HOW THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY ENABLES SCHOOL TEACHERS TO GENERATE EDUCATIONAL OUTCOMES: CASE OF SOUTH AFRICA

A Doctoral Thesis

Presented by

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DECLARATION

I hereby declare that the thesis

HOW THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY ENABLES SCHOOL TEACHERS TO GENERATE EDUCATIONAL OUTCOMES: CASE OF SOUTH AFRICA

is my own work, and all sources have been acknowledged through referencing.

Signed by candidate

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Kesewaa Koranteng

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Lord, our Lord, how majestic is your name in all the earth! …Ps 8:1

I am grateful for God's sustaining grace throughout my PhD journey. My gratitude goes to my supervisor, Professor Wallace Chigona, for his guidance and patience. I am indebted to my parents, Florence and Isaac Koranteng, for their continued love, care and encouragement. To my siblings, Akose and Kweku Koranteng, thank you for your love and encouragement. To my sister-in-law, Priscilla Adipa, thank you for your support. I am grateful for your feedback and encouragement during our long telephonic hours. May we pass on the baton of academic excellence to the next generation with the likes of Sankofa Koranteng, amongst others. To my confidantes, Adwoa Amparbeng and Rolean Godfrey, I am fortunate to have good friends like you. We are continually sharpening one another. Your presence in my life has been consistent through good and bad times. To My Love, Thomas Dunyo, thank you for loving and supporting me through your fervent prayers.

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DEDICATION

This thesis is dedicated to my parents, **Isaac** and **Florence Koranteng**. Your discipline and principles have shaped me to be the woman I am today!

THESIS ABSTRACT

Problem Statement: ICT is said to improve educational efficiencies and aids in addressing educational shortcomings in the developing world context. Although ICT holds the potential to greatly improve teaching, why and how ICT has the probability of transforming teaching, for actors and within the developing world context remains uncertain. The potential impact of these tools may be affected by contextual and socio-cultural factors. Socio-cultural factors may have a negative consequence on students' learning and can increase educational inequalities, especially in developing countries. The challenge is that existing research does not clearly explain how educational outcomes are generated through the use of ICT within the social-cultural context of teachers.

Purpose of the research: The objective of this study was to examine how educational outcomes are generated through the use of ICT in a developing world context, at a micro-level – an individual. The aim was to investigate how the use of ICT enables opportunities for school teachers to generate educational outcomes.

Research approach: The study adopted an interpretive approach using a qualitative method. It adopted a case study method. The study drew on the Capability Approach (CA) as a supplemented by individual differences conceptual framework and taxonomy of ICT affordances as a theoretical lens to explain why and how ICT affects teaching, for whom and in what context.

The study analysed the patterns between opportunities determined by affordances, individual differences that affect how ICT is used and educational outcomes. The study used a purposive sampling method to select seven schools. From the seven schools, fifteen teachers, seven principals, seven ICT coordinators or personnel in charge of ICT, and two heads of e-Learning in Western Cape education districts. Data was obtained through background documents, semi-structured interviews and direct observations of teachers.

Key findings: ICT enabled teachers to generate three outcomes: (i) teaching capability outcomes that led to improvements in content delivery, communication, and lesson preparation relating directly to teaching, (ii) basic human capability outcomes led to the needs of the teachers regarding their well-being being met (iii) communication capability outcomes led to teaching communities consisting of teachers that share resources and expertise. Individual differences of teachers, personal data (such as age, ICT skills training, education and level of expertise in the subject taught), social factors (such as rules and policies), shaping and influencing factors (such as personality type and role model) and environmental context (such as habits, customs, beliefs and cultural values) determined how teachers used ICT to enable capabilities. Various factors (such as infrastructure, learner engagement and excitement as well as ICT skills training) affected the choice of teachers to act on the opportunities afforded by ICT to generate educational outcomes.

The value of the study: The study makes three contributions. First, the research suggests theoretical propositions for explaining how the use of ICT enables teachers to produce educational outcomes. The study developed a conceptual framework by integrating Amartya Sen's CA, individual differences conceptual framework and taxonomy of affordance to explain how educational outcomes are generated through the use of ICT in the developing world context. The study found ICT artefact, features, supportive function (such as training and support) and affordances enabled opportunities, the teachers acted on these opportunities to generate efficiencies in teaching, their well-being and the broader educational community within the context of individual differences. Second, the study provides recommendations for planners and implementers to address issues on the actual realisation of ICT benefits by creating effective strategies that aim at improving

implementation of ICT in schools. These strategies should look at the opportunities generated from ICT and how teachers use these opportunities to achieve educational outcomes. Additionally, recommendations were provided for e-Learning coordinators who wish to deploy ICT and integrate it into schools' curricula to equip teachers with all the components of TPACK (Technology, Pedagogy and Content Knowledge). Additionally, e-Learning coordinators should provide a space for teachers to experiment, highlighting existing practices and providing support to achieve their personal goals, which are part of their value system. Third, empirical evidence and theory in this thesis contribute to the knowledge of ICT in education assessments by offering a better explanation of the capability outcomes in ICT in the education field.

Keywords: ICTs, Use, Individual differences, Teachers and educational outcomes, Developing countries, South Africa

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LIST OF ACRONYMS

ANT	Actor-Network Theory
BBC	British Broadcasting Corporation
BEd	Bachelor of Education
BSC	Bachelor of Science
CAD	Computer-Aided Design
CA	Capability Approach
CAT	Computer-assisted Teaching
CES	Centre for Education Studies
CSS	Cascading Style Sheets
DBE	Department of Basic Education
FET	Further Education and Training
GeSCI	Global e-Schools Communities Initiative
GETC	General Education and Training Certificate
ICT	Information and Communication Technology
ICT4D	Information and Communication Technology for Development
ICT4E	Information and Communication Technology for Education
ICT4T	Information and Communication Technology for Teaching
IS	Information Systems
IT	Information Technology
LMS	Learning Management Systems
MCSE	Microsoft Certified Solutions Expert
SDGs	Sustainable Development Goals
NEPAD	New Partnership for African Development
NQF	National Qualification Framework
PGCE	Postgraduate Certificate in Education
PLATO	Programmed Logic for Automated Teaching Operations
SACE	South African Council of Education
UNESCO	United Nations Educational, Science and Cultural Organisation
WCED	Western Cape Education Department
WWW	World Wide Web

GLOSSARY OF TERMS

Affordances	This refers to the functional properties that determine how a product could be used (Mechant, All, & De Marez, 2018).
Agency	This implies recognising individuals as responsible beings who act or refuse to act in one way or the other (Robeyns, 2011).
Capabilities	These are the opportunities a person can choose from to improve their lives or to achieve valuable beings and doings (Sen, 2017b). The enabling of opportunities for individuals and individual's choice are affected by individual differences.
Commodity	A tool that enables a persons to achieve beings and doings.
Curriculum	A curriculum entails the philosophy, the content, the approach and the assessment of the programme of learning (Griffin, 2018).
Functionings	This refers to the being and doings of teachers (Sen, 1999b).
Deployment	Involves installing, setting up, testing and running of computers
ICT integration	Implies reinforce appropriate use of technologies (computers, software applications, mobile devices, social media) in the delivery or presentation of instruction and assessment (Howie & Blignaut, 2009). It involves the pedagogy of social interaction and technology.
ICT integration into schools' curricula	Teaching and learning with technology in all the curricular areas (subjects and non-subjects) (Cruz, 2018).
Individual differences	Provides guidelines for identifying factors that make teachers differ and impact their use of ICT to achieve educational outcomes (Nyemba-Mudenda, 2015). Individual differences may be an individual's personal, social, environmental, influencing and shaping factors (Trauth, & Farwell, 1995; Trauth, 2017). Personal factors are traits of the individual such as age, gender, education, level of expertise on the subject taught. Social factors include social arrangements such as rules and policies. Environmental factors include infrastructure. Influencing and shaping factors are personal characteristics and personal influences that shape an individual's decision-making process.
Information and Communication Technology (ICT)	In this study, ICT is any communication device, application or product that stores, retrieve, manipulate, transmit or receive information electronically in a digital form (Barnes & Kennewell, 2017; Fraillon, Ainley, Schulz, & Friedman, 2014). For example, personal computers, digital television, email, robots (Howie & Blignaut, 2009).
Outcomes	These are capabilities and realised functionings that result from an individuals' choice to act on the opportunity in his or her capability set (Hatakka, Ater, Obura, & Mibei, 2014).
Well-being	This refers to the state of being comfortable, healthy or happy (Nyemba-Mudenda, 2015)

CHAPTER 1 : INTRODUCTION

1.0 Introduction

This chapter is an overview of the study. It explores Information and Communication Technology (ICT) integration in teaching. The chapter presents the research problem, purpose, research question and sub-question of the study. Additionally, it provides a synopsis of the research methodology for the study.

Section 1.1 provides a summary of the background of the study. Section 1.2 details ICT integration in education in developing world contexts. Section 1.3 discusses the case which represents the phenomenon under study. Section 1.4 provides the researched education sector in South African schools. Section 1.5 highlights the research problem. Section 1.6 presents the research question. Section 1.7 provides the research purpose. Section 1.8 gives an overview of the research methodology used in the study. Section 1.9 states the contribution and benefits of the study. Section 1.10 provides an overview of the theoretical approach for the study. Section 1.11 provides the delimitation of the research. Section 1.12 specifies the thesis structure.

1.1 Background to the study

Education is key to reducing poverty and inequalities and improving economic growth (Boud, 2000; Mirowsky, 2017). It develops human capabilities, which are vital to an individual's power to reflect, choose, obtain a voice in society and enjoy a good life (Mirowsky, 2017). In developing and developed countries, education in the 21st century that builds on student skills, including critical thinking, creativity and communication, is increasingly involving technology which similarly equips students to become independent and life-long learners (Owen, Palekahelu, Sumakul, Sekiyono, & White, 2018). In developing countries, the Sustainable Development Goals (SDGs)

acknowledge the significance of education that extends beyond basic literacy, numeracy and conventional methods. ICT is seen as an enabler (Wagner, 2018).

1.1.1 Significance of ICT in education

In this study ICT and education technologies are used interchangeably. ICT has gained a prominent role in teaching and learning over the past decades (Comi, Argentin, Gui, Origo, & Pagani, 2017). Most countries have significantly invested in the purchase and maintenance of ICT-related education devices (Comi et al., 2017). ICT has improved efficiencies in teaching and learning spaces – for collaboration and knowledge creation, either by simulating greater interaction through the use of collaborative tools (Akpabio & Ogiriki, 2017; Latif et al., 2018). Through ICT, teaching and learning processes are much easily applicable to practical situations and simplified. ICT helps to increase the quality of education and meet the requirements of the knowledge society (Behzadi, 2015). Digital competencies are seen as a core part of the 21st-Century skillset, and the work-force are driven towards attaining and using such competencies (Kostaris, Stylianos, Sampson, Giannakos, & Pelliccione, 2017; OECD, 2014). Thus, across the globe, education systems aim to develop the digital competencies of learners (Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017). Educational institutes seek to help teachers and learners with technology-related skill acquisition, self-based discoveries, assessments, storage, content creation, presentation and information sharing (Gil-Flores et al., 2017).

1.1.2 Integration of ICT in education

ICT is said to improve educational efficiencies and aids in addressing educational shortcomings. It is with this belief that international organisations (for example the World Bank, United Nations Development Program and International Telecommunications Union) have promoted investments in ICT infrastructure for education (Soper, Demirkan, Goul, & St Louis, 2012). Multinational institutions have established efforts to promote universal access to primary education through ICT across continental structures and

within countries (Cosentino & Sridharan, 2017). At the multinational level, the Global e-schools Communities Initiative seeks to deploy ICT into schools and integrate it into schools' curricula, to improve teaching and learning (Park & Tan, 2016). At a continental level in Africa, formal structures such as the New Partnership for African Development have developed programmes such as the e-Schools initiatives, to promote universal access and use of ICT in all schools (Augustine & Abugu, 2018). At a national level, the South African government has developed the e-Education policy to ensure that every learner can use ICT confidently and creatively to develop the skills and knowledge they need to achieve personal goals (DoE, 2004).

1.2 ICT integration in education in developing world context

In the developing world context, ICT is seen as a tool to help tackle educational shortcomings and improve educational efficiencies. Many developed and developing countries recognise the importance of ICT in transforming education. In developed countries, many classrooms are digitalised, with ICT used for teaching and learning (Ome & Okechukwu, 2017). A large number of developed countries have exploited the potential of ICT to transform teaching and learning (Kolmanič, Kohek, & Žalik, 2018; Kosakowski, 1998; Onwuabgoke & Ukegbu, 2010). As a result, studies on ICT integration in schools within the developed world context focus more on fundamental and personal factors that are pivotal to the successful integration of ICT into teaching and learning rather than whether ICT exists or not (Ertmer, Quinn, & Glazewski, 2019). In other words, teachers' pedagogical beliefs, teachers' attitudes, technology use in education, ICT competencies, technological and pedagogical content knowledge (Drossel, Eickelmann, & Gerick, 2017; Koh, Chai, & Lim, 2017; Marcus-Quinn & Hourigan, 2017; Tondeur, Aesaert, Prestridge, & Consuegra, 2018; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017).

