners? Collaborating? Interacting with them? Please explain.	Yes. They are willing
Facilitating conditions	
Do you believe you have enough support to use ICT from your superiors? What about general technical support? Explain	Yes. There is support from the superiors. Technical support, not that much.

Thank you. That will be all.

Figure 6-14: Illustration of an interview transcription

The interview results are presented in Subsections 6.5.2.1 to 6.5.2.17, based on the questions from the interview protocol. These results are in the form of summaries for each of the

questions in the interview protocol, starting with the demographic information and the educational background.

6-5-2-1 Demographic information and educational background

Of the participants taking part in the research, 71% referred to themselves as teachers and 29% as educators. The age groups of 19 to 25 and 26 to 40 represented 5% of the participants each and the rest of the participants, approximately 90%, were over 40 years of age. The participants had a combined teaching experience of over 577.01 years, with the average being 27.5 teaching years per participant. Of the participants, 67% were married, 24% were single, and 9% were divorced. Finally, 62% were female and 38% were male.

All of the participants had post-matriculation qualifications, and 86% of them completed the qualifications at a University; 62% had a 4 year+ degree and 24% had a 3 year degree.

6-5-2-2 Resource-constrained environment

The participants experienced difficulty in articulating the resource challenges that they experienced with their environment. The researcher was forced to alter the question in an effort to facilitate the capture of data on this key concept. The original question posed to the respondents was as follows: ***Please explain any resource challenges in your area***. However, respondents could not answer this question adequately. The interviewer then opted to break down the concepts related to resource constraints as follows: explain the resource challenges in your area, that is, whether you have sufficient access to the following resources: Running water; Electricity, Road infrastructure; and Telecommunication infrastructure. The summary of responses is tabulated in Table 6-10:

Table 6-10: Resource-constraints experienced by respondents

Resource scarcity			
Running water	**Electricity**	**Road infrastructure**	**Telecommunications infrastructure**
57%	33%	81%	67%

From Table 6-10 it is clear that the greatest challenges experienced by the participants were road infrastructure and telecommunications infrastructure, with running water and electricity presenting the least challenges.

6-5-2-3 What are technical challenges?

This question received a poor response rate, with only 38% of the respondents providing a response. None of the responses gave a direct answer on what technical challenges were. However, respondents were clear on what to do when experiencing technical challenges:

- '...There's a small ICT pot of specialists. Ask individuals in Polokwane...' – Teacher 13
- '...I believe you have to be computer literate, otherwise you will experience challenges...' – Teacher 14
- '...The main challenge relates to the skill levels of the teachers with a number of them experiencing (technical) challenges...' – Teacher 6

At least one of the respondents clearly articulated the confusion:

- '...Question too broad...' – Teacher 10

6-5-2-4 Do you know how to solve your technical problems?

The question was well answered by respondents. However, 19% of the respondents gave no responses. Some of the respondents (19%) believed in solving their technical problems themselves:

- '...We try to solve our technical challenges ourselves...' – Teacher 5

Others believed that technical challenges needed to be taken to other people, internally or externally:

- '...No. I give it (the technical problem) to somebody...' – Teacher 1

Some teachers believed in collaborating to solve their technical challenges:

- '...We collaborate with other teachers to solve our problems...' – Teacher 15
- '...We assist each other as teachers...' – Teacher 11

6-5-2-5 Can you teach your learners how to do their lessons on the tablet?

The question was well answered by the respondents, with only 19% providing no responses. However, 43% of the respondents never provided explanations, despite giving positive responses. Some pointed out that they were keen on improving, and others that they rely on their colleagues:

- '...No I plan on it...' – Teacher 16
- '...No. I ask someone else...' – Teacher 18

Some highlighted the significance of preparation:

- '...Yes. Only if I have sufficiently prepared...' – Teacher 20

6-5-2-6 Can you create your own teaching material for your learners? If not, are you interested in learning?

The question was well answered, but 29% of the teachers never responded to this question. Some of the respondents highlighted challenges with their willingness to learn:

- '...No. I use secondary material. Yes. I am interested in knowing...' – Teacher 1
- '...Not yet. I'm still learning how to use tablets...'

Other respondents were comfortable with their skills:

- '...Yes. I can create material...' – Teachers 15 and 16

6-5-2-7 Describe the level of your ICT skills on a day-to-day basis.

The question was well answered, with only 9% of respondents not providing responses. Some of the teachers pointed out that they did not use ICT daily:

- '...Not on a day-to-day basis. Sometimes...' – Teacher 10

Others focused on using ICT at work:

- '...Yes. I can use ICT in the classroom. At home I use social medial like WhatApp and Facebook...' – Teacher 19

Others pointed out that they also use ICT for social media:

- '...Yes. I use social media – WhatsApp® messages daily...' – Teacher 2

6-5-2-8 Do you believe using ICT is mentally demanding?

The question was well answered by respondents, with only a single respondent (4%) not providing any response. Some pointed out the non-trivial nature of learning ICT:

- '...Yes. It is mentally demanding as it is not easy...' – Teacher 4
- '...No. When you're still starting out. As you spend more time on it, it becomes easier...' – Teacher 12

Others pointed out that ICT was not a challenge to them:

- '...No. It is very easy...' – Teacher 3

Some teachers compared the effort to learn ICT to that of learning written material:

- '...No. It doesn't require more effort in comparison to using written material...' – Teacher 20

6-5-2-9 What do you think of the validity of the information from the Internet?

The question was well answered, with only 9% of the respondents not providing responses. Some of the respondents showed scepticism about the Internet:

- '...50/50. Some information is true, some isn't...' – Teacher 3
- '...It's okay, though one needs to be cautious when using this type of information...' – Teacher 6

Some trusted the information from the Internet:

- '...I think the information is valid...' – Teacher 2

While others did not trust the information at all:

- '...The information from the Internet is not valid...'

6-5-2-10 What do you know about cybersecurity, search, and plagiarism?

The question seemed too confusing and vague to earlier interviewees, and the search aspect of the question was therefore omitted in subsequent interviews. Despite these challenges, the question was well answered with only 19% not providing responses. Some of the respondents showed knowledge of the concepts:

- '...Not sure about cybersecurity but I believe it has something to do with hacking. Plagiarism is a matter of using someone's information without their permission...' – Teacher 6
- '...It's important to secure information we put on the Internet. Plagiarism relates to not using material without the owner's consent...' – Teacher 5

However, some explained that they had no knowledge of the concepts:

- '...I do not know anything about them...' – Teacher 3

6-5-2-11 Do you believe you have to be careful on the Internet? Please explain.

The question was well answered, with only 14% of the respondents not providing responses.

Some of the respondents were aware of the perils of the Internet:

- '...Yes. You have to be careful on the Internet...' – Teacher 18
- '...Yes. The Internet is not secure...' – Teacher 4

Others trusted the Internet:

- '...No. The Internet is safe...' – Teacher 11

6-5-2-12 Explain your interaction with colleagues regarding the challenges you experience with teaching and using ICT in general.

The question was well answered, with only 19% of the respondents not providing responses. Some respondents showed their support for interaction:

- '...If I experience challenges I consult me colleagues. We help each other....' – Teacher 4
- '...Yes. The team (teaching) plans on forming a professional learning committee (PLC) to other individuals with limited background to ICT...' – Teacher 16

Other respondents did not:

- '...I do not interact with colleagues...' – Teacher 15

Some of the respondents highlighted the benefits of interaction:

- '...I do not experience challenges with ICT because of the collaborations we undertake with colleagues...' – Teacher 11

6-5-2-13 Do you collaborate with your colleagues in using ICT? Briefly explain.

The question was well answered by respondents, with only 19% not providing any responses. Most of the respondents were positive on collaboration:

- '...We collaborate as educators and also with learners who are technologically adept...' – Teacher 14
- '...Yes we encourage group discussions....' – Teacher 21
- '...Yes. Teachers dealing with the same subject matter exchange ideas...' – Teacher 4

6-5-2-14 Do you believe that ICT can assist you in improving your work? Please explain.

The question was well answered by respondents, with only 14% not providing a response. Respondents gave a general consensus on the potential positive impact of ICT in their workplace:

- '...Yes. 21st century teachers need methods beyond the textbook and the chalk to use 21st century tools....' – Teacher 16
- '...Yes. A lot. I use ICT with the children and they improve focus and are exited... – Teacher 10
- '...Yes. Very much so. It makes teaching easier...' – Teacher 3

6-5-2-15 Do you believe ICT can be used effortlessly? Explain.

The question was well answered by respondents, with only 4% not providing any response. Respondents gave a general consensus on the effort necessary to use ICT successfully:

- '...Yes it requires a little bit of effort...' – Teacher 1
- '...No. You need to invest time and energy on it...' – Teacher 8
- '...No. ICT is not easy. ICT requires in-depth understanding before being used successfully...' – Teacher 17

Some respondents showed signs of despair:

- '...Using ICT is easy for some, but personally it is hard for me to use ICT...' – Teacher 9

6-5-2-16 Do you think your colleagues would like you to use ICT with your learners? Collaborating? Interacting with them? Please explain.

The question was well answered by respondents, with only 4% not providing any response. Respondents showed a general consensus with respect to the significance of collaboration:

- '...Yes. We have collaboration sessions where we share problems...' – Teacher 3
- '...Yes. I believe so. Colleagues are open to collaboration. We generally exchange ideas...' – Teacher 13

Some respondents showed uncertainty about collaboration:

- '...I don't know...' – Teacher 17

6-5-2-17 Do you believe that you have enough support from your superiors in using ICT? What about general technical support? Explain.

This question was answered by all the respondents. There was a general perception that there was support provided by superiors:

- '...Yes. 100%. Superiors assist with technical challenges...' – Teacher 11
- '...Yes enough support. We're also provided technical support...' – Teacher 18
- '...Yes. Yes. The superiors do provide technical support...' – Teacher 5

Some of the respondents did not see much support from their superiors:

- '...No. No technical support from the department...' – Teacher 6

The semi-structured interview was the last research instrument used.

6-5-2-18 Interview results summary

Following the transcription process, the documents were collated and aggregated to form a narrative of results outlining the interview process. The summary of the interview results is presented in Table 6-11:

Table 6-11: Summary of interview results

Demographic information and educational background
The majority[1] of the teachers in all the three participating schools were over the age of forty years. However, young teachers were also present. The average teaching experience for these teachers was over 25 years, with the majority being married females. All of the participating teachers had post-matriculation qualifications.
RCEs
Participants identified a lack of the following resources as contributing to their resource constraints: running water, electricity, and road and telecommunication infrastructure. Of these, participants expressed road infrastructure as posing the most severe challenge, and electricity the least challenge.
Digital literacy
Participants experienced challenges with digital literacy. Few of the participants were articulate when addressing typical attributes of technical, cognitive, and socio-emotional dimensions.
Technology adoption
Participants experienced challenges with technology adoption – From expressing ICT as a hindrance to their work, to lacking support from superiors making adoption a challenge. However, some of the participants were keen on collaborations and expressed a positive social influence in adopting ICT.