In developing countries, ICT integration is characterised by developmental discrepancies between the rich and the poor. This means there exist two sectors consisting of traditional and modern society (Çapuk & Kara, 2015). While schools in the

urban and more affluent areas are well resourced with ICT, schools in the low-income and rural areas lack basic infrastructure such as electricity, classrooms, instructional technology and telephones (Mireku, 2016). Barriers (such as lack of ICT, technical support, institutional support and teacher ICT skills training) to accessing functional infrastructure need to be minimised. With regards to teachers' professional development, this is mostly for adoption, and use of ICT in teaching and learning involving technical approaches focused on skills-based technical training rather than how to carry out activities that involve relevant pedagogies (Owen et al., 2018). ICT facilities and ICT skills are important, but need to be productively integrated into the curriculum if they are to make a positive impact on education (Mirzajani, Mahmud, Ayub, & Wong).

1.3 Case selection for the study

This section provides reasons for selecting the case of South Africa for the study. In addition it details why the sampled schools were selected from the Western Cape Province.

1.3.1 Why South Africa was selected

The case of South Africa was selected for a number of reasons. Education is a priority for the government and forms one of the highest investments (19.4%) from the total government public spending (Stats_SA, 2017). Despite substantial investments in education in South Africa, the education system is seen as the worst compared to low-income African countries. On the one hand, there are functional, well-resourced schools (approximately 25% of all South African schools), with high-quality teachers educating a small minority of the population, mostly in urban areas (Ben -Peretz & Feiman-Nemser, 2017). Approximately 75% of South African schools are poor and dysfunctional, with weak management and poor-quality teachers (Letseka, 2014; Spaull, 2011). The low quality of education in the lower grades is characterised by widespread failure of South African children to reach a basic threshold of literacy and numeracy (Bold et al., 2017).

Only a minority of South African learners, irrespective of grade or subject, are meeting the national curriculum standard (Ben-Peretz & Feiman-Nemser, 2017).

Subjects that are drivers of technological innovation and critical thinking, such as Mathematics and Science (Mateus et al., 2014), are under-performed, with a lack of foundational competencies. Although the national senior certificate examination pass rate was reported as 72.5% in 2016 (DBE, 2017), the average pass rate for Mathematics and Science was only 56.3% and 64.45% respectively. Furthermore, of the 37,290 learners who wrote Mathematics, only 30% received a grade above 40% (DBE, 2017). There was a low rate of learners who achieved an above-40% grade pass rate for both Mathematics and Science.

Poor quality education has led to a broad skills gap with a lack of skilled expertise to fill employment vacancies in the workforce (Mateus, Allen-Ile, & Iwu, 2014). The skills required for employment are advancing at a rapid rate, while teaching methods continue to be rooted in 20th-century pedagogies (Tarling & Ng'ambi, 2016). Compounding the issue are other complex factors, such as low teacher content knowledge, poor retention rates and subject choices, unequal educational opportunities as well as poorly skilled teachers. Teacher quality is seen as the most critical factor influencing the quality of education. The challenge is that there is a dearth of teachers that have strong content knowledge and pedagogical content knowledge:

> *…The challenge* [with education] *in South Africa is teacher training. The vast majority of* [teachers] *are incapable of delivering the curriculum. If one looks at systemic results of teachers* [when]*, they do competency tests* [the results are] *quite frightening averaging* [from] *10* [to] *15% on content* [knowledge] *and they are teaching the student(s). There is a problem in the system* [there are] *many teachers who cannot* [teach and] *believe erroneously* [that a] *smaller size* [d] *classroom* [and] *technology is going to add value and enable them* [to teach] (SHS_P)

Systemic factors and institutional factors such as teacher performance and accountability need to be addressed (Ben-Peretz & Feiman-Nemser, 2017). Schools are discovering new ways to enhance the quality of their offerings. The education environment is competitive. Over the past decades there have being signs of fundamental change towards service to the community, knowledge and skills production, legitimacy, accountability and value for money in institutional education offerings (Cheng, 2001). Educational objectives can be enabled through ICT (Mikre, 2011). Many new technologies that are interactive enable teachers to develop environments whereby students learn by doing, receive feedback, refine their understanding and build new knowledge (Bransford, Brown, & Cocking, 1999; Lin, Parsons, & Cockerham, 2019). Therefore, the appropriate use of ICT may enhance critical thinking, information handling skills, the level of conceptualisation and problem-solving tasks of learners (Bakar & Mohamed, 2008). The South African government recognises the significance of ICT in improving educational efficiencies and has developed the e-Education policy to ensure that every learner can use ICT confidently and creatively to develop the skills and knowledge. They need to achieve personal goals (DBE, 2004). As a result, ICT is increasingly being used for teaching in schools.

1.3.2 Why Western Cape, South Africa was selected

South Africa has the third highest ranking in Sub-Saharan Africa and a global ICT index ranking of 92 (Ben-Peretz & Feiman-Nemser, 2017). The South African government, through the Department of Basic Education (DBE), has taken significant steps to deploy ICT in schools and integrate it into teaching and learning. Provincial governments were tasked to implement the white paper on e-Education policy. In the Western Cape, the Khanya Technology in Education Project was initiated by the Western Cape Education Department (WCED) to implement computers along with computing hardware and software (Govender, 2008). The project, which was started in 2001 and ended in 2013, mandated the deployment of ICT by the year 2012 for curriculum delivery to support teaching and learning and improve learner performance in schools, especially those in disadvantaged areas (Govender, 2008). Despite efforts to deploy ICT into schools and

integrate it into teaching and learning, teaching remains mostly unchanged (Sehuhula-Mooketsi, 2016).

Challenges in realising the benefits of ICT investments stem from inadequate ICT resources, limited access to the Internet, technophobia and age-related adoption issues (older teachers struggle to adapt to using ICT for teaching), shortage of skilled teachers to teach ICT subjects, infrastructure and information security issues (for example technological theft and malware) (Sehuhula-Mooketsi, 2016; Tarling & Ng'ambi, 2016; Wilson-Strydom, Thomson, & Hodgkinson-Williams, 2005). Although there are conflicting perceptions about the success of the Khanya project, it is seen as the most successful ICT implementation project in South African schools. This guided the case selections for the study of schools with functional ICT infrastructure in the Western Cape, South Africa. Consequently, the case chosen afforded adequate data to address the research question because it enabled the researcher to access the evidence easily being in close proximity to the researcher.

1.4 The researched education sector in ICT in South African schools

In South Africa, due to the legacy of apartheid, there are developmental discrepancies between the rich and the poor. The fall of apartheid in 1994 has seen the South African education system being transformed to address what was primarily an unequal system.

By creating the e-Education policy, the South African government seeks to transform education through ICT. The main aims of the e-Education policy are to ensure the availability of ICT resources to support the development and sharing of electronic learning content, to equip every administrator, teacher and learner with the knowledge, skills and support required to successfully integrate ICT in teaching and learning (Hamann & Vandeyar, 2017). The policy advocates universal access to ICT through the deployment of networked computers and educational software and online learning resources to all schools in South Africa. The policy further pushes for the allocation of dedicated personnel to manage ICT facilities (DoE, 2003). The goals of the policy are

expected to be achieved through a clear set of guidelines that focus on advancing teacher ICT competencies by integrating the use of ICT into teacher pre-service and in-service training (Baturay, Gökçearslan, & Ke, 2017).

1.4.1 The role teachers play in ICT integration into schools' curricula

ICT has the potential to enhance teaching (Tarhini, Hone, Liu, & Tarhini, 2017) by enhancing teachers' professional knowledge and enabling them to plan and prepare effective teaching activities (Akpabio & Ogiriki, 2017). Teachers play an important role in successful ICT integration in the classroom (Bitner & Bitner, 2002; Hallgrímsson, 2018). Teachers' confidence, motivation and beliefs that influence their teaching (Hsu, Tsai, Chang, & Liang, 2017). Teachers directly determine the mode of instruction in the classroom. Individual personal factors such as gender, income, age, and level of education influence the use of ICT in teaching. For example, female teachers have weaker self-confidence in technology-related knowledge (such as, technology knowledge and technology pedagogical content knowledge) than male teachers (Lin, Tsai, Chai, & Lee, 2013). Similarly, teachers with more experience in using the Web have high self-efficacy while older and more experienced teachers have lower levels of self-efficacy in using the Web for instruction (Lee & Tsai, 2010). Thus, exploring the effects of individual factors in teachers' use of the opportunities offered by ICT to improve teaching is essential in ICT integration research (Hsu et al., 2017).

1.4.2 Challenges with the integration of ICT into schools' curricula in South Africa

With efforts by the South African government to ensure universal access and use of ICT, various measures have been put in place to increase provision of ICT and training workshops from DBE. While addressing the poorly skilled teachers with low content knowledge, the education policies, such as e-Education policy, advocate for transformation in teaching by integrating ICT into teaching and learning. Initiatives have been put in place to upskill and to provide professional development programmes to support ICT integration into schools' curricula.

However, status of ICT deployment into schools and its integration into schools' curricula (as defined by the e-Education policy) is far from desirable (Vandeyar, 2015). The implementation process is besieged with initiatives that are not directly aligned with the e-Education policy (Holcroft, 2004; Howie & Blignaut, 2009). There is a mismatch between the goals of the policy makers and the realities that exist in the district, province and school level implementations (Vandeyar, 2013). The result is unequal distribution of funding across schools within the country (Ndlovu, 2016).

Consequently, initiatives to ensure that every teacher has a laptop computer have failed. Other initiatives, for example SchoolNet SA, Telkom SuperCentres project, thintana I-Learn, GautengOnline and Khanya, have also failed to reach every school. This is observed specifically in rural parts of the country where basic infrastructure such as electricity, classrooms and telephones do not exist (Mireku, 2016). Additionally, many schools cannot afford ICT equipment and those that can, are insufficiently skilled in maintaining the equipment.

1.5 Research problem

The widespread availability and use of ICT in society is, in general, leading teachers to use these tools to complement the teaching process outside the traditional classroom context (Hinostroza, 2018). However, the potential impact of these tools can be limited by factors such as teachers' lack of digital skills to make effective use of such tools. Studies show that the integration of ICT into schools' curricula is affected by contextual and socio-cultural factors (Hinostroza, 2018). The contextual factors refer to the aspects of the environment where ICT is used. The socio-cultural factors refer to the teacher's use of ICT – how the teacher's habits, values and beliefs affect the use of ICT in teaching (see Table 1-1)

Table 1-1 Contextual and socio-cultural factors

Category	Example of contextual and socio-cultural factors
Contextual factors include	1. Technical issues or problems with equipment, 2. Lack of resources at the schools, 3. Ownership of up to date technology,
Socio-cultural factors include	4. Lack of subject knowledge and ICT related skills, 5. Pedagogical difficulties for teachers (such as subject knowledge, differentiation of learning, approaches to research topics assessment, lack of support), (Sentance & Csizmadia, 2017) 6. Competency level of teachers, 7. Teacher confidence in their skills, 8. A sense of purpose for ICT use, 9. Adequate ICT skills training of teachers and 10. Realistic time management.

Source: (Dawes, 2001; Mooij & Smeets, 2001; Sime & Priestley, 2005).

These contextual and socio-cultural factors may have a negative consequence on students' learning and can increase educational inequalities, especially in developing countries (See Table 1-1) (Hinostroza, 2018). Anecdotal research suggests that even with these factors, some teachers are willing to integrate ICT into curricula while others are not. Amidst the complexities, there is a dearth of information on why and how teachers choose to integrate ICT in their teaching (Tarling & Ng'ambi, 2016). In the developing world context, the focus of ICT in education is on advancing access to ICT in schools and integration into curricula. Focusing only on whether ICT exists or not seems to steer towards a techno-determinism perspective that ICT in itself can cause a change in behavioural patterns (Blau & Hameiri, 2017; Nye, 2007). However, there is a need to go beyond the availability of ICT for teaching and learning alone. Rather, studies should include how people realise the benefits of ICT – in other words, the opportunities ICT provide and how teachers use these opportunities to generate improvements in education (Mahan & Misnikov, 2004; Zelezny-Green, 2017). Although ICT holds

potential to greatly improve teaching, how it does so from the teachers' perspective and within which contexts, remains uncertain (Lawrence & Tar, 2018). The challenge is that discourses do not clearly explain how the opportunities ICT provides can be used to generate improvements in teaching within the social-cultural context of teachers. The study suggests that an analysis of ICT in education should include focus on the opportunities generated from ICT and how teachers use these opportunities to achieve desirable outcomes.

1.6 Research question

The main research question for the study is: *"How are educational outcomes generated for teachers through the use of ICT in teaching in developing countries"?* The study focuses on the Western Cape province, South Africa. This research question has the following sub-questions, provided in Table 1-2 together with their explanation.

Table 1-2: Research question and explanation

Research Question	Explanation
How does the use of ICT effect teachers in teaching?	Describe how educational outcomes are generated for teachers through the use of ICT
What educational outcomes do teachers generate through the use of ICT in teaching?	Explore the outcomes generated for teachers through ICT
What educational outcomes do teachers aspire for?	Explore the lives, teachers, value and have reasons to value
How do individual differences of the teachers affect their ICT use to generate teaching outcomes?	Explain how individual differences influence the conversion of capability input (for example ICT) into capabilities

1.7 Research purpose

The objective of this study was to examine how educational outcomes are generated through the use of ICT in a developing world context, at a micro-level. The aim was to investigate how the use of ICT enables opportunities for school teachers and how they

choose to use these opportunities to generate educational outcomes. The study looks at the importance and variations of local conditions and the social-cultural factors that affect the use of education technologies and the choice to use opportunities generated through ICT to achieve desirable outcomes from the perspective of the teacher (Tarling & Ng'ambi, 2016). The significance of this is to gain a better understanding of the potential effects of ICT in education (D'Ambra, Wilson, & Akter, 2017; Leonardi & Barley, 2010; Walsham, 1993).

1.8 Overview of the research methodology used in the study

The study employed an interpretive approach. Interpretivism was selected because it enabled the study to understand the opportunities that ICT enabled for teachers, the social-cultural and contextual characteristics of the teachers and the generation of improvements in the lives of teachers (Walsham, 1995). Interpretivism allowed the study to understand the social circumstances and experiences of the teachers. This was done by interrogating the personal experiences of the teachers and observing classroom teaching practices.

The study adopted a qualitative methodology. The methodology was used to gain the meanings and interpretations of teachers who are involved in ICT integration in schools (Holloway & Wheeler, 2013). The approach enabled the researcher to understand the viewpoints of teachers who were involved in ICT integration in their social and cultural context including the habits, culture, belief and values. The study used a purposive sampling method to select seven schools. From the seven schools, fifteen teachers, seven principals, seven ICT coordinators or personnel in charge of ICT, and two heads of e-Learning in Western Cape education districts. For administrative purposes, schools in the Western Cape province reside in eight education districts located in rural and urban areas. The study obtained data from the Metro South as well as Metro Central e-Learning coordinators district heads.

All the research participants were interviewed to gain multiple perspectives of the phenomenon at hand (Myers, 2019; Myers & Newman, 2007). The data obtained from the principals, ICT coordinators and heads of e-Learning in Western Cape education districts were used to validate the data collected from the teachers. Data was obtained from research participants through semi-structured interviews along with direct observations of teachers and background documents.

The study used the thematic data analysis method. Thematic analysis is a method used to identify themes and patterns of meaning across a dataset about a research question (Braun & Clarke, 2006; Braun, Clarke, Hayfield, & Terry, 2019). It emphasises the organisation and rich description of data sets for the study (Bonello & Meehan, 2019; Spencer, Ritchie, & O'Connor, 2003). The thematic analysis enabled the study to investigate the different realities of the research and to gain an understanding of the phenomenon of interest from the experiences of the respondents that were organised from which codes and themes were developed. The codes were grouped into categories to develop themes and identify existing frequencies within the themes (Braun et al., 2019; Joffe, 2012). The relationships between the themes were presented graphically. In this process, the researcher examined and recorded patterns within the data that were important to the research phenomenon and appropriate to the research question. Using a Capability Approach framework (Sen, 1999), the analysis was guided by existing theoretical concepts.

1.9 Contributions of the study

The study makes three contributions to the field of ICT knowledge. The research suggests theoretical propositions for explaining how the use of ICT enables teachers to produce educational outcomes in developing countries. The study found that ICT artefacts, features, supportive function (for example, training and support) and affordances enabled opportunities. Teachers acted on these opportunities to generate efficiencies in teaching, their well-being and the broader educational community within the context of individual differences.

The study provides recommendations for planners and implementers to address issues on the actual realisation of ICT benefits by creating effective strategies that aim at improving implementation of ICT in schools. These strategies should look at the opportunities generated from ICT and how teachers use these opportunities to achieve educational outcomes. Additionally, recommendations were provided for e-Learning coordinators who wish to deploy ICT and integrate it into school curricula to equip teachers with all the components of TPACK (Technology, Pedagogy and Content Knowledge). Additionally, e-Learning coordinators should provide a space for teachers to experiment, highlighting existing practices and providing support to achieve their personal goals, which are part of their value system.

Empirical evidence and theory in this thesis contribute to the knowledge of ICT in education assessments by offering a better explanation of the capability outcomes generated by teachers through ICT in the education field in developing countries.

The benefits of the study include:

- The study highlights how the use of ICT enables teachers to produce educational outcomes. It examined the relationship between ICT and educational outcomes. The research benefits decision-makers focused on creating solutions to address socio-technical problems in South Africa, across Africa and in other developing regions. It gives new insights into the phenomenon (ICT integration) under study. The study adds to existing strategies by adding empirical, theoretical insights.
- The study is of significance to school management. It emphasises on opportunities obtained from ICT use and how teachers choose to use these opportunities (as influenced by socio-cultural factors) to achieve desirable outcomes. Socio-cultural factors of teachers such as personal factors include motivation. The benefit of in-depth knowledge about individual level factors such as personality is that it may guide institutions on effective teaching with ICT. Effective use of ICT in teaching and learning may help teachers achieve their

educational goals, which may be for the greater good of the entire educational system.

- The study is of value to the teaching community in that it unveils the personal experiences of teachers, thereby drawing attention of decision makers to their needs.

1.10 Overview of the theoretical approach of the study

The study drew on the Capability Approach (CA) (Sen, 1980, 1999c) to provide a theoretical foundation for the research conducted (Trauth, Quesenberry, & Morgan, 2004). CA claims that freedom to achieve a desired lifestyle is important and that wellbeing is to be viewed in the context of *capabilities* – opportunities a person has to do and be what they value. *Functionings* are a person's 'beings and doings'. In the study, CA is supplemented with concepts from *individual differences* conceptual framework (Trauth, Quesenberry, & Morgan, 2004). *Individual differences* help to understand the impact of socio-cultural factors on an individual. This study identified the Conole and Dyke (2004) taxonomy of ICT affordances to understand the possible use of a tool in the teaching context.

According to Sen (1999), people have different methods of transforming the same bundle of goods into desirable outcomes. A limitation of traditional ICT access measurements in education is that they do not take into consideration and monitor how different teachers vary in the number and purpose of ICT used (Alampay, 2006). Although access to ICT is essential for its use CA acknowledges the importance that *individual difference, conversion factors, choice, capabilities and functionings* have on whether teachers will use ICT, how they use it, and how it is valued.

1.11 Delimitation of the research

The study was undertaken in a developing world context. The focus was on schools in the Western Cape, South Africa. The study explored how ICT holds potential for

transforming teaching, for which actors, and within which context. In this instance, the case study method allows for the selection of schools from regions to ensure that insight into the factors of ICT in schools is representative of the varying environments of the schools. The choice of schools was based on these considerations and convenience to the researcher. In the Western Cape, 34.6% of schools fall under the Quintile 5 category of least poor schools. The Khanya project, one of the major government-funded initiates which provided a large-scale implementation of ICT in Western Cape schools, was deemed as remarkably successful (Louw, Muller, & Tredoux, 2008; Van Zyl, 2011). The demographics of the Western Cape varies dramatically between affluent schools in major urban centres such as Cape Town and impoverished schools in isolated rural villages with inadequate infrastructure (SMART, 2011). Schools in urban parts of the Western Cape offered a larger pool of schools to select from which was convenient for the researcher. Seven schools were selected based on their relevance to the phenomenon under study. The study was situated in the Information System (IS) discipline and not in the education discipline. Since the study is viewed from the IS perspective, it does not expound on pedagogical issues.

1.12 Thesis layout

This section presents a summary of each chapter.

Chapter One introduces the context of ICT in teaching. It provides a rationale for the focus on developing world specifically how ICT artefact and socio-cultural context influence the opportunities offered through ICT and how teachers choose to use these opportunities to generate outcomes. With focus on ICT in education in developing world context being on advancing access to ICT into schools, few studies have addressed what teachers' value and how they use ICT to achieve what they value – how they realise the benefits of ICT. The chapter presents the background to the study, research problem and research question.

Chapter Two provides literature on key themes in the study forming a background for the theoretical re-description of the study. It focuses on the role of teachers in teaching. As a background to the theoretical chapter, this chapter reviews literature on the key concepts of the study –- teaching, ICT, capabilities, individual differences and outcomes.

Chapter Three provides the theoretical approach for the study. It presents the focus lens from which the study may be viewed and defines the boundaries of the study. The chapter justifies the appropriate theoretical approach for the study, the limitations of the theory and how incorporation of other theories strengthens its explanatory power.

Chapter Four details the methodologies in this study. This leads to an explanation of the research, sampling, data collection methods and analysis used, as well as the ethical considerations of the study. The chapter discusses how multiple-case-study was used to investigate the research question in the study.

Chapter Five presents the case description of the study. It describes the situated context of the study, and it includes the sociocultural-geographical contexts. The chapter presents a background to the research findings by presenting the characteristics of the teachers, which relates to their demographics, lives that they value according to (Sen (2017), and goals.

Chapter Six presents the results of the study. In this chapter ICT skills training and its effect on ICT use in teaching is highlighted. The chapter examines the socio-cultural factors (such as personal, influencing, social and environmental factors) that influence the conversion of ICT into educational outcomes. The idea of agency is summarised and the opportunities offered by ICT in teaching is substantiated.

Chapter Seven discusses the key findings of the study by highlighting existing literature and how the study adds to or validates it. Findings that were unique to the study were presented to add to a body of knowledge.

Chapter Eight presents the conclusion and recommendation of the study. The chapter further indicates ways in which it addressed key requirements for interpretive research. It reflects on the PhD journey, which brings light to the limitations of the study.

CHAPTER 2 : LITERATURE REVIEW

2.0 Introduction

The focus of the study is on how the use of ICT enables teachers to generate educational outcomes. This chapter reviews the literature for the study. The literature engages with ideas of what education technology and ICT affordances are and how they can contribute to technology use and enable opportunities in the context of teaching. The factors that affect the use of ICT are provided to highlight the teachers' realities of teaching. What and how outcomes can be realised for individuals is discussed.

Section 2.1 presents a background on teaching while Section 2.2 presents a description of learning theories that guide instructional strategies and techniques for facilitating learning. Section 2.3 features the role of the teacher in the classroom. Section 2.4 highlights ICT in education and capability. Section 2.5 discusses use of ICT as determined by affordances. Section 2.6 conditions under which improved access to ICT enhances capabilities. Section 2.7 provides details on ICT in education in the South African context. Section 2.8 summarises the chapter.

2.1 Background on teaching and learning

A background on learning gives definitions and beliefs about how learning occurs which play an important role in facilitating what people know and do (Ertmer & Newby 2013; Wiewiora, 2019). Therefore, brief descriptions of concepts of learning along with learning theories in this section provide instructional strategies and techniques for facilitating learning (Petersen-Brown et al., 2019).

'Learning' is the process of gaining and altering of knowledge, skills, beliefs, attitudes and behaviour (Schunk, 2012; Schunk 2019). It occurs through studying, real-life experiences and observable behaviour. Learning can take place at the foundational level such as when a child learns how to calculate 2+2 or say a word (for example, "Mom") or play with other children (Fox, 2018). At a more complex level, learning takes

place through multifaceted learning tasks such as writing a mini-thesis, driving a car or leading a team in a group project (Gabor & Gerken, 2018).

Theories of learning are conceptual frameworks that explain how information is captured, processed and retained during learning (Chaudhary, 2013; Makewa, 2019). Worldviews and understanding are obtained and transformed by environmental factors and former experiences. The two stances on the origins of knowledge and how it relates to the environment are rationalism and empiricism (Lanzarini & Probst, 2018). The significance of these positions is that they may be reflected in learning theories. Therefore, a brief background on the origins of knowledge provided in the subsequent sections is useful for discussions on learning theories.

2.1.1 Foundations of knowledge

The two themes on the knowledge that is relevant to learning theorists are: from where does knowledge come and how do we come to know? The two views on the origins of knowledge – rationalism, and empiricism – are found in learning theories (Lanzarini & Probst, 2018) .

Rationalism is the idea that knowledge is acquired through reasoning (Galavotti, 2019; Schunk, 2012). The rationalist perspective originates from Plato and separates knowledge gained through reasoning from that which is gained through senses martin (Cooper, Hamilton, & Cairns, 1961; Martin, 2019). Through humans' senses, *things*, such as plants or buildings, are revealed, while *ideas* are acquired through thinking about what is known. Learning takes place when people reflect on innate ideas about the world (Descartes, 1993; Chang, 2019), which involves the process of remembering that which already exists in mind. For example, one's encounters with grass in one's lifetime highlights what one already knows in one's mind (Hamlyn, 1967; Chang, 2019). The nature of green grass (greenness, leaf texture, low-growing and other characteristics) is known, not through a reflection on one's idea about the given

encounter with the green grass nor through seeing it in real life, but as an act of the mind (Hülse, Egeth, & Deese, 1980).