Key:
[1]Majority – more than 50% of the participants

The interview results were coded as part of the qualitative data analysis process, as described in Chapter 7.

Having provided the summaries of the results based on each of the qualitative data collection tools used in the research, the next section describes the triangulation of these results. Triangulation was discussed extensively in Subsection 1.7.1.

6-6. Triangulation in the research

Triangulation was used in the research for confirmation and completeness. According to Houghton, Casey, Shaw, and Murphy (2013), the two main purposes of triangulation in qualitative research are confirmation and completeness. Confirmation in qualitative research refers to comparing data gathered from multiple sources to assess the extend to which the findings can be verified (Casey & Murphy, 2009; Houghton et al., 2013), and completeness of data is mainly concerned with using multiple data collection tools or sources to gather multiple perspectives so as to portray as complete a picture as possible of the phenomenon under study (Casey & Murphy, 2009; Houghton et al., 2013).

Triangulation facilitates validation and corroboration of research findings within a study based on the use of multiple data collection tools (Ritchie et al., 2013; Saunders et al., 2016). Results from the quantitative pilot study and the qualitative observation and interview instruments could be confirmed and corroborated. The research adopted method triangulation across cases on the multiple data collection tools used in the case study.

6-7. Summary

The results and findings from the qualitative data collection process formed a basis from which the qualitative data analysis could be undertaken. The qualitative data analysis facilitated the empirical investigations that constituted the evaluation and validation of the conceptual model for the attainment and enhancement of digital literacy through technology adoption in RCEs for ICT use.

The qualitative results and findings facilitated the coding and theme identification processes, and supported the process of addressing the challenges investigated by the qualitative data collection instruments. The qualitative data analysis further supported the interpretation process undertaken through hermeneutics, and supported the inception of the final model.

Chapter 7 *Data analysis and interpretation*

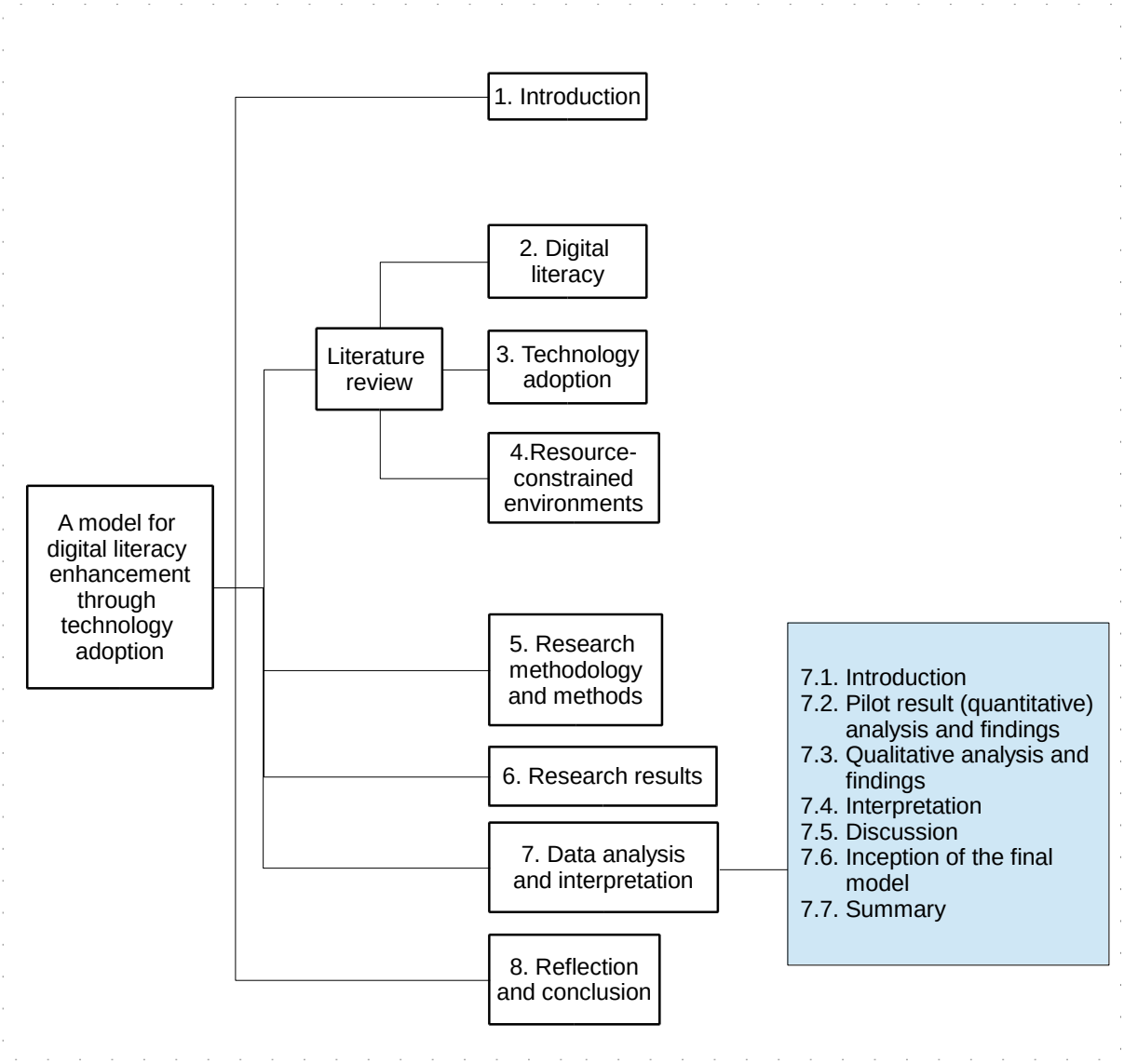


Figure 7-1: Research outline with emphasis on reflection and conclusion

The diagram reflects the chapter outline. The aim of this chapter is to present the reflections on the research process, with a focus on key aspects such as the research questions, research methodology, and research contributions (see Section 7.1). Possible future research is outlined and the limitations of the current research is presented, along with the final reflections.

7-1. Introduction

Chapter 6 presented the results of the data collection process based on the quantitative and qualitative instruments that were adopted. This chapter will outline the data analysis and

interpretation processes. In line with the adopted sequential explanatory design mixed method research, the quantitative analysis process will be presented first, followed by the qualitative analysis process. Priority is given to the qualitative rather than the quantitative analysis:

quan -> QUAL

The process was motivated in Subsection 5.4.4.2. The quantitative analysis involved results from the pilot (survey) instrument, and the qualitative analysis involved results from the observation and interview instruments. Upon conclusion of the data analysis process, the interpretation of qualitative results based on hermeneutics is presented. The interpretation facilitates the design of the final model to address the research questions.

7-2. Pilot result (quantitative) analysis and findings

The survey collected data to investigate the viability of key concepts when undertaking qualitative research, namely, digital literacy and technology adoption. The context of the research was resource-constrained environments (RCEs). Attributes of digital literacy, that is, the technical, cognitive, and socio-emotional dimensions, were investigated. For technology adoption, the following attributes were investigated: social influence, performance expectancy, effort expectancy, and facilitating conditions. The technology adoption attributes were dictated Unified Theory of Acceptance and Use of Technology (UTAUT), as adopted in the research. Table 7-1 presents the findings of the survey:

Table 7-1: Findings of the survey

Digital literacy	
Technical dimensions	Participants show limited abilities and exposure to addressing their own technical challenges, thus illustrating weak technical dimensions.
Cognitive dimension	Participants show strong cognitive dimensions by having good ICT skills, despite not having particularly strong ICT conceptual knowledge.
Socio-emotional dimension	Participants show the socio-emotional dimension. Participants collaborated both face-to-face and on social media by forming collaboration groups (WhatsApp® groups).
Digital literacy	More than 60% of the participants are not comfortable with their digital literacy skills despite showing strong abilities in terms of the attributes of digital literacy.
Technology adoption (UTAUT)	

Performance expectancy	More than 90% of the participants showed strong performance expectancy.
Continuance expectancy	More than 95% of the participants wanted to continue teaching with ICT, showing strong continuance expectancy.
Effort expectancy	More than 90% of the participants wanted to expend the necessary effort to assist learners in learning using ICT, since they considered that their learners will experience little challenges from learning using ICT; thus, these participants showed strong effort expectancy.
Effective use	More than 90% of participants noted that their learners were motivated to use ICT for their learning, with less than 15% believing that ICT will inhibit learners from progressing, showing strong effective use.
Facilitating conditions	Participants generally believed that there is adequate support from their school and superiors, but noted that the technical support from the school and superiors was limited.

These findings validated the selected location and participants as suitable for undertaking the qualitative empirical investigation. The location satisfied the condition of being an RCE, and the participants were participating in ICT use exercises, and were informed and willing to participate in the research (Creswell, 2013).

7-3. Qualitative analysis and findings

Qualitative data collection involved participant observations and semi-structured one-on-one interviews.

7-3-1. Participant observation

The qualitative analysis of participant observation entailed the analysis of field notes captured by the researcher during the observation process. Since the researcher's field notes on participant observation yielding limited text, the qualitative analysis captured descriptions of key points of the observation process. As pointed out in Subsection 5.5.4, the observation protocol directly captured ICT use and indirectly captured digital literacy and technology adoption. Table 7-2 outlines the key findings of the observation protocol, as well as the themes emanating from the observation process:

Table 7-2: Observation findings based on the observation protocol

Concepts	*Discussion*	*Themes*
ICT use	• Single tablet assignment per teacher; and	ICT use

	• Group work activities.	
Digital literacy	• Teacher training facilitated by the UFS, referred to as Teacher Professional Development for Digital Mobile Learning (***technical dimension***). • Teachers were given activities that facilitate the understanding of ICT concepts, extending these concepts to learners and fellow teachers through teaching and collaboration, respectively (***socio-emotional dimension***). • Reporting by teachers through the Memoirs and Reflective Journals mobile application (***socio-emotional dimension***). • Generation of new content or uploading of existing content (***cognitive dimension***). • Reflection by teachers to facilitate alignment with lessons and general ICT use (***cognitive dimension***). • Teachers were conducting their lessons based on a standardised work plan designed by facilitators from the UFS, involving content, pedagogy, and technology (***technical dimension***). • Access to learner tablets by teachers for monitoring and assessment purposes (***cognitive dimension***).	ICT training ICT impact
Technology adoption	• A principal of at least one of the schools was directly involved in the training programme. In some other schools, deputy principals or other senior members of the school were involved (***facilitating conditions***). • Teachers were given activities facilitating the understanding of ICT concepts, extending these concepts to learners and fellow teachers through teaching and collaboration, respectively (***effort expectancy*** and ***social influence***). • Each school had an ICT champion who assisted the other teachers within the school with their ICT challenges, mainly their technical challenges (***effort expectancy***). • Teachers encouraged learners to make multimedia recordings of class activities or to use mobile applications outside of their lessons to deepen their understanding (***effort expectancy***).	ICT training ICT support ICT impact

From Table 7-2 it is clear that the teacher training sessions and classroom sessions involved aspects of ICT use, digital literacy, and technology adoption. Major themes emanating from the observation process are as follows: ICT use, ICT training, ICT impact, and ICT support.