From the rationalist viewpoint, the focus of instruction is on structuring new information:

(1) To assist learners' in converting the items of interest to a form that is stored in memory (encoding), and

(2) To assist learners' in recalling existing knowledge.

Empiricism is the view that knowledge is derived from experience (Hume, 1740). The position adopted from Aristotle holds that knowledge is obtained from sensory impressions (Hart, 2017). Structures in the organism receive stimuli from the environment and convey them to the brain (Locke, 2018). According to Locke (2018), an organism is born with no knowledge, and its learning takes place through interaction with its environment.

The positions of empiricism and rationalism on the origins of knowledge provide a background for comparing behaviourism, cognitivism and constructivism perspectives of learning (Bealer, 1999; Muin, 2019).

2.2 Learning theories as instructional strategies for teaching

The significance of learning theories in relation to instruction is that it provides instructional designers with fundamental approaches and methods for facilitating learning. Learning theories include behaviourism, cognitivism and constructivism, which are discussed in the subsequent sections.

2.2.1 Behaviorism learning theory

Behaviourism is the study of human behaviour (Harasim, 2012; Saari, 2019). It focuses on how people behave and especially how to change or elicit an observable behaviour

(Skinner, 2011). Behaviourism introduced a way to study and to shape learning that could be repeated and replicated (Pritchard & Woollard, 2013). It could:

> *'… predict, given the stimulus, what reaction will take place; or, given the reaction, state what the situation or stimulus is that has caused the reaction' (Watson, 1930, p. 11).*

Central to behaviourism is the idea of stimulus and response: a particular act stimulated a certain reaction, a response that could be observed, repeated and quantified. From the behaviourist point of view, how a person behaves is influenced and learned from the environment bandura (Bandura & Walters, 1977; Belle, 2019).

A limitation of behaviourism is that it is unable to explain most social behaviours. This is because for the behaviourist scientist, what one cannot see or measure does not count. Behaviourists would consider only what they could see and the ability to measure what was seen. Yet, the power of the mind to influence or make decisions that are not directly related to an external stimulus is highly significant. The mind plays a tremendous role, even if it cannot be seen. If behaviourism treated the mind as a black box, cognitive theory recognise the importance of the mind in making sense of the material world. Cognitivism seeks to understand what is inside the black box of the mind in order to emulate it computationally.

2.2.2 Cognitivist learning theory

Unlike the behaviourist learning theory, which focuses on observable behaviour, cognitivism focuses on the cognitive process. This includes solving problems, forming concepts and processing information. Cognitivist theorists emphasise the acquisition of knowledge (Snelbecker, 1999; Al-Jarrah, Mansor, Talafhah, & Al-Jarrah, 2019). As a result, the focus is on theorising learning processes and on addressing issues on how information is received, organised, stored and retrieved by the mind. Learning is marked by the advancement in the phases of knowledge acquisition and not in the changes of stimulus and response (Bower & Hilgard, 1981; Bloodgood, 2019).

Knowledge acquisition is viewed as a mental activity with the learner being an active participant in the learning process (Winne, 2001; Garnjost & Lawter, 2019). Following this argument, effective instruction must be based on a student's existing mental structure.

2.2.3 Constructivist learning theory

Constructivism views learning as a process of meaning-making through experiences (Bednar, Cunningham, Duffy, & Perry, 1992; Saltis, Critchlow, & Smith, 2019). In constructivism, new knowledge is developed by building on a learner's prior knowledge (Idris, Ion, & Seery, 2019). This is to help learners develop their own conceptual framework (McGuire, 2006). Constructivists believe that people learn by constructing their knowledge of the world through experiences and reflecting upon those experiences in combination with the existing knowledge (Bednar et al., 1992; Tuerk, 2018). A learner actively participates in creating and constructing meaning in a joint environment.

2.3 Importance of the role of a teacher

Instruction is a set of events that facilitate the learning process (Gagne, Wager, Golas, Keller, & Russell, 2005). Compared to teaching, which refers to events that are set in motion by a teacher, instruction refers to all the events that may have a direct effect on an individual's learning. As mentioned, a learner or a teacher may manage instructional events. Learners can gain knowledge generated from a page in a book, an image, an educational programme or through physical artefacts (Merrill, Kowallis, & Wilson, 1981). However, a teacher plays an essential role in organising these events (Hsu et al., 2017) as an instruction must be well planned to fulfil its desired goal. The teacher plays a crucial role in the classroom in that he/she is responsible for making decisions with regards to each occurring event (Jones & Chen, 2016). Although the decision-making process takes place from moment to moment, teachers follow a planned lesson design. The lesson is a part of a larger design in the presentation of a topic. The goal of

designing instructions is to enable and support the learning of the student. Although the goal of an instruction may be to help people learn, this goal may or may not be achieved (Gagne, 1992; Islam & Salam, 2019). Learning can take place without instruction; however, the effects of instruction on learning are often beneficial and usually easy to observe.

Beliefs about how learning occurs and is defined, has a significant impact on instruction (such as environments that facilitate what people know or do). There is, therefore, a link between the designing of instruction and learning theories. The significance of learning theories is that they provide instructional designers with instructional approaches and methods for facilitating learning. The three appropriate stances of learning (behavioural, cognitive, and constructive) offer a systematic foundation for planning and conducting instructional design activities and are summarised in design activities in Table 2-1.

Table 2-1: Learning theories and how they guide teachers to facilitate learning

Behaviourist learning theory	Cognitivist learning theory	Constructivist learning theory
• Identify the stimulus that will enable the desirable response	• Understand learner characteristics, generate learning experiences and situation to impact learning outcome	1. Instruct learners on how to construct meaning
• Simulate a situation whereby cues are matched with target stimuli	• Structure new information based on previously acquired knowledge, abilities and experience	2. The teacher seeks to align and design experiences for the learners
• Organise condition to enable an appropriate response	• Organise and practice instruction using learner feedback	

From the behaviourist viewpoint, the role of a teacher is to influence the feedback provided by a learner, which is triggered by a stimulus (McIver, Fitzsimmons, & Flanagan, 2016) (see Table 2-1). For this to be achieved, the learner should be aware of

how to provide a favourable response as well as the circumstances within which the response should be made. The focus of behaviourism is, therefore, on the process of stimulus and response and on how a response can be observed, replicated and multiplied (Ertmer & Newby, 1993; Kawai, 2019). The role of a teacher or designer is three-fold. First, the teacher determines which signals can result in the desired response. Second, the teacher simulates a situation whereby the cues are matched with target stimuli in a natural setting. Third, the teacher needs to organise the appropriate conditions that will enable the appropriate responses from students (Ertmer & Newby, 1993).

Cognitivist theories emphasise how knowledge can be meaningful. A teacher within the cognitivist perspective seeks to help the learner arrange and relate new information to the existing knowledge found in memory. The task of the teacher or designer within the cognitivist stance is three-fold (see Table 2-1). First, the role of a teacher is to understand that the individual characteristics of a learner generate various learning experiences and situations that can impact learning outcomes. Second, an effective way to structure new information is to focus on the previously acquired knowledge, abilities and experiences. Third, the role of a teacher is to organise and practise with feedback so that the new information is effectively and efficiently assimilated and accommodated.

The role of a teacher in the constructivist viewpoint is to present learners with opportunities to carry out tasks independently thereby encouraging self-based discoveries (see Table 2-1). The goal of a teacher, therefore, is to ensure that learners can understand and expand on facts they know. Here knowledge transfer is assisted through participation in tasks within meaningful contexts. Although the emphasis is placed on the learners' construction, the teacher or designer's role is still crucial. The role of a teacher within the constructivist learning theory is twofold. First, the role is to instruct the learner on how to construct meaning. This is to monitor, assess and update those constructions effectively. Second, the teacher seeks to align and design experiences for the learners so that genuine and appropriate contexts may be experienced.

2.4 Information and Communication Technology in education and capability

The study adopts the freedom-centred view that claims that evaluation of well-being should focus on the opportunities people have to pursue the life they find meaningful (Sen, 2017c). The two key points used reflects the “freedom to achieve various lifestyles”, and the achievement of a person of what they manage to “do or be”. The idea of agency refers to a change agent whose value judgement sets the conditions that represent the quality of life (Robeyns, 2018). As a result, the focus is on the ability to achieve a desirable state of being rather than a predefined list of what quality of life should be – people themselves define the latter. The means by which more freedom may be obtained is known as a commodity (such as income, or ICT).

2.4.1 Education technology

In the context of CA, ICT in teaching and learning is a tool that enables teachers to achieve a lifestyle they value. The reasoning for this expectation can begin by looking at the advancements in educational technology and how they have improved efficiencies in teaching and learning.

The knowledge economy of the 21st century is defined by new technology-based innovations that are centred on knowledge, information efficiencies and literacies (Aydalot & Keeble, 2018; Koranteng, 2012). Over the past decade of the 21st century, ICT has enabled dramatic transformations across the globe by creating opportunities for people, improving living standards, facilitating modernisation, increasing productivity, connecting people and communities as well as improving educational efficiencies (Mago & Mago, 2015). ICT has the potential to enhance teaching (Tarhini et al., 2017) by enhancing teachers’ professional knowledge and enabling them to plan and prepare for teaching activities that are efficient (Akpabio & Ogiriki, 2017).

This section provides a brief overview of education technology. It briefly discusses developments in technologies in teaching and learning as well as the Internet and education technology.

2.4.2 Background to education technology

Education technology refers to the creation, management and use of technological resources and processes to generate improvement and facilitate teaching and learning (Magdalene & Sridharan, 2018). Education technology dates back to 1920 when visual media were widely accepted, and educational films were used for instruction (Saettler, 2004). A teaching machine was created by Sidney Pressey in 1926 to test and confirm learning tasks (Pressey, 1950). Comprising a drum and paper that offered a set of multiple-choice questions and answers (Saettler, 2004). A feature on the machine (a small lever at the back of the machine) allowed the teacher to advance from one question to another (Saettler, 2004). However, the development of the teaching machine was met with a lack of interest.

A limitation of this early teaching machine was the lack of ease of use, which in turn affected the perception of the usefulness of technology as a whole. The successful adoption and the actual use of technology are influenced by the perception that it is useful and easy to use and meets the needs of the adopter (Natarajan, Balasubramanian, & Kasilingam, 2018). Since the first education technology was clumsy and inefficient, it was not accepted by school communities (Skinner, 2016). In other words, it was not able to enhance teaching and learning. Continuous improvements in education technology, such as the first educational television station in 1953, has continuously led to improved efficiency in teaching and learning (Benjamin, 1988). Today, community radio and TV broadcasting, *inter alia*, can be used to broadcast education programmes for supporting distance learning (Pickard, 2017).

2.4.3 Education technologies and the Internet

Development in learning systems is particularly evident with the emergence of the Internet. The Internet is characterised by multiple networked computers developed through the Advanced Research Projects Agency (ARPA) Network (Chen, Cheng, Hu, Jiang, & Lu, 2017). The continuous innovations in interconnectivity technology by

pioneers such as Vincent Cerf opened possibilities for more innovations in subsequent years (David, 2001).

As a new technology advancement, the World Wide Web (WWW) offered massive interconnectivity solutions to the original Internet. The WWW innovation expanded the Internet's infrastructure and protocols. Developed by Tim Berners-Lee in 1991, it extended the interconnectivity capacity of the original Internet, beyond the wide-area network boundaries, into world-wide levels of connectivity. This way, the WWW enabled information exchanges between networks, regardless of the area where information was stored, the method used to store this information, or the system used to manage it (Berners-Lee, Cailliau, Groff, & Pollermann, 1992). It allowed access to a universe of online information, resulting in communities of people that gather, disseminate, and share information (Duker, Bonney, & Adibi, 2018). Tools based on the WWW have been key enablers of teaching in modern education, from the use of search engines to electronic learning (Kushwaha, 2018). Teaching and learning can be enhanced through the use of search engines. A search engine is an Internet-based application, such as a web browser, that enables access to resources (such as documents, files, lecture videos, tutorials, and information) (Magdalene & Sridharan, 2018). Educational resources support multiple ways of learning by enabling varied presentation styles, thereby enabling flexible instructional processes. With students having access to personal laptops, the instructional process changes. Thus, ICT allows lessons to be more student-centred and constructivist (Corkin, Coleman, & Ekmekci, 2018).

Through intelligent learning objects and other interactive tools, students can learn in an interactive learning environment that extends beyond time and space (Cope & Kalantzis, 2009; Rubens, Kaplan, & Okamoto, 2012). Examples of electronic learning objects are interactive hand-held tools and web-enabled learning management systems (LMS) (Nguyen, 2017). The web-enabled LMS affords considerable functionality for teaching. It provides tools that enable interactive activities including virtual classrooms, online forms of assignments and messaging. Through these tools, teachers are able to track and monitor a student's learning process, which includes the statistics of frequency of

access, activity logs on the system and status of submission of assignments (Nguyen, 2017). Internet-based student response systems enable teachers to assess the progress of students through quizzes and exercises by reviewing their understanding at class, individual student and question level to enable focused remediation (Awedh, Mueen, Zafar, & Manzoor, 2015).