7-3-2. Semi-structured one-on-one interviews

The analysis of the interview results followed the qualitative data analysis process introduced in Subsection 5.6.2.2, and involved the transformation of raw interview data to textual data. The resulting textual data were analysed using the 'six step' framework (Creswell, 2012). The analysis of interview data entailed coding, data description, and theme identification.

7-3-2-1 Coding

Coding was only applied to the interview results. The textual interview data followed open and focused coding (Given, 2008). The interview questions captured the theoretical grounding and assertions made in the research (Saldaña, 2015). These questions were numbered for identification purposes, as outlined in Table 7-3:

Table 7-3: Interview question and code correlation

Codes	Interview question and identifier
• ICT DEBATE*	6. *Do you believe the use of ICT is mentally demanding?*
	14. Do you think your colleagues would like you to use ICT with your learners? Collaborating? Interacting with them? Please explain.
• ICT TRAINING • ICT ACCEPTANCE • ICT USE DYNAMICS • ICT SOCIO-ECONOMIC OPPORTUNITIES AND CHALLENGES • ICT OPPORTUNITIES AND CHALLENGES TOWARDS LEARNERS AND TEACHERS • ICT INTEGRATION IN	1. What are technical challenges?
	2. Do you know how to solve your technical problems?
	3. Can you teach your learners how to do their lesson on the tablet?
	4. Can you create your own teaching material for your learners? If not, are you interested in knowing?
	5. Describe the level of your ICT skills on a day-to-day basis.
	7. What do you think of the validity of the information from the Internet?

TEACHING • ICT ADOPTION BY LEARNERS • ICT ETHICS • ICT ETHICS TOWARDS LEARNERS	8. What do you know about cybersecurity, search, and plagiarism?
	9. *Do you believe that you have to be careful on the Internet? Please explain.*
	12. Do you believe ICT can assist you in improving your work? Please explain.
	13. Do you believe ICT can be used effortlessly? Explain.
• COLLABORATION OPPORTUNITIES AND CHALLENGES	10. Explain your interaction with colleagues regarding challenges that you experience with teaching using ICT, and challenges in general.
• COLLABORATION DYNAMICS	11. Do you collaborate with your colleagues in using ICT? Briefly explain.
• TECHNICAL AND NON-TECHNICAL SUPPORT FROM SUPERIORS	15. Do you believe that you have enough support from your superiors to use ICT? What about general technical support? Explain.

The data related to RCEs was not excessive, and was described in a simplistic manner. This was undertaken mainly in Subsection 6.5.2.2, and will be highlighted in the next subsection.

7-3-2-2 Data and theme description

According to Sutton and Austin (2015, p. 229), "Theming refers to the drawing together of codes from one or more transcripts to present the findings of qualitative research in a coherent and meaningful way". This is more clearly articulated by Creswell (2012), who points out that themes are similar codes that are aggregated together to form a major idea in the database, and that highlight their significance in qualitative data analysis. Themes may encapsulate significant attributes of the data relating back to the research question(s), thus aligning themes closer to the interpretation process (Langenhoven, 2016).

The analysis database entailed the transcriptions of interviews, and anecdotal and field notes related to both the classroom and the learner observations. This database was less than 50 pages long for the entire empirical evidence, thus prompting a combination of hand and computer-based analysis.

The interview codes from Subsection 7.3.2.1 facilitated the identification of themes. An initial list of ten themes was identified, and this was collapsed into a final list of eight. Table 7-4 illustrates:

Table 7-4: Interview themes identified from the elicited codes

Codes	Initial theme	Final theme
• ICT DEBATE	1. The significance of ICT awareness	1. ICT awareness 2. ICT training 3. ICT literacy 4. ICT use 5. ICT impact 6. ICT acceptance 7. ICT ethics 8. ICT support
• ICT TRAINING • ICT ACCEPTANCE • ICT USE DYNAMICS • ICT SOCIO-ECONOMIC OPPORTUNITIES AND CHALLENGES • ICT OPPORTUNITIES AND CHALLENGES TOWARDS LEARNERS AND TEACHER • ICT INTEGRATION IN TEACHING • ICT ADOPTION BY LEARNERS • ICT ETHICS • ICT ETHICS TOWARDS LEARNERS	2. The role of training in general ICT use 3. The impact of ICT literacy on technical challenges 4. The role of tablet access to ICT use in the classroom 5. The role of ICT in day-to-day socio-economic activities 6. ICT acceptance through peer-to-peer stimulation based on teacher leaner interaction in the classroom 7. The use of ICT in teaching enhancement through rich content and learner stimulation 8. Ethics essential in ICT	
• COLLABORATION OPPORTUNITIES AND CHALLENGES • COLLABORATION DYNAMICS	9. The role of collaboration in learning and teaching ICT	
• TECHNICAL AND NON-TECHNICAL SUPPORT FROM SUPERIORS	10. The role of superiors in facilitating support and providing avenues for technical support	

Supporting evidence for participant responses to correlate the themes back to the interview questions is outlined in Subsections 7.3.2.2.1 to 7.3.2.2.10.

7-3-2-2-1 The significance of ICT awareness

The discussion was centred on challenges imposed by ICT, and mitigation approaches in the form of training and collaboration. Some participants acknowledged the challenges that they experienced with ICT:

- '...Yes. It is mentally demanding as it is not easy...' – Teacher 4
- '...Yes. ICT requires a lot of effort...' – Teacher 8
- '...No. When you're still starting out. As you spend more time on it, it becomes easier...' – Teacher 12

Others saw ICT as posing minimal to no challenges:

- '...No. It is very easy...' – Teacher 3

Some participants considered collaboration as an important platform for exchanging ideas:

- '...We collaborate as educators and also with learners who are technologically adept...' – Teacher 14
- '...Yes we encourage group discussions....' – Teacher 21
- '...Yes. Teachers dealing with the same subject matter exchange ideas...' – Teacher 4
- '...I do not experience challenges with ICT because of the collaborations we undertake with colleagues...' – Teacher 8

Others saw collaboration as cumbersome:

- '...Transport issue are a problem and we don't have time to interact with fellow teachers...' – Teacher 16

7-3-2-2-2 The role of training in general ICT use

Some of the participants noted the significance of ICT training:

- '...The way we were trained by facilitators from the university they make everything to be easier...' – Teacher 3
- '...ICT requires in-depth understanding before being used successfully ...' – Teacher 16

- '...Up to now after training I have improved. I am able to select apps to use for my needs...' – Teacher 18

Others opted to use third parties:

- '...No. I refer technical challenges to someone else...' – Teacher 15

7-3-2-2-3 The impact of ICT literacy on technical challenges

- '...I believe you have to be computer literate, otherwise you will experience challenges...' – Teacher 14

- '...The main challenge relates to the skill levels of the teachers with a number of them experiencing (technical) challenges...' – Teacher 6

7-3-2-2-4 The role of tablet access to ICT use in the classroom

- '.... There are no sufficient tablets to cover all the learners...' – Teacher 11

- '...However, more tablets are necessary to cover all the teachers and learners...' – Teacher 14

7-3-2-2-5 The role of ICT in day-to-day socio-economic activities

Most of the participants use ICT on a day-to-day basis, mainly for social media:

- '...I use social media...' – Teacher 2, Teacher 4

- '...I can use ICT in the classroom. At home I use social medial...' – Teacher 17

Other showed more in-depth use:

- '...Yes I use mobile applications and the Internet on a day-to-day basis...' – Teacher 15

7-3-2-2-6 ICT acceptance through peer-to-peer stimulation based on teacher learner interaction in the classroom

The role of mobile applications in the stimulation of learners is clearly articulated by some participants:

- '...Using ICT with different apps activates the learner's mind and keeps them motivated...' – Teacher 11

Peer-to-peer interaction between teachers and learners was also noted as essential:

- '...We collaborate as educators and also with learners who are technologically adept...' – Teacher 12
- '...We have collaboration sessions where we share problems...' – Teacher 3

7-3-2-2-7 The use of ICT in teaching enhancement through rich content and learner stimulation

- '...Because most of the time learners do not enjoy book materials. Using ICT with different apps activates the learner's mind and keeps them motivated...' – Teacher 11
- '...Yes. More information can be found in the devices that we use than in the books that we use for our teaching...' – Teacher 3

7-3-2-2-8 Ethics essential in ICT

- '...Sensitive information must be secured...' – Teacher 3
- '...Plagiarism is when work that is not original is used and it unacceptable...' – Teacher 11
- '...Because one needs to find out that the information (from the Internet) is not distorted...' – Teacher 17
- '...Some information (from the Internet) is not good for learners...' – Teacher 5

7-3-2-2-9 The role of collaboration in learning and teaching ICT

- '...We get together to discuss challenges and try to resolve them...' – Teacher 5
- '...Yes I consult colleagues when experiencing challenges...' – Teacher 7
- '...I do not experience challenges with ICT because of the collaborations we undertake with colleagues...' – Teacher 8

7-3-2-2-10 The role of superiors in facilitating supporting and providing avenues for technical support

- '...Yes there is support from the superiors. Technical support, not that much...' – Teacher 1
- '...Yes enough support. We're also provided technical support...' – Teacher 18

- '...Yes. We get support from the superiors. So far no technical support, but might made available in the future...' – Teacher 21

The interview clearly illustrates a correlation between questions based on the key concepts of the research and the themes resulting from the coding, data, and theme description processes.