2.4.4 Information and Communication Technology and capability

In the context of CA, ICT is seen as a type of commodity that enables individuals to achieve a lifestyle they value (Sen, 1999c; Sen, 2017c). The logic behind this expectation begins by looking at the functional attributes of ICT (Yim & Gomez, 2018). ICT influences a person's capability by providing access to information. Information shared through technology such as ICT may be a capability enhancer, allowing people to make better judgements by having access to knowledge that was not available to them (Hamel, 2010). Access to information resources is the beginning of knowledge acquisition. Knowledge is a resource that can be acted upon, and it is fundamental to development since "Informational limitation restricts or distorts consequential judgements" (Sen, 1997, p. 302). Tools such as mobile phones and the WWW have transformed the ease at which people may exchange and share information across distances (Hamel, 2010). Increased access to information leads to knowledge, and it is a tool that may promote autonomy and participation in a formal institution in the economic, political, social and cultural spheres of life (Foster & Yaoyuneyong, 2016; Ndukwe, Casal, Nnoli-Edozien, & Ike, 2007).

CA highlights how freedom is enabled or enhanced by choice where commodities (in this study, ICT) play an instrumental role (Thapa & Sæbø, 2014; Zheng, 2009). The challenge, however, is to understand the process by which ICT develops or expands individual opportunities (Thapa & Hatakka, 2017). Studies have suggested several frameworks to explain the relationship between technology and capabilities. These frameworks include extension theory and Actor Network Theory (ANT). Extension theory

relates to technology as an extension of humans. While ANT refers to the influence of technology on human capabilities within the socio-cultural context (Latour, 2005).

'Extension theory' refers to the use of technology to enhance capabilities. From the extension theory perspective, technology is a part of a human organism (Lawson, 2010). As an extension of a human organism, technology may replicate, increase or supplement bodily or mental capabilities (Gefen & Straub, 1997). This means that technologies can extend various capabilities of a human. For example, a phone is an extension of the voice (Lawson, 2010). Television is an extension of one's eyes and ears. The computer is an extension of the brain. The electronic media are an extension of the human nervous system. A critique of the extension theory is that by not taking the social factors into context, the technology may fail to enhance capabilities. The actual impact of technology on capabilities is achieved when it occurs within the socio-technical context of an individual (Haenssgen & Ariana, 2018).

The technical objects should be examined within and as part of a network and not in isolation (Latour, 1987). This is because they form the properties, features, and rules of the network they belong (Ritzer, 2004). In a technology network, capabilities are enhanced when the properties of material artefacts are used to extend the properties of people. Thus, capabilities are enhanced through technical activities and capabilities of material artefacts. Technology is a tool that could expand valued capabilities (Lawson, 2010). The human capability is, therefore, determined by the continuous interaction between the elements – individual, technical artefacts, physical circumstances and social structures. For example, a phone must be placed within a technical network so that it may access to the correct telephone signal or electrical voltage. However, for the phone to be used, it must be implanted within a particular relationship (Lamb & Davidson, 2002), which can refer to technical or social relationships. An example of a technical relationship is a bulb connected to electrical wires, while a social relationship may involve a parent and son.

These theories (extension theory and ANT) are useful in providing a macro-level description (Thapa & Hatakka, 2017). However, they do not explain the mechanism of ICT use and the effect in detail, where ICT is regarded as neutral and as a commodity that will automatically contribute to an individual's capability set (freedom of choice to be an active participant in society) (Hatakka, Devinder, & Sæbø, 2016). This view has been criticised by Zheng and Stahl (2011), who argue that seeing technology as neutral is too simplistic; they call for a more "sophisticated and critical view of technology" (Zheng & Stahl, 2011, p. 70). This signifies a gap in the literature, which can be reduced by gaining a deeper understanding of the process of ICT use and the actor's role in the process. In their research, Thapa and Hatakka (2017) propose the use of affordances from ecological psychology to provide a lens to understand the process of ICT in information and communication technology for development (ICT4D) to better understand how ICT can lead to development. In their study, Thapa and Hatakka (2017) embark on research to illustrate how affordances can enhance understanding of the mechanisms by which ICT enables or constrains possibilities and opportunities for individuals and groups (Thapa & Hatakka, 2017). Their findings show that the benefits of ICT can be harnessed only if the users can perceive and actualise the affordances of ICT.

The use of affordances to describe the possibilities for goal-oriented actions that technical objects offer to specified users has received growing attention from IS researchers. However, few studies have gone beyond contextualising parts of the concepts into a specific context. Thus, in their study Bernhard, Recker, and Burton-Jones (2013), sought to extend extant theory on the origin and actualisation of affordances. The study illustrated an emergent theory in the context of conceptual process models and offered suggestions for operationalising and testing the model empirically (Bernhard et al., 2013). In their study, Andrade and Doolin (2013) sought to understand how resettled refugees interact with computer technology. Their study analysed how information technology users interpret the affordances of computer technology relative to the unique needs of the specified users. The study found that the user's experience, current circumstances and evaluation of future outcomes significantly

influence the perceived affordances of the technology and shaped the way it was used. In their study, Lehrig, Krancher, and Dibbern (2017) sought to find the processes through which users perceive and actualise the potentials for action, or affordances, offered by collaborative platforms. They found that users perceive affordances through three alternative processes:

- Imitating – The process of using what is learnt about technology use to perceive possibility for innovative technology use
- Exploring – Innovative technology use is possible when the characteristics of the technology is understood
- Transferring – The process of perceiving the possibility of applying user's existing technology use to a new purpose

After perceiving affordances, users often need to arrange for configuration to enable the perceived action potential. The emerging theory suggested that these perception and actualisation processes depend on complex ways, at an individual-level (knowledge, self-efficacy, and perceived complexity) and at a higher level (advice networks, collective knowledge) (Lehrig et al., 2017).

Focusing on the relationship between the infrastructure of ICT and people's use of those technologies. It should be noted that the use of the term affordance in design emphasises on the intended use. Conole and Dyke (Conole & Dyke, 2004) approach to affordances focuses on "possible use". Like Conole and Dyke (Conole & Dyke, 2004) this study looks at the uses ICT invites and the facilitates, it lends itself to and what it can do well.

2.5 Use of ICT as determined by affordances

This section discusses how the concept of ICT affordances determines ways of technology use and appropriate technology use to generate opportunities in the context of teaching. ICT affordances expound on Sen's Capability Approach as elaborated in Chapter 3.

2.5.1 Affordance

Affordances, as defined by Gibson, refers to the “properties taken with reference to an observer” (Gibson, 2014, p. 143). It is based on the idea that these properties, as perceived by an observer, can determine the possible use of something. (James, 1979, p. 127). The perception of an observer is important as it determines the use of technology (McGrenere & Ho, 2000). Therefore, affordances link perception to action that can be achieved by an actor (Jamone et al., 2018). The way in which teachers use ICT extends beyond the functional properties (real affordances) as designed by the manufacturer. It is possible to find teachers using technology differently from their intended design.

Norman (1999) differentiated between *real* (as designed by the manufacturer) and *perceived* (as perceived by the user) affordances that are fundamental to how they are used (Bardram & Houben, 2018; Norman, 1999). Perceived affordances can be dependent on the experience, knowledge or the culture of a person (Antonenko, Dawson, & Sahay, 2017). An affordance is a relationship between the properties of an object and the capabilities of the agent that determine how the object could be used (Bucher & Helmond, 2017). A change in the needs and goals of an actor does not change the real affordance. Affordances are perceived based on information sources such as sight, touch, sound, taste and odour. Therefore, limited knowledge or experience about a particular technology may result in real affordances not being maximised (Antonenko et al., 2017). This is because an actor will focus on how they perceive the affordance in their context and relation to their needs.

Affordances are functional properties of technology that determine its possible use, indicating the limitations and inappropriate use of technology (Conole & Dyke, 2004). Details about the properties of ICT guide the selection of appropriate technologies for achieving ICT in education goals (Mishra & Koehler, 2006). An understanding of ICT affordances influences the uptake of its integration into school curricula. Consequently, it helps to understand the challenges of ICT integration amongst teachers (Stockless,

2018). For example, affordances of brainstorming and mind-mapping tools are that they enable the generation of new ideas and concepts. Consequently, presentation tools enable lesson and class notes recording, and the creation of training videos as well as interactive presentations (Kandzia, Linckels, Ottmann, & Trahasch, 2013).

Concepts of affordances as indicated by Conole and Dyke (2004) are used in this study to aid explanations of the relationship between ICT and the capabilities it enables in individuals. In explaining the relationship between ICT and humans, it is argued that technology does not have the power of agency (power to change practice) (Rubagiza, Were, & Sutherland, 2011). There is, therefore, no cause and effect relationship (determinism) between technology and humans. However, affordances describe undiscovered possibilities that are highly explanatory for relationships between ICT and humans (Somekh, 2008). This is because an individual develops mental models as they gain more experiences through the use of ICT. An individual's mental model of ICT use forms a conceptual tool for finding new ways of using ICT (Somekh, 2008). A teacher may only use a specific ICT (for example, PowerPoint) for presentation. However when exposed to new multimedia (such as a landscape image via the Internet) they may think of new ways of using the presentation tools that incorporates the image, thus enhancing their power to perceive possibilities (Wang, Wang, & Tang, 2018).

2.5.2 ICT Affordance

Affordances refer to the functional properties of an item that determines its possible use (Gibson, 2014; Mechant et al., 2018). They are the actual and perceived properties of an item (Norman, 1999). Affordances of ICT reflect an inventor's cultural assumptions (Majchrzak, Markus, & Wareham, 2016; Somekh, 2007). An understanding of ICT affordances helps to systematically apply the technology in teaching and learning (Conole & Dyke, 2004). To understand how ICT affordances determine the possible use of a tool in the teaching context, this study identified the Conole and Dyke (2004) taxonomy of ICT affordances. They suggested the following taxonomy: Accessibility, Speed of change, Diversity, Communication and Collaboration, Reflection, Risk, Fragility

and Uncertainty, Immediacy, Monopolisation and Surveillance as summarised in Table 2-2.

Table 2-2: Classification and explanation of ICT affordances

Classification of ICT affordances in teaching	Definition of ICT affordances in teaching	Rational for (selected) ICT affordance concepts for the study
Accessibility	ICT makes it easy to gain information	Evidence of accessibility in the study could be seen whereby teachers and learners used ICT (e.g. Internet) to search for information and to gain knowledge that extends beyond textbook content (Agarwal, 2018)
Collaborativity	Collaborative affordances make it easy for groups of people to work together to achieve a common goal (Mukherjee, 2017).	
Communication	ICT affords opportunities individuals to interact and exchange information with one another (Dobler, 2017)	Evidence of communication could be seen in the study whereby teachers and learners used ICT (such as email and social networking platforms) for synchronously and asynchronously communication
Diversity	ICT offers access to a wide range of diverse resources (such as information searches and educational software)	Evidence of diversity could be seen with teachers using ICT to access past examination papers and to gain information to assist note taking during lesson preparation.
Fragility	ICT is vulnerable to abuse, and disruptions from effects such as viruses and SPAM email.	
Immediacy	Immediacy is the speed at which information exchanges happen (Derboven, Geerts, & De Grooff, 2017)	Evidence of immediacy could be seen whereby through ICT learner results could be immediately communicated to parents or guardians.
Monopolisation	The dominance of a software product that supports the educational application	
Multimodal	Involves creating connections between multiple modes of representation to communicate various interpretations (Ng, 2015). Multimodal relates to narrative multimedia (Bourbour & Masoumi, 2017) and.	Evidence of multimodal could be seen on the educational software, which used text, graphics and sound to explain concepts to learners.
Non-linear	These are features that are interactive and involves content that is context sensitive	
Reflection	Through the use of asynchronous communication tools prolonged discussion are enabled and time is given for consideration of knowledge claims	
Risk	Unintended consequences of uses of ICT.	
Speed of change	Communication tools facilitate rapidly changing information	
Surveillance	Using monitoring tools to peoples ICT use behaviour	
Uncertainty	ICT is not predictable since there are instances when it does not function well (such as servers are offline).	

Source: Conole and Dyke (2004)

Table 2-2 summarises the taxonomy of ICT affordances by Conole and Dyke (2004). Accessibility, Communication, Collaboration, Immediacy, Reflection and Multimodal are explained to give a clearer outlook on how they are used in teaching and learning.

Accessibility

ICT makes it easy to gain information (Peña-López, 2015). ICT enables teachers and learners to search for information and to gain knowledge that extends beyond textbook content (Agarwal, 2018). Evidence of this affordance is found in the ability to obtain multiple formats of information compiled by subject experts through search engines, with few time and space constraints (Peña-López, 2015). ICT such as tablets, personal computers and smartphones enable access to the Internet from anywhere and at any time.

Communication

Communication affords the means for teachers and learners to interact and exchange information (Dobler, 2017). Types of communication interaction include face-to-face and technology-mediated communication (Chatterjee, Sarker, & Siponen, 2017). With technology-mediated communication, devices such as mobile ICT can enable synchronous and asynchronous communication. Synchronous communication involves the exchange of information with one or more participants at the same time (Downey & Bedard, 2018). Sending and receiving information is done in real-time allowing for instant feedback. Rapid feedback enhances knowledge retention as quick responses allow the audience to learn from their mistakes. (Chatterjee et al., 2017). Examples of synchronous communication are chat rooms and online learning platforms. Synchronous like chat or video conferencing is highly time dependant and only works when all participants are online at the same time thus requires good time management (Srivastava, 2019). Asynchronous communication refers to the intermittent transmission of information at any time (Kaur, 2018). It is self-paced and allows participants to engage in information sharing without the need for the other participant's simultaneous involvements (Ogbonna, Ibezim, & Obi, 2019; Safavi, 2008). An example of asynchronous communication is an email message can

be sent to a recipient who may respond later (Chatterjee et al., 2017). Time delays in reactions may discourage response and collaborative projects (Srivastava, 2019).

Collaborativity

Collaborative affordances make it easy for groups of people to work together to achieve a common goal (Mukherjee, 2017). Collaboration is enabled in environments that allow diverse knowledge contribution and sharing of knowledge and expertise (Bankole & Venter, 2017). It is important for all members of a group to participate and contribute towards negotiating the outcome of their activities. Evidence of this can be seen where teachers debate about different ideas and try to work together through interaction to reach a common understanding (Ndlovu, 2016). Collaborative technologies such as e-Learning platforms are used to interact and to share files and information (Bardram & Houben, 2018).

Immediacy

Immediacy is the speed at which information exchanges happen (Derboven et al., 2017). ICT is a tool that can be used to achieve quick responses and real-time transacting (MacCallum, Day, Skelton, & Verhaart, 2017). For example, mobile technologies enable communication to happen in real time (MacCallum et al., 2017). For a teacher, ICT can be used to inform parents instantly of learners' results (MacCallum et al., 2017).

Reflection

Reflection entails *"careful thought about the assumptions that underlie any belief or form of knowledge"* (Dewey (1933) in Durall, Leinonen, Gros, and Rodriguez-Kaarto (2017, p. 1), Leinonen, Gros, & Rodriguez-Kaarto, 2017, p. 1). Reflection is key for transformation, knowledge generation, making meaning of past experiences, decision making and problem solving. With ICT, users can make meaning and judgements based on shared information or ideas (Chatterjee et al., 2017). ICT, such as asynchronous communication tools, enables reflection (Conole & Dyke, 2004). Asynchronous tools present opportunities for users to engage in discussions over longer time-frames than possible in face-to-face communication (Wang & Dostál,

2017). Prolonged discussions offer more time for knowledge claims to be considered and critically analysed (Harvey, 2018). In learning, the ability to reflect affects learners' self-knowledge and self-regulation. As students become aware of their behaviours and reasons for their behaviour, they may improve decisions made and control their learning process.

Multimodality

Multimodality relates to narrative multimedia (Bourbour & Masoumi, 2017) and involves creating connections between multiple modes of representation to communicate various interpretations (Ng, 2015). It is the integration of various modes of communication or representation that can be written text (names), sound (music) or images (illustrations) (Bezemer & Kress, 2015). Multimodal text found on websites (achieved through hypertext and search engines) makes it non-linear and enables different forms of learning (Maher, 2011).

2.5.3 The use of ICT in teaching

A curriculum entails the philosophy, the content, the approach and the assessment of the programme of learning (Griffin, 2018). Integrating ICT into the curriculum, therefore implies the alignment of education technologies with pedagogy (Admiraal et al., 2017). ICT integration is the use of appropriate technologies (for example, computers, software applications, mobile technologies, social media and the Internet) during the delivery or presentation of instruction and learner assessment. It is the use of ICT to reinforce and enhance valuable skills (for example, memory recall, understanding, application, creativity and evaluation). This section engages with the literature on what and how teachers use ICT in education.

Teachers use ICT to carry out supportive tasks and for teaching in the classroom (Tondeur, Van Braak, & Valcke, 2007; 2004). As a supportive function, teachers use ICT for administrative tasks (for example, learner assessments, lesson preparations, subject delivery and maintaining records of learner progress) (Tondeur, Aesaert, Prestridge, & Consuegra, 2018). Teachers use ICT in the classroom to assist and

enhance teaching. For example, software applications may be used for formative and summative assessments as well as to enhance effective classroom engagement. Summative assessment is the assessment of a test takers skill and knowledge carried out at the end of a learning program (Cizek, Andrade, & Bennett, 2019). The summative can be done through oral questioning, portfolio, and multiple test items to measure the ability, achievements and interest of the learner. Formative is an assessments process used during teaching and learning to provide feedback to adjust on-going teaching and learning for the goal of improving student achievement in learning outcomes. Examples of formative assessment could be quizzes that are used for grading, and student-developed rubrics for evaluating work in a specific subject area. Consequently, presentation software may be used to present teaching materials, and game-based software applications may be used for enjoyable and fun based formative assessments.

The growth of communication systems, audio and video technology has enhanced the potential ICT in education. ICT is used for teaching in many ways, listed in Table 2-3.

Table 2-3: Modes for ICT use in teaching

Category	Modes for ICT use in teaching
Information creation and dissemination:	1. Manipulating text and data 2. Presentation and dissemination information 3. Information seeking and handling 4. Capture, organising and sharing notes 5. Computer-aided mathematics and science instruction
Information Management and storage	6. Personal management 7. Cloud storage 8. Educational learning network for creation and management of online classroom community
Communication	9. Video-sharing platforms 10. Communication 11. Social networking
Assessment	12. Evaluation and assessment

Reasons why ICT is deployed into schools and for what purpose can be explained through the common rationale, which includes pedagogical, social, vocational and catalytic rationale.

Pedagogic rationale is when ICT is used to deliver school curricula (for example, Mathematics, Physical Science and Geography) and to assist in learning (Xiang, 2018). ICT provides versatile ways for teachers to present educational material, which engages, is simple, increases understanding and enables information retention (Hawkridge, 1990). Through ICT, students and teachers may exchange ideas, and gain clarification on complex concepts from experts via online platforms. It enables collaborative tasks to be carried out with learners or experts, even from other countries.

Social rationale is when, with a proliferation of ICT in society, learners need to be equipped to use ICT. When learners are confident and capable of using ICT, they

can achieve their personal goals and actively participate in society (Derboven et al., 2017).

Vocational rationale is when ICT forms an academic field of study (Hawkridge, 1990). With ICT as an academic field of study, learners are taught about the functionality of the components of ICT. Typically, an ICT subject at secondary school level involves imparting information skills such as word processing, or the creation of PowerPoint presentations to learners (Watson, 2001). The training ranges from the basics on how to operate a computer to more complex training such as gaining fundamental programming skills for a career in IS, Information Technology (IT) or computer science (Barnes & Kennewell, 2017; van Braak, 2001).

Catalytic rationale is when ICT is used to improve teaching, administrative and managerial efficiencies (Hawkridge, 1990). ICT may transform and enable innovative teaching and learning. ICT use helps to pursue critical thinking and problem-solving skills. ICT promotes collaborative and life-long learning (Jack & Higgins, 2019).

2.6 Conditions under which improved access to ICT can enhance teachers' capabilities

The process from the means (the technology introduction) to the ends (resulting impacts of the technology) differs between individuals: something that leads to positive effects for one individual could lead to no – or even an adverse – effect on another. Freedom is, hence, the opportunities that people have based on their local conditions.

2.6.1 Conditions which affect how teachers use ICT to generates educational outcomes

The use of ICT in education can be affected by local conditions. Such conditions include psycho-sociological and contextual factors that influence how teachers integrate ICT in their teaching (Clayton & Emery, 2009; Kozma, 2002). Contextual factors signify the characteristics of the environment in which ICT is used. Psycho-

sociological factors relate directly to the teachers' use of technology, both psychologically and socially. These factors form the main ideas for this section as they help to understand the influences on teacher-based ICT use.

Contextually, different types of school environments bring about different difficulties in the deployment of ICT and its integration into school curricula (Koh, Chai, & Tsai, 2014). For example, in a classroom setting, one such factor is the ratio of learners per computer in the computer laboratory. The requirements for completion of an assignment could be accessing relevant information and typing it. With the importance of individual focus on computing tasks, a higher learner-per-computer ratio may result in one learner dominating the use of ICT while the others watch passively. This could lead to ineffective teaching and learning using computers since not all learners benefit fully from the efficiencies of the computers.

Infrastructure is a further contextual factor affecting the integration of ICT into school curricula (Glowatz & O'Brien, 2018). When it comes to the availability of computers in schools, there needs to be appropriate infrastructures such as electricity, telephones, physical space and Internet connectivity (Tondeur, van Braak, et al., 2017) . While the availability of such infrastructure may be readily accessible in schools in affluent areas, their availability (or ease of acquisition) in disadvantaged schools is not ensured (Mireku, 2016). Without a reliable supply of electricity, it would be difficult to ensure the regular functioning of ICT facilities. This means that teachers lack the resources to carry out their ICT curriculum integration.

Institutional management affects the integration of ICT in school curricula (A. Chigona, Chigona, W, Kausa, & Kayongo, 2010). School environments that are characterised by a top-down management style with minimal consultation between levels do not allow teachers to express the goals they wish to pursue and the freedom to bring about achievements they value (Czerniewicz, Williams, & Brown, 2009). Teachers may feel compelled to use ICT and therefore do not use it effectively (Czerniewizcz & Brown, 2009), or they may feel limited by a lack of institutional support and vision (Casanova, Price, & Avery, 2018). Many teachers feel uncertain of

the function of ICT and the direction they should achieve ICT in educational goals. They also lack technical support and ICT skills training.

The psycho-sociological are the personal factors of the teacher that are pivotal to the successful integration of ICT into schools' curricula (Alenezi, 2017). For example, such factors are perception, understanding and attitude (Ertmer, 1999; Peeraer & Van Petegem, 2011). The perception of ICT in education has continuously evolved since its introduction in 1960 (Sawyer, 2017). At its inception, ICT was perceived as a tool that could understand programmed instruction and physically replace teachers. However, in the 21st century, ICT is viewed as providing inter-networking devices for personal and broader use (Voogt, 2004).

Teachers' knowledge and willingness to use ICT in teaching is often associated with sociological factors such as age, gender and personality traits. These demographic factors may influence the perceived norm of technology used to teach a specific subject in a school (Pierce & Ball, 2009). Younger and middle-aged teachers may agree with using ICT in teaching while older teachers may not. Female teachers may find little time for ICT at home because they are busy with domestic chores. They may feel technologically incompetent for tasks such as trouble-shooting ICT (De Choudhury, Sharma, Logar, Eekhout, & Nielsen, 2017). In the developing world context, women continue to be less technologically oriented than their male counterparts (Purushothaman, Holmfeld, & Kuruvilla, 2019). Women are less intense users of both email and the Web, and they use the Web less diversely than men do (Purushothaman et al., 2019). In a knowledge society where virtually all significant aspects of human life (economics and commerce, politics and governance, and cultural change), ICT are interwoven into life, women risk falling further behind unless concrete steps are taken to prevent this. The human perspective acknowledges the existence of gender-specific constraints to women's active engagement with ICT, in particular in access, affordability and usage patterns (Alozie & Akpan-Obong, 2017). The constraints include the absence of relevant information or technology.

Temperament and personality are related terms that affect a person's behaviour. An individual's temperament is that individual's inherent emotional nature, the speed and intensity with which they react in specific conditions (for example, emotional simulation, strength, response rate and moods). Common temperaments are sanguine (warm, pleasant), phlegmatic (slow-moving, apathetic), choleric (quick to react, hot-tempered), and melancholic (depressed, sad) (Aaen, 2010; Salmani Nodoushan, 2011).

Personality is a dynamic and organised set of traits possessed by individuals that uniquely affects their thinking, motivation and behaviours in diverse conditions (Hassanzadeh, Gholami, Allahyar, & Noordin, 2012). Personality traits are commonly termed introversion and extroversion (Judge, Higgins, Thoresen, & Barrick, 1999; Naqshbandi, Ainin, Jaafar, & Shuib, 2017). An introvert is someone who has an "exaggeration of thought process in relation to directly observable behaviour" (Freyd, 1924, p. 74); they tend to retract from social interaction. An extrovert is an individual who has a low "thought process in relation to directly observable social behaviour" (Freyd, 1924, 75) who tends to create social interactions. In relation to temperaments, the unstable extrovert is termed 'choleric' and the stable extravert is termed 'sanguine'. The stable introvert is termed 'phlegmatic', and the unstable introvert is termed 'melancholic' (Clark & Watson, 1999). See Table 2-4.