7-4. Interpretation

The sequential explanatory mixed method design was adopted in Subsection 5.4.4.2. This design dictates that integration takes place at the interpretation stage (Creswell et al., 2010). Priority is given to the qualitative aspect. Figure 7-2 illustrates:

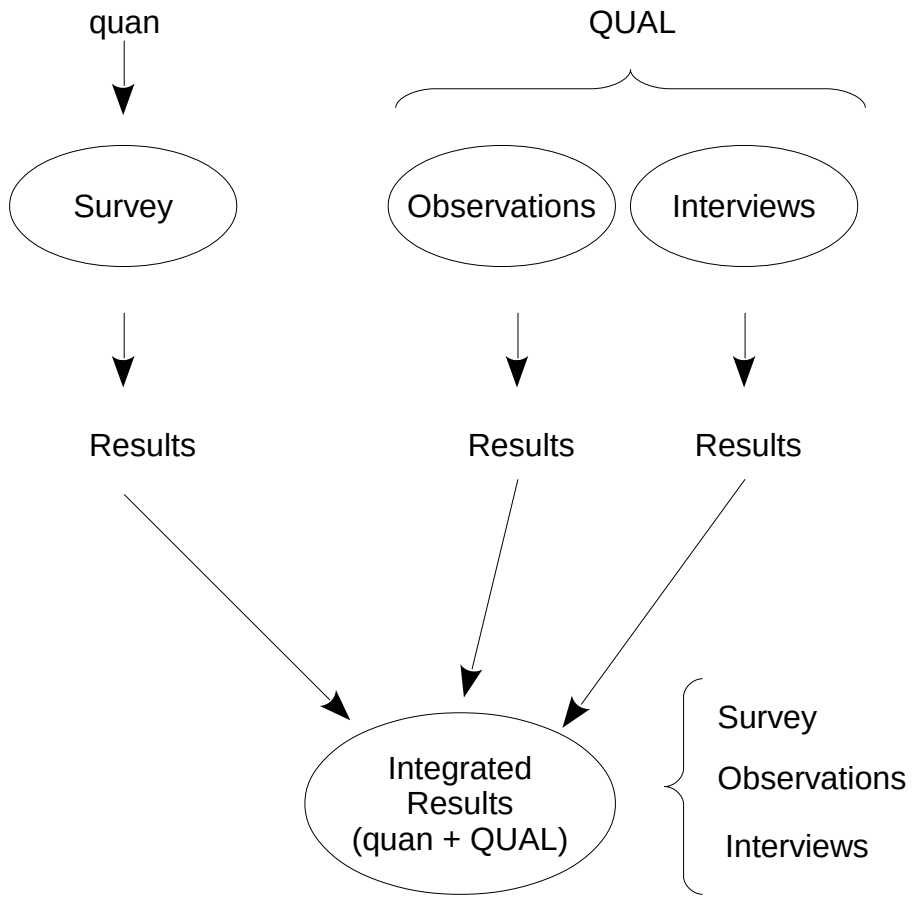


Figure 7-2: Interpretation: Integration of quantitative and qualitative results

The interpretation process consists of hermeneutics and integration. Since priority has been given to the qualitative enquiry, hermeneutics will be undertaken on the qualitative findings. The integration stage combines the quantitative and qualitative results and findings.

7-4-1. Hermeneutics

The interpretation process undertaken in the qualitative results was grounded in hermeneutics. The qualitative results involved extensive textual and image data, which necessitated the research to adopt hermeneutics as an interpretation philosophy appropriate for such an analysis process. It is noted that hermeneutics extends beyond simply textual understanding to understanding as a fundamental principle of human action and day-to-day life encounters (Wernet, 2013).

The principles that apply to hermeneutic interpretive research (Klein & Myers, 1999) are outlined in Table 7-5:

Table 7-5: Hermeneutic interpretation of the findings of the research (adapted from Langenhoven (2016)

Principle of Interpretive Field Research	**Explanation**	**Applicability**
Hermeneutic Circle	All human understanding is achieved by the iteration between the interdependent parts and the whole.	The enquiry of attributes related to digital literacy and technology adoption by the researcher to understand ICT adoption and use in the selected area of Perskebult, Limpopo, an RCE. Further, how ICT use in that area had the potential to facilitate the comprehension of digital literacy and technology adoption.
Contextualization	Advocates placing the intended audience in the context of the research settings to facilitate the view leading to the current state being investigated.	This is illustrated in Chapter 5, Subsection 5.5.1. The researcher describes the location of the field research, and the attributes of both the participating schools and the teachers.
Interaction	Advocates critical reflection on how the data was socially constructed through the interaction of the researcher with the participants.	The researcher interacted with the participants through the semi-structured one-on-one interviews and participant observations in socially constructing the empirical data used to validate the theoretical foundations.
Abstraction and Generalization	Relates to the researcher providing idiographic details of data interpretation leading to a theory describing human understanding and social action to	Abstraction focused on the context of the study, as well as theories of digital literacy and technology adoption with the aim of informing future studies in a similar context. A single location was used in the

	facilitate understanding on the part of the reader.	research. For generalization to be a possibility, multiple locations and how the deviations between these locations impact on the study will have to be investigated. Such a study may facilitate generalization. However, for the purposes of the current study, no such generalizations were attempted.
Diagonal Reasoning	Relates to addressing possible theoretical preconceptions from the research design to the actual research findings.	In the analysis phase undertaken in Section 7.3, the interpretations were done in line with the theoretical underpinnings of digital literacy and technology adoption. Any deviations due to context sensitivity are noted in that section.
Multiple Interpretations	Openness to the fact that participants can provide different interpretations of the same sequence of events.	It was noted that, despite the participants experiencing similar challenges related to resource-constraints, their attitude and interpretations impacted their interaction with the learners differently. This led them to view digital literacy needs and challenges in the area differently. However, the collaboration undertaken by the participants enabled them to be informed about the views their peers had, and potentially cross-pollinated their view and interpretations of the phenomena they were experiencing.
Suspicion	Being aware of biases and distortions in narratives from participants	The researcher anticipated differing accounts of similar experiences. A tool that was used extensively to counter this challenge was the semi-structure one-on-one interviews. These semi-structured interviews were adapted slightly based on the responses of the participant interviewed. However, the main structure remained, sp as to capture as many of the attributes related to concepts being investigated as possible.

The principles of hermeneutics clearly align with the empirical data and the associated findings. The significance of hermeneutics in explaining phenomena related to ICT was succinctly articulated by Boland (2002) and Cohen et al. (2007). As previously pointed out, Cohen et al. (2007) focused hermeneutics on the interaction of the researcher and the

participants, and the interpretations provided by researchers on the activities of the participants in relation to the phenomena under study. However, according to Boland (2002), the view of ICT as a hermeneutic process deviates from seeing ICT as a tool to achieve user objectives, socio-economic or otherwise, to seeing ICT as facilitating an environment of acting out interpretations, that is, actively appropriating meaning about our situations and ourselves.

In the context of the current research, this would mean that ICT would extend beyond simple pedagogy to information dissemination and sharing between learners and teachers, between teachers, and among both learners and teachers. These aspirations may potentially be achieved through enhanced levels of digital literacy from both teachers and learners, which will clearly be facilitated by technology adoption.

Having aligned the principles of hermeneutics to the findings and data of the current research, the next section undertakes the integration process in line with the sequential explanatory mixed method research.

7-4-2. Integration

Each of the survey results will be combined with observation results as well as the interview results, where applicable. This will be complemented by literature or references to literature in order to support or contradict the empirical results. The integration process will use results from Tables 6.7, 6.8, and 6.11. For the participant observations in Table 6.8, *ideas with no impact are excluded*. Table 7-6 illustrates the integration process:

Table 7-6: Integration of quantitative and qualitative results

	Quantitative	Qualitative	
	Survey	***Observation***	***Interview***
Digital literacy			
Technical dimensions	Participants show limited abilities for, and exposure to, addressing their own technical challenges, thus illustrating weak technical dimensions.	The dimension had a high impact in both the teacher training and the classroom sessions.	Participants showed signs of experiencing challenges with digital literacy. Very few of the participants were articulate when addressing typical attributes of technical,
Cognitive	Participants show strong	The dimension had a high	

dimensions	cognitive dimensions by having good ICT skills, despite not having particularly strong ICT conceptual knowledge.	impact on both the teacher training and the classroom sessions.	cognitive, and socio-emotional dimensions.
Socio-emotional dimensions	Participants show strong socio-emotional dimensions. Despite not using social media extensively for collaboration, participants do collaborate strongly, potentially using face-to-face encounters.	Despite not being used directly, the use of the dimension is implied when teachers collaborate and exchange ideas on a social media platform.	
Technology adoption (UTAUT)			
Performance expectancy	More than 90% of the participants showed strong performance expectancy.	The construct had limited impact on teacher training, but high impact in the classroom sessions.	Participants illustrated challenges with technology adoption, from expressing ICT as a hindrance to their work to lacking support from superiors making adoption a challenge. However, some of the participants were keen on collaborations and expressed a positive social influence in adopting ICT.
Effort expectancy	More than 90% of the participants wanted to expend the necessary effort to assist the learners in learning to use ICT, since they considered that their learners will experience little challenges from learning to use ICT. Thus, these participants showed strong effort expectancy.	The construct had a high impact on teacher training, and a moderate impact in the classroom sessions.	
Social influence	No impact	The construct had a high impact on teacher training and no impact on the classroom sessions.	
Facilitating conditions	Participants generally believed that there is adequate support from their school and superiors, but noted that	Despite this construct not being directly used, the fact that the teacher training and classroom sessions were taking place implies a strong impact for this	

	the technical support from the school and superiors was limited.	construct.	
RCEs			
	Implied from location considerations as selected through the ICT4E project		Four resources were identified for determining resource-constraint challenges experienced by participants, namely, running water, electricity, and road and telecommunication infrastructure. Of these, participants considered road infrastructure as posing the biggest challenge, and electricity the smallest challenge.

7-5. Discussion

This section pertains to the integration of quantitative and qualitative analysis from Table 7.6. In terms of digital literacy, participants experienced challenges across all its dimensions. However, in the survey and observations, participants showed understanding of all the dimensions of digital literacy, except for the technical dimensions in surveys. Participants were observed to be comfortable with the technical dimensions in both the training and classroom sessions.

In terms of technology adoption, participants experienced challenges in the interviews across all the constructs of UTAUT, except for social influence. In terms of observations, participants showed no challenges with any of the constructs of UTAUT except for performance expectancy, which had limited impact on the teacher training sessions.

In terms of the survey, only social influence had no impact on the participants. Facilitating conditions also showed limited impact due to the limited support that the participants perceived to receive from their superiors.

Finally, in terms of RCE challenges, only the interviews were used to capture information about this concept. In terms of surveys and observations, this concept was implied from discussions in Subsection 5.5.1. In addition to the resource challenges conceived from theory, road infrastructure was noted by the participants to pose the biggest challenge to their ICT use, followed by running water. The next section presents the final model.

7-6. Inception of the final model

The final model extends the conceptual model by the additional attributes from Table 7.6, these being general infrastructure and running water. General infrastructure has already been added to the list of resources from the conceptual model. Hence, only the resource of running water needs to be added to the conceptual model to extend it to the final model. Figure 7-3 illustrates:

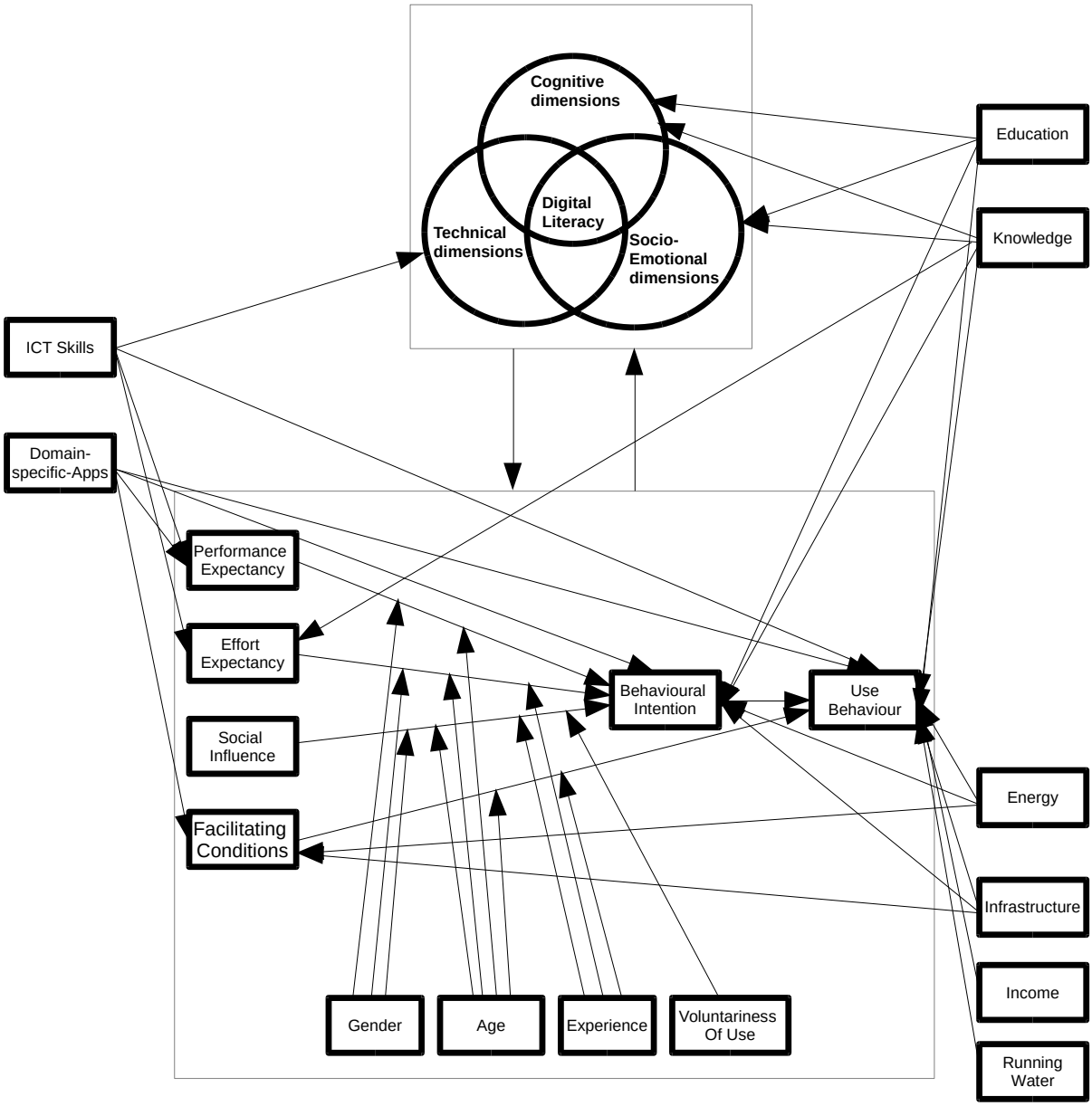


Figure 7-3: The model for the attainment and enhancement of digital literacy through technology adoption for ICT use in RCEs.

Figure 7-3 illustrates that the model for the attainment and enhancement of digital literacy through technology adoption for ICT use in RCEs incorporates the dimensions of digital literacy, the constructs of UTAUT, and the characteristics of RCEs.

The model evolved from digital literacy in Chapter 2, and was extended in Chapters 3 and 4 by adding constructs of UTAUT and attributes of RCEs, respectively. In Chapter 7, the model was extended to the current final model by evaluating and validating the empirical findings of a mixed methods enquiry.

7-7. Summary

In this chapter, the model for the attainment and enhancement of digital literacy through technology adoption for ICT use in RCEs was developed. The results of the empirical enquiries facilitated the data analysis undertaken in the study. Based on the adopted mixed method research choice, the data analysis involved quantitative and qualitative aspects. In light of the priority given to the qualitative design, hermeneutics was used to ground the interpretation process. The integration of the quantitative and qualitative results was undertaken in line with the sequential explanatory mixed methods research.

The final model was extended from the conceptual model, which in turn evolved from literature reviews on the concepts of digital literacy, technology adoption, and RCEs; this provided the theoretical foundations for the study. Empirical findings were then incorporated into this model, so as to extend it into the final model for digital literacy attainment and enhancement through technology adoption for ICT use in RCEs.

Chapter 8 *Reflection and conclusion*

8-1. Introduction

ICT use by individuals in resource-constrained environments (RCEs) presented the study with challenges and opportunities. The research aimed to highlight the opportunities and mitigate the challenges of ICT use in RCEs using digital literacy through technology adoption.

This concluding chapter presents a summary of the research by reflecting on the research questions, research methodology and methods, as well as the research contributions. The delineations and assumptions of the research are also reflected upon, and limitations of the project are presented before highlighting possible further research. Lastly, the final reflection in the form of a conclusion is presented.

The purpose of the research was to explore the attainment and enhancement of digital literacy through technology adoption for supporting individuals in RCEs with ICT use.

The objectives of the research as presented in Section 1.4 were, firstly, to investigate the significance of digital literacy for ICT use and, secondly, to investigate the significance of technology adoption for ICT use. The third was to confirm the significance of digital literacy and technology adoption for ICT use, and the final objective was to identify the opportunities and mitigate the challenges of RCEs in technology adoption and digital literacy.

8-2. Research overview

The research problem of the study was informed by the fact that the proliferation of ICT has facilitated the socio-economic participation of individuals and contributed towards the impact of the global Sustainable Development Goals (SDGs) and other regional goals. These regional goals and SDGs are driven towards challenging (social) inequality, poverty eradication, protecting the planet, and ensuring prosperity for all through a sustainable development agenda. However, individuals in RCEs are plagued by a number of resource constraints, including ICT access and use.

ICT access and ICT-related literacy have been shown to be major factors that affect ICT use by individuals. Technology adoption, particularly the Unified Theory of Acceptance and Use of Technology (UTAUT), has been shown to facilitate ICT access and use. Digital literacy is

an ICT-related literacy that facilitates the use of ICT by individuals across different socio-economic backgrounds.

The fact that there is no evidence of a model that uses technology adoption to enhance digital literacy for ICT use by individuals in RCEs provides the motivation and rationale for this problem-centred research. Based on the background and problem statement, the main research question was formulated as follows: *What elements should a model comprise of to enhance digital literacy through technology adoption in resource-constrained environments (RCEs)?* (*See*: Section 1.3).

The sub-research questions that supported the investigation of the main research question are as follows:

- *What are the elements of digital literacy that are relevant to technology use?* (see Section 1.3).
- *What are the elements of technology adoption that influence the attainment of digital literacy?* (see Section 1.3).
- *What constraints does an RCE present for the attainment of digital literacy through technology adoption?* (see Section 1.3).

The next section presents the evidence that the sub-research questions as well as the main research question have been addressed, by providing the relevant evidence.

8-3. Research questions answered

The elements of a model to enhance digital literacy through technology adoption in RCEs (main research question) were successfully identified. The sub-research questions served as building blocks for supporting the construction of a model that enhanced digital literacy enhancement through technology adoption in RCEs.

8-3-1. First sub-research question answered

Table 8-1 presents how the first sub-research question (SRQ) was addressed.

Table 8-1: Addressing sub-research question 1

Concept	***Description***
SRQ1	What are the elements of digital literacy that are relevant to technology use?

Addressed in	Chapter 2
Main findings	The literature review on digital literacy revealed that the digital literacy framework contains dimensions that facilitate ICT-related literacy that is relevant to ICT use. The core dimensions are as follows: • Technical dimensions; • Cognitive dimension; and • Socio-emotional dimensions. The roles of these dimensions are to provide the technical and operational skills necessary for day-to-day activities, the cognitive skills necessary for handling digital information, and the ability to responsibly use communication skills in digital social environment, respectively. These dimensions collectively facilitate technology use by individuals.

8-3-2. Second sub-research question answered

Table 8-2 presents how the second sub-research question was addressed:

Table 8-2: Addressing sub-research question 2

Concept	***Description***
SRQ2	What are the elements of technology adoption that influence the attainment of digital literacy?
Addressed in	Chapter 3
Main findings	The literature review on technology adoption revealed that UTAUT can be used as an individual-centred technology adoption model that can facilitate ICT adoption. UTAUT posits four direct determinants of user acceptance and usage behaviour (performance expectancy, effort expectancy, social influence, and facilitating conditions) and four moderating determinants of behavioural intention (age, gender, experience, and voluntariness of use). The four direct determinants of user acceptance and usage behaviour were shown to facilitate the attainment of digital literacy (see Subsection 3.5.2 and Subsection 3.6).

8-3-3. Third sub-research question answered

Table 8-3 presents how the third sub-research question was addressed:

Table 8-3: Addressing sub-research question 3

Concept	***Description***
SRQ3	What constraints does an RCE present for the attainment of digital literacy through technology adoption?

Addressed in	Chapter 4
Main findings	The conceptual model for digital literacy enhancement through technology adoption in RCEs was incepted in Chapter 2 and extended in Chapter 3. The literature review on RCEs presented some of the resources that affect ICT use in RCEs. This model was further extended for the context of RCEs by incorporating resource challenges in RCEs in Chapter 4. (see Section 4.4).