Table 2-4 Personality traits and description

Personality type	**Description**
Choleric	Short-tempered, fast, or irritable
Melancholic	Analytical, wise, and quiet
Sanguine	Enthusiastic, active, and social

The relationship between personality traits and technology use is that it is a fundamental psychological mechanism that manages individuals' behaviour. The

personality dimension that is often defined as introversion or extroversion is related to many aspects of human computer interaction (Bervell & Umar, 2018). Personality traits influence behaviour patterns in technology use and the willingness to adopt ICT. An individual's behavioural intentions concerning technology acceptance is an important determinant of attitude (Camadan, Reisoglu, Ursavas, & Mcilroy, 2018). Since extraversion is characterised by individuals that generate social interactions, energetic and companionable, these individuals have a "can do it" attitude (Rosen & Kluemper, 2008). Extroverts tend to lead sharing and communication activities in social environments, and are therefore, more likely to use technology that will place them upfront in social environments (Roberts, Pullig, & Manolis, 2015).

Differences are observed in the personalities of early adopters and late adopters of ICT (Barham, Chavas, Fitz, & Schechter, 2018). Early adopters reflect a more positive attitude towards change, motivation and a better ability to deal with uncertainty and risk (Liu, Zhao, Chau, & Tang, 2015). Attitude is a factor that influences the integration of ICT into school curricula. It impacts on how individuals interact within organisations. Individuals with a positive attitude are more willing to adopt and use new technology innovations (Rogers, 2010). The benefit of in-depth knowledge about individual level factors such as personality is that it may guide intuitions on effective technology use (Camadan et al., 2018).

Teacher efficacy affects the integration of ICT into school curricula. It is a person's belief that they can lead learners to success (Armor, 1976; Bandura & Walters, 1977; Dixon, Yssel, McConnell, & Hardin, 2014). Self-efficacy is defined by Bandura (1986) as:

> *"People's judgments of their capabilities to organise and execute courses of action required attaining designated types of performances. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses" (p. 391)*

Teachers may have ICT skills (for example, sending emails, browsing the Internet, or capturing data) that allow them to use software or hardware. However, computer self-efficacy refers to an individual's assessment of whether they could apply their ICT skills for broader tasks (for example, preparing written reports or analysing financial

data) (Compeau, Correia, & Thatcher, 2017). The significance of computer self-efficacy is that a high computer self-efficacy is seen to affect the choice to use and adopt ICT (Compeau & Higgins, 1995). Within the teaching context, it affects how and in what way ICT is used.

Values are principles that guide behaviour (Sekiwu & Botha, 2014). They are yardstick for measuring individual progress and determining individual goals. Values can be classified as moral values that include love, tolerance, respect, responsibility, care, empathy, resilience and creativity. People grow within moral specific moral traditions. Consequently, democracy of a country flourishes when citizens are guided by moral values (Chowdhury, 2016). The advancements in new technological innovations emphasises on the importance of morals, values and ethics and their benefit to society (Chowdhury, 2016). Values and virtues form the basis for teaching practices (Reiss, 1999). Therefore, teaching is a moral activity (Maaranen, Kynäslahti, Byman, Jyrhämä, & Sintonen, 2019). Teachers' decisions are influenced by values.

2.6.2 ICT enabled educational outcomes

Technological developments are centred on scientific knowledge and problem-solving with the aim of expanding human capabilities (Afshari, Bakar, Luan, Samah, & Fooi, 2009). Technology can influence how people access, gather, analyse, present, transmit and simulate information (See, 1994). ICT offers life-improving benefits (such as Improved efficiencies in governance, communication, travelling, buying and selling). An individual can decide whether they find the benefits of ICT useful and choose to exploit ICT related benefits.

Outcomes are a result of an individual's choice to act on their opportunities. Exploiting opportunities provided by ICT may generate a wide variety of outcomes in education. Outcomes obtained from ICT in education may be economic and non-economic (Hatakka et al., 2014). As an economic outcome, ICT in education may transform the teaching and learning environment by allowing learning to be done in

an active, self-directed and constructive way, thereby equipping learners with necessary 21st-century learning skills (such as creativity, communication, collaboration and critical thinking) that allow access to employment opportunities (Soulé & Warrick, 2015). The non-economic benefits of ICT in education are life-improving elements such as to be ICT literate, knowledge of both health and the environment. Consequently, 'being modern' (up to date) is of intrinsic value for individuals (Chowdhury, 2016; Robeyns, 2006).

2.7 ICT in education in the South African education context

This section seeks to highlight the existing realities of ICT integration in the South African context. It provides a brief overview of ICT in education policy implementations, the stakeholders and focuses areas as well as the pre-service and in-service ICT teacher training.

2.7.1 ICT in education policy implementation

The goals and aims of ICT in education are defined by policy and decision makers that provide a way in which ICT should be used in teaching (Baron & Bruillard, 2003). In line with the developing world contexts, this study highlights the aim of ICT integration into school curricula. The aim of ICT strategy for education and training curriculum policy differs across countries in the developing country contexts (for example, Kenya, Botswana and South Africa).

The level and the depth of training is inadequate to support the effective integration of ICT into school curricula (Chisholm et al., 2004; Mojela, 2013). The conversion of these aims to the actual use of ICT in teaching is affected to a lack of electricity, infrastructure, Internet connectivity and financial support (Wambiri & Ndani, 2017).

In South Africa, the e-Education policy seeks to ensure that every learner can use ICT confidently and creatively to develop the skills and knowledge they need to achieve personal goals (DoE, 2003). Large-scale collaborations between the

government, the private sector and the public-private collaborative projects and growth in the urban areas, mean that the rural areas are left out.

In South Africa, ICT implementation in schools and its integration into curricula involves several stakeholders. Stakeholders have multiple roles in the various stages of development as summarised in Table 2-5 (Meyer & Gent, 2016).

Table 2-5: Stakeholders and focus areas of ICT implementation into schools

	Stakeholder	**Focus areas**
Macro Level	Department of Basic Education	Policy planning and implementation, funding.
	Provincial government	Policy planning, financial support, strategies for ICT integration processes, teacher training professional development
Meso Level	Educational district	Support, monitor, provide guidelines, training, and community engagement.
Micro Level	School management	Planning, goal-setting, administration, ICT integration into school, ICT support for teachers
	Teachers	Teacher training and professional development, ICT adoption and use, administration, peer support.
	ICT in School initiatives and projects	Solutions to ICT deployment and its integration into schools' curricula.

The key role players of ICT in the education system are DBE, as represented by the national, provincial ministries at the macro level, education districts at the meso-level and the schools at the micro level.

In terms of the implementation of ICT in schools in the Gauteng province, the Gauteng Online project has been implemented. In the Western Cape, the Khanya project has sought, without much success, to deploy ICT into schools and integrate it into schools' curricula. Smaller computer projects have also been established in

some provinces in South Africa to provide Internet connectivity to schools. One of these projects is in the Eastern Cape, namely the Connect Eastern Cape. With efforts to deploy computers into schools, it is important to ensure its full integration into school curricula to transform the teaching and learning process (Kabatangare, 2019).

For the most part, South African schools in affluent areas have the skills and resources to achieve ICT-in-education goals. However, this is not ordinarily true for schools in disadvantaged areas which lack basic facilities such as classrooms, electricity, telephones and libraries, let alone ICT (Mireku, 2016). As a result, the goals of ICT deployment and integration into school curricula are far from being achieved. With regards to ICT deployment, the learner per computer ratio ranges from a high learner per computer ratio in the affluent areas, to a low ratio in less affluent areas, to schools with no access to ICT (Nonyane & Mlitwa, 2008; Koranteng, 2012b). Regarding ICT integration, few subjects within schools in disadvantaged communities have a computer-facilitated aspect (Koranteng, 2012; Mlitwa & Nonyane, 2008). Consequently, teachers are given only basic computer literacy training and no specialised training in educational technologies (Nonyane & Mlitwa, 2008; Koranteng, 2012b). Considering the efforts made to deploy ICT into schools and integrate it into school curricula, few schools gain from the benefits of ICT. A lack of ICT means that teachers and learners are deprived of the full benefits of ICT to improve teaching and learning and to enable them personally to be employable and improve their standard of living.

2.7.2 Pre-service and In-service ICT teacher training in South Africa

In South Africa, in-service and pre-service programmes are facilitated by DBE at local, provincial and national levels. Pre-service and in-service teacher training comprises teacher learning and development programmes (Howell & Sayed, 2018). Pre-service training generally consists of coursework and field experience aimed at preparing future teachers. In-service training seeks to equip teachers that are under-qualified or who seek to improve their academic qualification with skills to achieve

scholarly success (Holtman, Martin, & Mukuna, 2018). Effective teacher training enhances the performance of teachers and improves learner achievement (Karagiorgi & Charalambous, 2006).

With regards to ICT integration into pre-service and in-service training, the quality and quantity of ICT experience have a strong influence on teachers' adoption of technology (Howell & Sayed, 2018). ICT use in pre-service and in-service training equips teachers with the skills to help them integrate ICT into teaching and learning. As a result, South African universities have incorporated ICT literacy (including email, end-user computing, programming, word processing, Spreadsheet and database skills) in the in-service and pre-service training teacher education curriculum (Dube, Nhamo, & Magonde, 2018). However, empirical evidence shows that pre-service teachers do not feel adequately prepared to integrate technology into the classroom effectively (Johnson, 2012; Turgut, 2017). As a result, pre-service and beginning teachers struggle to integrate technology sufficiently in their teaching. The way teachers are taught does not match how teachers use ICT in their teaching. Pre-service teacher education focuses mainly on basic computer literacy and computer use (Koehler & Mishra, 2009). Research shows that for pre-service teachers' effective technology integration to occur, there needs to be an intersect between pedagogical and content knowledge or the understanding of educational programmes or systems (Farjon, Smits, & Voogt, 2019; Koehler & Mishra, 2009; Mouza, Karchmer-Klein, Nandakumar, Ozden, & Hu, 2014).

2.8 Summary of chapter

In synthesis, ICT has potential to support one's capability in making informed choices and pursuing the kind of lives people value (Sen, 2000; Yim & Gomez, 2018). Nevertheless, everyone is still at the beginning stage of understanding how people in developing countries use ICT in their everyday lives and how it leads to capability enhancements (Yim & Gomez, 2018). This follows arguments against technological determinism – that ICT should be examined within specific uses and settings to capture the role it plays in the social and economic meaning-making. There is a need

to examine how people's capabilities are enhanced from their own perspective (Yim & Gomez, 2018). Thus, the focus is more on the ability to reach the desired state of being rather than listing what better conditions is – people themselves define the latter. The link between ICT and enhanced capabilities has been explained using frameworks including extension theory and ANT. However, these theories do not explain the mechanism of ICT use and the effect in details, where ICT is regarded as neutral and as a commodity that will automatically contribute to an individual's capability set (freedom of choice to be an active participant in society) (Hatakka et al., 2016). This signifies a gap in the literature, which can be reduced by gaining a deeper understanding of the process of ICT use and the actor's role in the process. Affordances can enhance understanding of the mechanisms by which ICT enable or constraint possibilities and opportunities for individuals and groups (Thapa & Hatakka, 2017). However, few studies have gone beyond contextualising parts of the concepts into a specific context. The process from means (the technology introduction) to ends (resulting impacts of the technology) differs between individuals: something that leads to positive effects for one individual could lead to no, or even negative effects of another. Freedom, hence, involves both the process of development and the opportunities that people have, based on their local conditions. Research indicates that local conditions include contextual and pyscho-sociological factors. Contextual factors (such as infrastructure) signify the characteristics of the environment in which ICT is used and institutional management. Psycho-sociological factors (such as age, gender, personality trait, perception, understanding and attitude) relate directly to the teachers' use of technology, both psychologically and socially, as well as teacher efficacy and ICT skills (Chigona, Chigona, Kayongo, & Kausa, 2010; Ertmer, 1999; Glowatz & O'Brien, 2018; Purushothaman et al., 2019; Tondeur, Aesaert, et al., 2017). The success of the implementation of ICT is not dependent of the availability or absence of one individual factor but is determined through a dynamic process involving a set of interrelated factors (Ten Brummelhuis, 1995).

The study sought to answer the question of how the use of ICT enables teachers to generate educational outcomes. This was achieved in three ways. First, the study

described how the teacher uses the opportunities enabled through ICT to achieve outcomes. Second, the study explored the outcomes generated for teachers through ICT. Third, the study explained the individual differences that influence the use of ICT to generate capabilities.

CHAPTER 3 : THEORETICAL APPROACH

3.0 Introduction

The chapter specifies a theoretical background for the study. A theory is a systematic set of principles that elucidates real-life events. The theoretical constructs guide how the key elements of the empirical setting were defined. The theoretical framework provides a focal lens that defines the perspective from which the study is viewed.

Section 3.1 gives a theoretical overview of the study. Section 3.2 provides an overview of the Capability Approach (CA) and section 3.3 the key terms of the Capability Approach. Section 3.4 details the choice of an individual to act on their capability set. Section 3.6 explains why CA was supplemented with explanatory frameworks. Section 3.7 illustrates the operationalisation of CA. Section 3.8 presents the use of CA in research, section 3.9 provides the application of CA in ICT in research, section 3.10 provides the relevance of the capability approach in this study. Section 3.11 summarises the chapter.