8-3-4. Main research question answered

Table 8-4 presents how the main research question (MRQ) was answered:

Table 8-4: Addressing the main research question

Concept	***Description***
MRQ	What elements should a model comprise of to enhance digital literacy though technology adoption in resource-constrained environments?
Addressed in	Chapter 4, Chapter 7
Main findings	The final model that aimed to understand and explain technology use amid enhancing digital literacy through technology adoption in resource-constrained environments resulted from the validation and extension of the conceptual model using empirical findings. The case study facilitated the in-depth investigation of the research challenge and the mixed method research facilitated the reporting of the resulting outcomes. The results of the mixed method research facilitated the data analysis process, which entailed quantitative and qualitative data analyses. Hermeneutics formed the grounding of the interpretation process, with the final interpretation outcomes integrating the quantitative and qualitative data analyses as dictated by the sequential explanatory mixed method research approach adopted in the research. Through these findings it was possible to illuminate the challenges posed by resource-constrained environments in the use of digital technologies. Further, the impact of digital literacy dimensions as well as the technology adoption constructs on technology use in resource-constrained environments was highlighted.

8-4. Summary of the research design

The research design provided a blueprint of how the research was conducted. As pointed out in Chapter 1, this entailed linking the research questions and research methodology with the interpretation and research conclusion (*cf.* Section 1.6). This is illustrated in Figure 8.1:

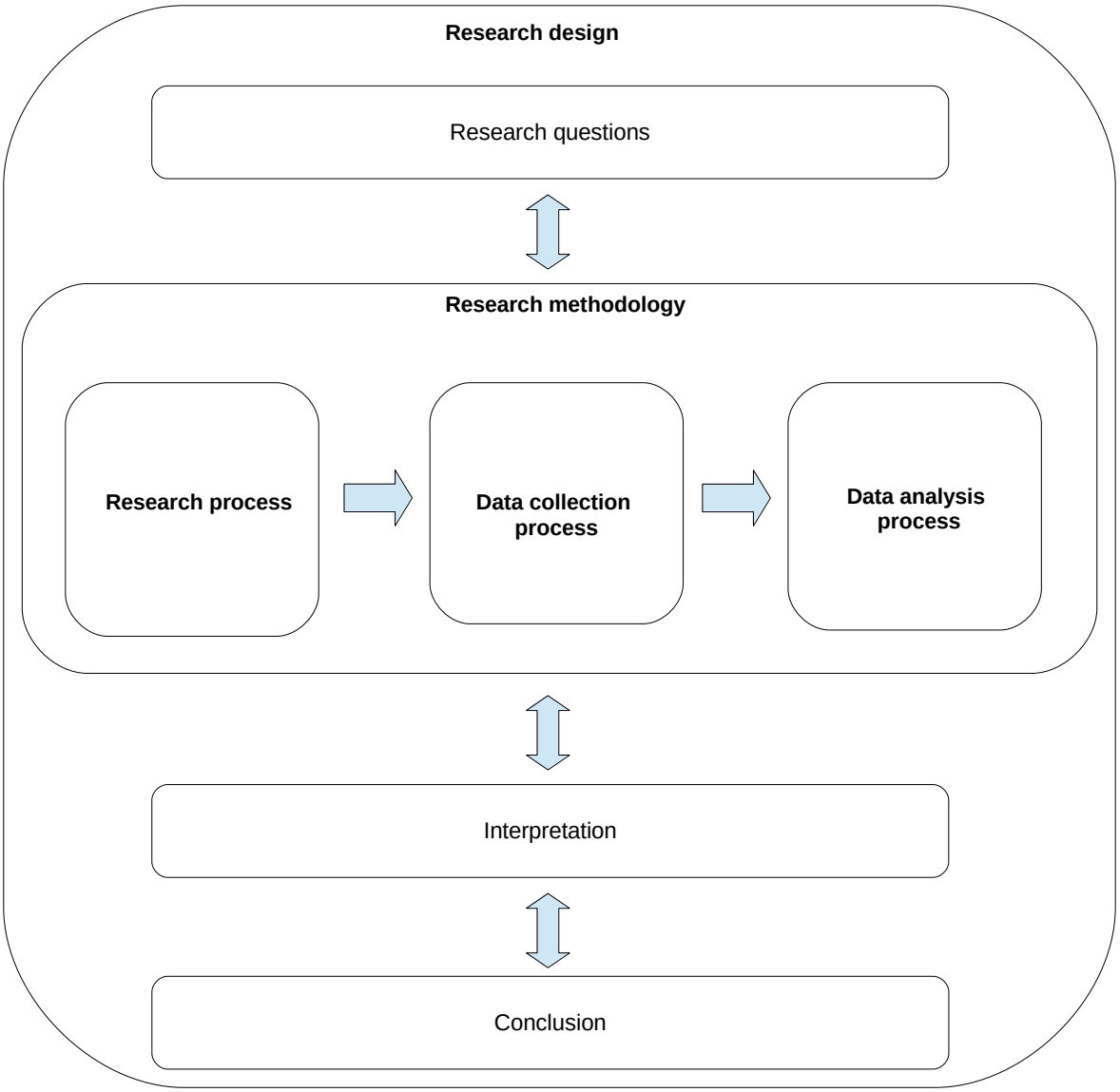


Figure 8-1: The research design (adapted from Creswell (2013) and Yin (2015))

This research design can be described as in Table 8-5:

Table 8-5: Description of the research design

Stage	Input	Output	Section	Description	Trustworthiness – Ethical considerations
Inception	Research purpose	Research questions	Chapter 1	Background identifies challenges and opportunities of ICT use	
Conceptual design	Research questions	Conceptual model	Chapters 2, 3, and 4	Literature review facilitates the incremental design of the conceptual model	

Evaluation and validation	Conceptual model	Final model	Chapters 5, 6, and 7	Research process – data collection, data analysis process, interpretation	
Reporting	Final model	Recommendations and informing research and practise	Chapter 8	Research conclusions	

Table 8-5 indicates that the research is conceived through the background of the study, grounded by the research purpose. Research questions are incepted from the research purpose. The literature review is undertaken to provide theoretical grounding and develop the conceptual model. The latter is evaluated and validated through the methodology, which encompasses the research, data collection, and analysis processes. The interpretation process is undertaken on the findings from the data collection process, and the final model is developed. Recommendations to research and practise are made in the conclusion of the research.

8-5. Reflection on key findings

The research reflection on key findings of the research is presented in Table 8-6:

The key findings of the research were guided by the research objectives. Table 8-6 outlines the key findings based on the associated research objective:

Table 8-6: Key findings of the research

Research objective	Key concept (s)	Section (s)
To investigate the significance of digital literacy to ICT use	Digital literacy through the technical, cognitive, and socio-emotional dimensions facilitates ICT use by supporting the effective use of ICT. Further, users can have the necessary cognitive skills to handle digital information and the ability to use communication skills in a digital environment.	Section 2.5.2
To investigate the significance of technology adoption to ICT use	UTAUT, through its core constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions, facilitates ICT use. Performance expectancy motivates a user to use ICT; effort expectancy informs the user on the non-trivial nature of ICT use and the need to put an effort into ICT activities; and social influence relates to the motivation to use ICT	Section 3.5.2

	based on the influence of peers and facilitating conditions on the support that individuals get to use ICT.	
To confirm the significance of digital literacy and technology adoption to ICT use	The constructs of UTAUT and the dimensions of digital literacy facilitate the effective use of ICT.	Section 2.5.2, Section 3.5.2, and Section 3.6
To identify the opportunities and mitigate the challenges of RCEs to technology adoption and digital literacy	Technology adoption and digital literacy facilitate ICT use by individuals and supports participation in the digital age with impact on socio-economic participation.	Section 2.5.2, Section 3.5.2, and Section 3.6

8-6. Chapter summary

The research consists of eight chapters. Each of the chapters can briefly be summarised as follows:

Chapter 1: Introduction

The Introduction presents the background of the research as well as the research challenges and opportunities. The research purpose is presented, and facilitates the stating of the research questions. Key concepts, which will form the theoretical grounding of the research, are identified. The research motivates its relevance by outlining the significance of the problem, followed by how the research challenges embodied in the research questions can be solved through the methodology. In light of the need for human participants in the research, ethical considerations are highlighted as a requirement.

Chapter 2: Digital literacy

The first of three literature review chapters is presented. Digital literacy is highlighted as a key concept to ground the research. The landscape of digital literacy theories is explored and the digital literacy framework is adopted for the research. The significance of digital literacy dimensions on effective ICT use is highlighted. The conceptual model addressing the challenges of the research is initiated.

Chapter 3: Technology adoption

The second of three literature review chapters is presented. Technology adoption is highlighted as a key concept to ground the research. The complexity of technology adoption and ICT use is highlighted. In light of the numerous technology adoption models and theories

available, social cognitive theory is adopted as a theoretical lens to inform the adoption of a technology adoption model. UTAUT is adopted as an appropriate adoption model for the research. The constructs of UTAUT are shown to facilitate ICT use. The conceptual model is extended to support the ICT use component towards addressing the research challenges.

Chapter 4: The enhancement of digital literacy through technology adoption – the context of resource-constrained environments

The last of three literature review chapters is presented. Resource-constrained environments (RCEs) are highlighted as the context of the research. The research identifies resources inherent in RCEs that inhibit effective ICT use. The conceptual model is then extended to cater for these resources towards addressing the challenges of the research.

Chapter 5: Research methodology and methods

The chapter adopts a research methodology that facilitates the undertaking of empirical investigations for evaluating and validating the conceptual model developed in Chapter 4 in a systematic manner. The methodology is identified to facilitate the research, data collection, and data analysis processes. The research process contains the philosophical underpinnings of the research, as well as the research strategies and choices necessary for addressing the research challenges. The research design is identified as linking the research challenges with the research methodology, interpretation, and conclusions. The significance of trustworthiness in the form of triangulation and ethical considerations is highlighted for both validating the research findings and conducting the research in an ethical manner.

Chapter 6: Research results

The research results of the sequential explanatory mixed methods research underpinning the empirical investigation are presented. In line with the research choice, the quantitative results are presented first, followed by the qualitative results. Priority is given to the qualitative results. Having presented the results, triangulation is also presented.

Chapter 7: Data analysis and interpretation

The quantitative data analysis is conducted through descriptive statistics. The qualitative data analysis uses codes and thematic analysis. In light of the extensive textual data in the qualitative enquiry, hermeneutics directed the interpretation process, followed by the

integration of the quantitative and qualitative findings of the research. The final model was incepted based on the empirical validation of the conceptual model.

Chapter 8: Reflection and conclusion

The chapter presents the conclusion of the research. Central to this process is the reflection on the challenges that the research aimed to address, as well as how they were addressed. Some of the contributions, delineations and limitations of the research are presented, as well as possible future research.

8-7. Contribution to knowledge

The findings of the research contributed to Information Systems theories, particularly those dealing with technology adoption in an RCE, such as rural areas. The impact of technology adoption and digital literacy to ICT use is well known. However, there is limited evidence of the enhancement and attainment of digital literacy through technology adoption to facilitate ICT use. Using the context of RCEs magnifies the impact of the contribution.

The next section presents delineations and assumptions made in the research.

8-8. Delineations and assumptions

The following delineations and assumptions were made:

- The research was conducted with willing participants who were actively involved in ICT use;
- The participants were adults and additional consent from next of kin was unnecessary;
- The location of the research needed to be a rural area with sufficient resources to facilitate ICT use;
- Participants were not vulnerable groups; and
- Participants had working knowledge of using mobile devices and possibly personal computers.
- The major thrust of the study was qualitative approach due to its strengths of addressing phenomena involving human participants. However, the study used a pilot to explore the viability of the research, particularly the context. As a result the data collection used was a mixed method approach.

8-9. Three reflections on the study

Three reflections on the study are presented in the section, namely, scientific, methodological, and personal reflections.

8-9-1. Scientific reflection

The study focused on informing research and practise on the significance of ICT use for socio-economic participation in light of the eminent digital age. Prerequisites to effective ICT use in the form of digital literacy were identified (see Chapter 2). However, ICT use assumes the acceptance and adoption of ICT, and this was highlighted (see Chapter 3). The research highlighted that ICT use is not sufficient for socio-economic emancipation, but that the use of digital literacy concepts enhances one's ICT use. The context of RCEs was selected for the research due to potential clarity on the significance of effective ICT use (see Chapter 4).

The sequential explanatory mixed method research proved to be sufficient for conducting empirical investigations on the attainment and enhancement of digital literacy through technology adoption towards ICT use (Creswell et al., 2010; Ivankova & Stick, 2007). Trustworthiness in the form of ethical considerations is very important when human participants are involved and should be considered for the entire research process.

8-9-2. Methodological reflection

The research investigated a number of methodologies throughout the research process. Some of these methodologies were abandoned in the final stages when data collection was about to commence or even in progress. One special mention is the design science research methodology. This methodology facilitated the construction of a model, but not necessarily the phased approach which was necessary for the research.

The research eventually adopted a methodology that facilitated the phased approach of iteratively developing a model to address the challenges posed by the phenomenon in the context of resource-constrained environments. The research onion was instrumental in directing the data collection, and data analysis processes for the research. The research process described the philosophical grounding of interpretivism for the research, which guided the research. In light of the mixed method research adopted, data collection and analysis involved both the qualitative and quantitative approaches, with priority given to the qualitative enquiry and integration in the interpretation phase (see Chapter 7).

8-9-3. Personal reflection

The research was inspired and motivated by the rapid advancement of ICT globally. Having being exposed to the field of Human Computer Interaction (HCI), the researcher always had a curiosity of challenges experienced by select user groups on the access, adoption, use, and possibly effective use of ICT. The context of a rural area provided the necessary contrast that allowed the researcher to see the depth of the challenge of ICT use by individuals experiencing resource challenges.

Curiosity alone was never going to be enough. An exploration of technology acceptance model, though interesting was quite challenging and providing the motivation of one model over a plethora of others was not a trivial task. Digital literacy was also interesting and posed several challenges. The exploration of digital literacy and technology adoption provided an interesting contrast due to the level of maturity of the two theoretical concepts. However, the most challenge was posed by the research context itself. Research always described the context of resource-constrained environments without necessarily defining it. For the purposes of the research it was necessary to define this context. The justification of a rural area as a resource-constrained environment was anticipated to be a simple task, of which this was never the case.

Despite the challenges posed by the grounding theoretical concepts of the study, the outcome of managing to integrate these concepts in harmony was an interesting revelation. The persistence thrown to the challenge seemed to periodically provide the required results in an obscure manner. However, at the end the final model resulted and allowed for the investigation of the phenomenon of interest in the context of interest.

8-10. The way forward

Technology adoption is a non-trivial concept in Information Systems (Davis, 1985). UTAUT contains elements that can assist in explaining and understanding ICT use across a number of domains (Venkatesh et al., 2003). Future studies may use multiple locations over a longitudinal study for validating the model developed in the research. Different user groups and domains can also be investigated, for example, the health domain. It would be interesting to also investigate effective ICT use in digital literacy in urban areas.

8-11. Conclusion

The challenge of ICT use and effective ICT use is one that is always posing challenges for Information Systems and Computer Science. Investments are frequently made on captivating systems which users never actually use. In the advent of information societies, knowledge economies and the digital age mainly in developed countries ICT is playing an important role in socio-economic participation. However, this is generally not the case for developing countries like South Africa. Rural areas in these developing countries in the form of resource-constrained environments experience the most challenges.

The theoretical concepts on technology adoption and digital literacy proved to be accommodative of resource constrained environments resulting in a conceptual model which explained ICT use in rural areas. Rural areas being an instance of resource-constrained environments. The empirical investigation of the conceptual model facilitated its evaluation and validation even in light of challenges relating to the data collection process and the trustworthiness which encompassed the entire research process. The analysis and interpretation of the findings of the research facilitated the extending of the conceptual model to the final model. Through the model, the challenges addressed by the research were realised.

The model for digital literacy enhancement through technology adoption in resource-constrained environments achieved its goal of facilitating ICT use in rural areas. The model encompassed dimensions of digital literacy which facilitated the reflection on ICT use to allow for the effective use of ICT by individuals. The model also encompassed the constructs of technology adoption which facilitated ICT acceptance and use. Finally, the attributes of resource-constrained environments were also taken into consideration in order to extend the model to rural areas.

The research showed that ICT use is possible using digital literacy through technology adoption for users in RCEs.

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Appendix A: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) RESEARCH AND ETHICS COMMITTEE

8 November 2017

Ref #: 088/PMLM/2017/CSET_SOC
Name: Pule Muzi Lincholn Matyila
Student #: 31810322

Dear Pule Muzi Lincholn Matyila

Decision: Ethics Approval for 3 years (Humans involved)

Researcher: Pule Muzi Lincholn Matyila
P.O. Box 850, Morula, 0196
31810322@mylife.unisa.ac.za, +27 73 186 3693

Supervisor(s): Prof A. Botha, abotha@csir.co.za, +27 12 841 3265
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Proposal: A model for digital literacy enhancement through technology adaption in resource-constrained environments

Qualification: MsC.

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 8 November 2017 to 8 November 2020.

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

Open Rubric

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be communicated in writing to the Unisa College of Science, Engineering and Technology's (CSET) Research and Ethics Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.

3. 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.
4. 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 require additional ethics clearance.
5. Permission to conduct this research should be obtained from the participating entities prior to commencing field work. The research is also covered by the CSIR ethical clearance based on the project as ran by the Department of Rural Development and Land Reform (DRDLR).

Note:

The reference number 088/PMLM/2017/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

Adde da Veiga

Dr. A Da Veiga

Chair: Ethics Sub-Committee School of Computing, CSET

Prof I. Osunmakinde

Director: School of Computing, CSET

for (PROF IW ALDERTON)

Prof B. Mamba

Executive Dean: College of Science, Engineering and Technology (CSET)

Approved - decision template – updated Aug 2016

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Appendix B: Interview protocol

Demographic information:

- Professional career?
- Age group range: 0-18, 19-25; 26-40; 40+
- Years in the profession?
- Marital status
- Gender

Educational background

- Ranges: Grade 12; 3 year qualification; Type of qualification; 4 year + qualification

Resource-constrained environment

- Please explain any resource challenges in your area.

Dimensions of digital literacy

- Technical
  - What are technical challenges?
  - Do you know how to solve your technical problems?
  - Can you teach your learners how to do their lesson on the tablet?
  - Can you create your own teaching material for your learners? If not, are you interested in knowing?
  - Describe the level of your ICT skills on a day-to-day basis
- Cognitive
  - Do you believe using ICT is mentally demanding?
  - What do you think of the validity of the information from the Internet?
  - What do you know about cybersecurity, search, and plagiarism?
- Socio-emotional
  - Do you believe you have to be careful on the Internet? Please explain.
  - Explain your interaction with colleagues regarding the challenges you experience with teaching and using ICT in general.
  - Do you collaborate with your colleagues using ICT? Briefly explain.

Attributes of UTAUT – Technology adoption

- Performance expectancy
  - Do you believe ICT can assist you in improving your work? Please explain.
- Effort expectancy
  - Do you believe ICT can be used effortlessly? Explain.
- Social influence

- Do you think your colleagues would like you to use ICT with your learners? Collaborating? Interacting with them? Please explain.

- Facilitating conditions
  - Do you believe you have enough support from your superiors to use ICT? What about general technical support? Explain.

Appendix C: Survey instrument involving ICT acceptance and Digital Literacy

This section tells us the level of your digital literacy based on three dimensions, namely: the technical dimension, the cognitive dimension, and the socio-emotional dimension. The first dimension is the technical dimension:

How much do you agree with the following statements?	Completely Disagree	Disagree	Agree	Completely Agree
I know how to solve my own technical problems*	1	2	3	4
I can learn new technologies easily*	1	2	3	4
I keep up with important new technologies*	1	2	3	4
I know about a lot of different technologies	1	2	3	4
I can teach my students to select appropriate software to use in their projects*	1	2	3	4
I have the technical skills I need to use ICT for learning and to create artefacts (e.g., presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt	1	2	3	4
I have good ICT skills	1	2	3	4

*If you ***agree*** or ***completely agree*** with any of the items in 1, 2, 3 or 4, please provide an explanation below:

……

……

The second dimension is the cognitive dimension:

How much do you agree with the following statements?	Completely Disagree	Disagree	Agree	Completely Agree
I am confident with my search and evaluate skills in regards to obtaining information from the Web*	1	2	3	4
I am familiar with issues related to web-based activities, for example, cyber safety, search issues, and plagiarism*	1	2	3	4

*If you ***agree*** or ***completely agree*** with any of the items in 1 or 2, please provide an explanation below:

……

……

The third and final dimension is the socio-emotional dimension:

How much do you agree with the following statements?	Completely Disagree	Disagree	Agree	Completely Agree
1. I frequently obtain help with my teaching work from my friends over the Internet, for example, through Skype, Hangouts, Facebook, and Blogs*	1	2	3	4
2. ICT enables me to collaborate better with my peers on teaching concepts and learning opportunities*	1	2	3	4

*If you ***agree*** or ***completely agree*** with any of the items in 1 or 2, please provide an explanation below:

……

……

I think my level of digital literacy is (Please circle on a scale of 1-10 below)

Very low									Very high
1	2	3	4	5	6	7	8	9	10

Please explain your option above:

……

……

The next set of questions relate to attributes of ICT acceptance using the UTAUT acceptance model in teaching, as governed by the theoretical framework of ICT4E in rural schools:

How much do you agree with the following statements?	Completely Disagree	Disagree	Agree	Completely Agree
(PE) I expect to find ICT useful in my teaching work*	1	2	3	4
Using ICT will enable me to exercise my teaching work easier	1	2	3	4
Using ICT will enable me to positively teach more learners	1	2	3	4
(CI) I intend to continue using ICT for my teaching rather than discontinue using it*	1	2	3	4
My intentions are to continue using ICT for teaching rather than traditional teaching	1	2	3	4
I would like to discontinue using ICT for teaching	1	2	3	4
(EE) ICT use for teaching is clear and understandable*	1	2	3	4

Teaching using ICT will be easy and I believe my learners will experience little challenges with it	1	2	3	4
ICT will introduce challenges to teaching learners	1	2	3	4
(Perf.) I anticipate learners to be motivated in learning with ICT methods*	1	2	3	4
I believe that my learners will not progress when learning using ICT	1	2	3	4

Key:

SI – social influence

PE – performance expectancy

EE – effort expectancy

CI – continuance intention

FC – facilitating conditions

*Please explain your answers to questions 1, 4, 7, and 10 above:

……

……

Other attributes that are used from the main instrument to capture facilitating conditions (FC) are as follows:

How much do you agree with the following statements?	Completely Disagree	Disagree	Agree	Completely Agree	Not Applicable
I would like to know how to teach using technologies*	1	2	3	4	5
Other educators encourage me to integrate tablets / computers in teaching and learning	1	2	3	4	5
I would like to teach using ICTs	1	2	3	4	5
The school's ICT coordinator or committee encourages me to integrate tablets / computers in teaching and learning *	1	2	3	4	5
The principal encourages me to integrate tablets / computers in teaching and learning	1	2	3	4	5
The technical support in my school is adequate*	1	2	3	4	5
The instructional support (i.e., support provided by the HOD or principal to guide teaching and learning) in my school is adequate	1	2	3	4	5
The technical infrastructure in my school is adequate	1	2	3	4	5

*Please explain your answer to questions 1, 4, and 6 above:

……
……
Other comments:

……
……

Appendix D: Participant information sheet

rural development & land reform
Department:
Rural Development and Land Reform
REPUBLIC OF SOUTH AFRICA

CSIR

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PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 088/PMLM/2017/CSET_SOC
Research permission reference number (if applicable): N/A

Date: February / March 2018

Title: A model for digital literacy enhancement through technology adoption in resource constrained environments.

Dear Prospective Participant

My name is Pule Muzi Lincholn Matyila and I am doing research with Adele Botha, a professor in the School of Computing towards a MSc. (Computing) at the University of South Africa. We have funding from Centre for Scientific and Industrial Research (CSIR) for the completion of the research. We are inviting you to participate in a study entitled 'A model for digital literacy enhancement through technology adoption in resource constrained environments'.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that can benefit the researcher in informing research and practice on considerations necessary for facilitating the use of Information and Communication Technologies (ICT) in resource-constrained environments, e.g., rural, semi-urban areas. It is anticipated that through the adoption of the guidelines outlined in the study, research and practice may be informed on considerations necessary for the effective use of ICT by individuals in their day to day activities. As a result thereof individuals from these environments can be part of the digital age and knowledge society.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited to participate in this research since you fit the criteria of an individual from a resource-constrained environment who may benefit from effective use of ICT. The criteria used for determining an individual from a resource-constrained environment is based on academic literature.

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Estimated sample size and implications

Questionnaire:

A total of between 15 and 30 participants will complete the questionnaire for the purposes of the research project.

Interview:

A total of between 5 and 10 participants will participate in the semi-structured interview process.

Please note that your participation on the research is purely voluntary. Should you wish not to continue with the participation, you are welcome to withdraw your participation at any time with full reservation of your rights.

Instruments used in the research

Questionnaires, semi-structured interviews and participant observation are the only instruments to be used in the research for data collection purposes. The selected number of participants for each instrument is guided by availability and the theoretical concept of theoretical saturation which refers to a state where it is anticipated that no new information will be introduced by adding more participants. Further, it is acknowledged that the qualitative data collection methods may not require a high quantity of participants.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Describe the participant's actual role in the study.

The study involves questionnaires, semi-structured interviews and participation observation. You as a participant will be requested to participate in any of the following activities:

- Complete a questionnaire
- Participate in a short interview not lasting more than 10 minutes
- Be observed while performing a specific task

Interviews may involve voice recording, and note taking. Both activities are for analysis purposes. Participant observations will involve observation while completing a set activity.

Describe the time allocated to conduct interviews/focus groups.

Please note that you will be requested to participate in an interview session. The interview undertaken is a semi-structured interview meaning that there are no set questions for the interview. However, the questions will have a common theme on the general use of ICT. The interview process will contain no more than ten (10) questions and feel free to ask for additional explanation of the question or request the question to be skipped if you are uncomfortable to

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provide and answer. The interview process is not expected to take a maximum of fifteen (15) minutes.

If you are participating in the participant observation process, you will be requested to perform a task using a tablet. Predefined tasks will be made available, but you are welcome to introduce your own. Instructions will be communicated in English. Please let this not intimidate you and feel free to ask any questions at any time. Note that you are free to withdraw your participation at any time with full reservation of rights. The observation process is not expected to take more than the duration of the session which is anticipated to be no more than thirty (30) minutes.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Statement that participation is voluntary and that there is no penalty or loss of benefit for non-participation.

Participating in this study is voluntary and you are under no obligation to participate in the research. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. Please feel free to ask any questions regarding your consent. You are free to withdraw participation on the research at any time with full reservation of your rights and without giving a reason.

Potential use of surveys and implications

A mixture of open ended and closed questions will be asked with an emphasis of open ended questions. The open ended question will be used to structure the questionnaire and the open ended question will be used to encourage participants to provide depth to the research process.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Please note that there are no direct benefits that you will gain by participating in this research. It is anticipated that by understanding your digital literacy levels it may be simpler to improve them and effectively participate in the digital age and knowledge society. Research and practice may also be informed on design considerations necessary for facilitating effective use of ICT in your environment, i.e., resource-constrained environments.

ARE THEIR ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

Please note that there are no anticipated negative consequences for you if you participate in the research. The research needs to gather information on the attributes of a group of interest.

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Despite participants used in the research, no personal information of an individual is used in the research only the attributes.

Potential level of inconvenience and/or discomfort to the participant

The main inconvenience will be time. Please note none of the questions are meant to make you uncomfortable but simply to inform the research in order to meet its objectives. No personal information or information that directly describes you will be captured at anytime. Note that if you are part of the interview candidates then a voice recording may be taken with your consent. The purposes thereof are only for analysis purposes and will not be used beyond that.

Finally, at the end of either an interview or observation session you will be debriefed. The results of the research may be made available to you if you so wish. The contacts of the researcher, the researcher's supervisor as well as the researcher's institution in relation to ethics will be made available to you. Please feel free to contacts these people regarding the research should the need arise.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Please note that any information you provide to the researcher as well as your identity will be kept strictly confidential.

Extent to which confidentiality of information will be maintained

Please note that your confidentiality as well as you privacy will be maintained at all times during the research process, including but not limited to the analysis and reporting stages of the research.

You have the right to insist that your name should not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Please note that your answers will not be directly linked to you under any circumstances. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

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Information dissemination

Please note that the information you provided may be used in the research for information dissemination which may include the research report, dissertation, conference proceedings or journal articles. At no time will your personal information be used. The information you provide will be coded and pseudo names will be used where necessary. These efforts will be undertaken to protect your privacy and confidentiality.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a minimum period of five years in a locked cupboard for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

Information and data termination

The hard copies of the interview results and observation records will be shredded, while the soft copies of the results will be deleted permanently from the hard disk and other storage mechanisms for example memory sticks and external hard disks.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Please note that there will not be any remuneration offered for participation and participation will be on a voluntary basis. If there are any costs incurred by your participation feel free not to partake in the research.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received ethics approval from the Ethics Sub-Committee School of Computing, UNISA College of Science, Engineering and Technology's (CSET) Research and Ethics Committee, Dr. Adele da Veiga, 011 670 9175 and email address dveiga@unisa.ac.za.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Pule Muzi Lincholn Matyila on 012 841 4918 (073 186 3693) or email pmatyila@csir.co.za. The findings are accessible for five (5) years.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact the researcher (student) Pule Muzi Lincholn Matyila on 012 841

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4918 (073 186 3693) or email pmatyila@csir.co.za or the supervisor Prof. Adele Botha at 012 841 3265 and email address abotha@csir.co.za.

Should you have concerns about the way in which the research has been conducted, you may contact my supervisor Prof. Adele Botha at 012 841 3265 and email address abotha@csir.co.za. Contact the research ethics chairperson of the Ethics Sub-Committee School of Computing, UNISA College of Science, Engineering and Technology's (CSET) Research and Ethics Committee, Dr. Adele da Veiga, 011 670 9175 and email address dveiga@unisa.ac.za if you have any ethical concerns.

ACKNOWLEDGEMENTS

This work acknowledges the DRDLR ICT4E Project which is funded by the Department of Rural Development and Land Reform (DRDLR), and supported by the University of the Free State (UFS) through their training of the teachers and NARYSEC youth at the identified 24 schools in 9 provinces in South Africa. The project is managed, operationalised by CSIR, Meraka that is also doing monitoring and evaluation and baseline assessments with ICT Audits.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

Full names: Pule Muzi Lincholn Matyila

Signature: _____ Date: _____

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Appendix E: Participant consent form

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CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to voice recording during the interview process and potentially having my photo taken as part of a group during the observation process. (No recording of users will be undertaken during participant observation, only during semi-structured interviews)

I have received a signed copy of the informed consent agreement.

Participant Name & Surname..... (Please print)

Participant Signature.....Date.....

Researcher's Name & Surname..... (Please print)

Researcher's signature.....Date.....

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