3.1 Theoretical overview of the study

The study is about usage, outcomes, processes, social and cultural factors as well as commodity in the field of ICT in education. A commodity is a tool that enables an individual to achieve the lifestyle of value. The use of a commodity (such as ICT) depends both on the features of the commodity and the characteristics of the user. With regards to the commodity, its functional properties determine its possible use, with the user, personal, social and cultural factors may influence the use of the commodity. Outcomes are ‘doings and beings’ that are a result of an individual’s choice to act on the opportunities available. The study seeks to understand how teachers use ICT to produce desirable outcomes in teaching in the context of developing countries. It focuses on the outcomes that result from teachers realising the benefits that a commodity (such as ICT) have to offer.

In research, frameworks commonly used in ICT integration into education research focus on ICT adoption (Setiawan, Yanti, & Miraj, 2018). Since this study focuses on capabilities, outcomes, social and cultural factors, the CA is deemed suitable. The study supplements CA with the Conole and Dyke (2004) taxonomy of ICT affordances to understand how these affordances determine possibilities for ICT use in the teaching context. The individual differences' conceptual framework also aids in understanding the impact of institutional and cultural factors on the individual as shown in Section 3.6.

3.2 Capability Approach – An overview

The Capability Approach (CA) is an economic theory of welfare (Robeyns, 2005, Plagerson & Patel, 2019). Despite earlier research on CA, it was reinterpreted and formalised in the 1980s by Amartya Sen (Basu & Kanbur, 2008). Aspects of CA may be traced back to, amongst others, Aristotle, Adam Smith, John Stuart Mill and Karl Marx. Amartya Sen pioneered the approach in its present form more recently, Martha Nussbaum has made significant developments (Nussbaum, 1995, 2003; Nussbaum, 2001, 2009).

CA is a normative framework used to conceptualise notions of poverty, inequality or well-being (Jepson et al., 2017). It is used to assess whether the freedoms people have are enhanced (Robeyns, 2005). For example, longevity may be viewed as an enhancement of the freedom to live long lives (Sen, 2017). Although income is important (in well-being analysis), income-based analysis processes do not acknowledge the physical and social conditions that affect people's ability to convert similar resources into different levels of well-being (Bondo, 2018; Robeyns, 2005). As a result, Sen suggests a new viewpoint for analysing equality that will take into consideration human diversity and the diversities of variables on which equality could be evaluated (Walker & Unterhalter, 2007).

CA is used in various fields such as development studies, welfare economics, social policy and political philosophy (Koskinen, 2017; Robeyns, 2005). The framework is

used to evaluate and assess an individual's well-being, aspects of which include economic opportunities, political liberties, social power, security, health and education (Robeyns, 2011a). It has been operationalised in the field of ICT4D (Hatakka & De, 2011). In ICT for education research, CA has been used for research such as on analysing the impact of access to ICT on development and limited ICT use as a capability deprivation (Redmond & Skattebol, 2017; Zheng & Walsham, 2008). CA presents a tool and a framework to conceptualise inequality and well-being (Madon, 2004) and, therefore, does not explain and evaluate poverty, inequality and well-being. Explanatory theories are required to supplement CA to explain aspects of policy and social transformation. In this study the individual differences conceptual framework – to understand impact of instructional and cultural factors on individual and taxonomy of ICT affordances – determines possible use of ICT in teaching are used to expand on the explanatory power of CA.

3.3 Capability Approach – Key constructs

From the CA viewpoint, when conducting normative evaluations and policies (such as, poverty measurement, cost-benefit and inequality analysis), focus should be on what people can 'do and be', which is known as their functionings (Bondo, 2018; Robeyns, 2005). Achieved functionings are the opportunities that a person uses within a specific context (Burger, McAravey, & Van der Berg, 2017; Saito, 2003). Sen stresses the need to focus on people's capabilities, which are their freedom to lead the quality of life they value (Bacher et al., 2018; Qizilbash, 1996), for example, to carry out activities such as reading, working or being politically active (Haenssgen & Ariana, 2018; Mitra, 2006). CA, therefore, enables one to look at an individual's well-being holistically (Alkire & Deneulin, 2009) beyond a monetary context. These may include access to quality education, improved learner results and the acquisition of skills to make one employable. Table 3-1 highlights the key concepts of CA the subsequent sub-sections will discuss the constructs.

Table 3-1: Definition of key capability approach concepts

Concept	Description	Examples in education
Commodity	An instrument that helps individuals carry out valuable achievements (Zimmermann, 2006).	Software applications
Capability	An individual's ability to carry out actions and activities they see as valuable (Sen, 1982). It refers to *opportunities* an individual may have to do or be.	• To enable access to good education • To improve the education delivered • To improve human capital by ensuring learners complete examinations
Functionings	The actual achievement of what a person values. It refers to an individual's beings and doings (Sen, 1999a).	• Better information access • Better classroom interaction • Better personal organisation • Better lesson preparation
Agency	Recognising individuals as responsible beings who may act or refuse to act in one way or the other (Sen, 1999a)	
Choice	The choice aspect may refer to an individual's decision to act on opportunities in their capability set (Hatakka, Devinder, & Sæbø, 2016).	
Well-being	State of being comfortable, healthy or happy (Nyemba-Mudenda, 2015)	
Outcomes	*"The capabilities and realised functionings that are results of an individual's choice to act on the opportunities within their capability set"* (Hatakka et al., 2014).	

3.3.1 Capabilities

A capability is a freedom individuals have to achieve what they value and have reason to value (Robeyns, 2005). An individual's capability is:

> *"*[The] *various combinations of functionings that a person can achieve. The capability is thus a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another" (Sen, 1992, p. 40).*

Capabilities are the notion of freedom, the real opportunities the individual has regarding the life they may lead (Kato, Ashley, & Weaver, 2017). CA may capture the fact that two persons may have different substantial opportunities even when they have exactly the same set of means: For example, a person with disability may do less than an able-bodied person may, with exactly the same income and other primary goods. The person with disability can, therefore, not be judged to be equally advantaged with the same substantive opportunities as the able-bodied person with

the same set of means. In a similar way, an affluent person who fasts may have the same functioning achievement regarding eating or nourishment as a destitute person who is forced to starve. However, the latter has a different “capability set” than the former (the first may choose to eat and be well nourished in a way the second cannot).

3.3.2 Functionings

Functioning refers to an individual’s ‘beings and doings’ (Burger et al., 2017; Robeyns, 2005). Functioning is the achievement of desirable outcomes. Functions may be elementary, such as being adequately nourished, being in good health. Being able to go to school, being educated and being literate. These may be strongly valued by all for obvious reasons. Others may be more complex, but still widely valued, such as achieving self-respect or being socially integrated. Individuals may, however, differ from each other in the weights they attached to make these different functionings valuable. Functioning is the achievement and capability is the ability to achieve. In education, for example, beings and doings (functionings) of an individual are being able to go to school, being educated and being literate.

3.3.3 Agency

An agent is someone who brings about change and whose achievement is judged regarding their values and objectives (Sen, 1999b). A person is an agent if they pursue what they value or have reason to value (Sen, 1999b). Evaluation of agency achievement involves assessing the person’s success in pursuit of all the objectives that they have reason to promote. Agency is the ability to act on what a person values and has reason to value (Sood, 2017). It is what a person is free to do and achieve in pursuit of whatever goals or values he or she regards as important (Kinghorn & Coast, 2018). Agency refers to a person’s ability to choose from the availed opportunities based on personal values and circumstances (Khader, 2018). It factors in the involvement of the individual in the development process (Robeyns, 2005). This refers to whether or not they choose to use the facilities to improve their lives, depending on what they value and their circumstances.

3.3.4 Well-being

A person's achievement of well-being may be seen as an evaluation of the 'wellness' of the person's state of being. An evaluation of 'wellness' involves assessing the constituent elements of the person's being, seen from the perspective of their own personal welfare. The different functionings of the person will make up these constituent elements (Coast et al., 2018). For teachers, the different types of well-being relate to their occupation and performance (Robeyns, 2005; Zheng & Walsham, 2008). Stress levels and distraction increase when the well-being of a teacher is reduced (Stephens, 2017). Constrained occupational well-being may be a result of the implementation of policies or rules. The goal of an individual may be to achieve well-being (Sen, 1999b). Although commodity is a significant contributor to an individual's well-being, there are components of well-being (such as being literate, being educated and being able to make choices) that are not directly acquired with income (Shifa & Leibbrandt, 2017). Even with the same bundle of goods or commodities, different human beings attain different levels of well-being are attained by different human beings (Sen, 1992).

3.3.5 Conversion factors

Conversion factors are personal, social and environmental elements that enable or inhibit individuals from expanding their capabilities (Robeyns, 2006). Personal characteristics such as income, literacy, age and gender, influence a person's ability to convert the features of a commodity (such as income, technology) into achieved functionings (such as improved teaching). The characteristics of social context consist of social factors, which are:

- Social norms (such as rules that govern behaviour, values, teacher roles);
- Social institutions (such as public policies, governmental laws, education) and;
- Social structures (such as political structures, organisations) (Zheng & Walsham, 2008).

Environmental factors such as infrastructure, telecommunication, electricity, and resources also influence an individual in converting the features of the commodity into functionings. Conversion factors may also enhance or inhibit a person's choice to use capabilities at hand to achieve an outcome. With the CA being highly abstract and difficult to operationalise into the empirical context. The individual differences conceptual framework elucidates how the differences between teachers affect the generation of capabilities (Quesenberry & Trauth, 2012).

3.4 Choice

Choice refers to an individual's decision to act on opportunities in their capability set (Hatakka et al., 2016). The opportunities enabled for an individual in general and their choice are affected by conversion factors (Robeyns, 2011b). In the context of the study, conversion factors such as personal, social and environmental characteristics such as literacy, lack of confidence and lack of infrastructure affect teachers' decision to choose to use the opportunities offered through ICT (Kleine, 2010).

3.5 Selection of relevant capabilities

CA is criticised for lacking legitimacy as a methodology within research platforms and for being too vague, for not specifying important capabilities or for not providing a clear set of guidelines on how the selection of capabilities should be done (Pérez, 2017). This has resulted in calls for a list of capabilities which may be used to evaluate the quality of life, well-being, inequality and social justice (Barrington et al., 2017). The weak critique is the lack of systematic methodological reasoning on how the selection of capabilities should be made for such evaluations. The strong critique is to endorse a list of capabilities (Nussbaum, 2011). This section highlights the two critiques and their arguments as well as justifying why the researcher chose to use Sen's approach in this study. The section concludes with the procedural methodologies that were followed to select the list of capabilities for teachers using ICT in teaching.

Capabilities may be attained at both individual and collective levels. It may consist of elements relating to health, income and education (Malakar, 2018). In addition, all citizens are entitled to basic social justice. However, Nussbaum argues that the content and opportunities that make up fundamental capabilities need to be clearly defined (Sood, 2017). Therefore, the level of health, income and education attainment need to have a specific threshold level. She asserts that the level at which freedom/capability is attained is vague in Sen's writing. She endorses a specific list of the *Central Human Capabilities* as the focus for measuring the quality of life and for basic political principles formulation that she justifies as being relevant universally (Nussbaum, 2001).

Sen and Nussbaum have different ways of applying CA because of their expertise and academic disciplines (Robeyn 2003). Nussbaum's academic discipline stems from Law. For Nussbaum, CA is used to develop a theory of justice critiquing the status quo and promoting just relations between individuals and society Nussbaum, 2011). The central human capabilities list entails ten capabilities – life, physical health, bodily integrity, sense, imagination and thought, emotions, practical reason, affiliation, other species as well as play and control over one's environment (Nussbaum, 2001). The list is compiled at a general level; it is open-ended, and may, therefore, be converted into a more specific list to suit the society in question (Garriga, 2014). The list is a minimum account of social justice. A fully just society cannot be maintained if citizens are not provided with these capabilities at a specific threshold level (Pérez, 2017).

Sen's perspective is derived from the field of social choice and thus maintains that the list of capabilities should be developed through democratic processes. Sen does not advocate for a fixed list of capabilities (Cin, 2017), so her version of CA is flexible and deliberately unspecified (Mitra, 2018). Sen suggests that the choice and importance of capabilities depends on what is seen as valuable to an individual (Fragoso, 2017). Further emphasis is put on the role of agency. Therefore, agency, choice and the freedom to reason should be taken into consideration when selecting appropriate capabilities. With the ability to define one's capabilities, researchers have

the flexibility to develop and apply CA in diverse ways that suit a context (Alkire, 2002).

3.5.1 Limitation of a fixed list of capabilities

The selection of a fixed list of capabilities for quality of life measurements have limitations (Garza-Vázquez & Deneulin, 2018). First, a fixed list of capabilities may have epistemological limitations when drawn from pure theory (Robeyns, 2018). CA is used to accomplish epistemological goals, such as welfare, quality of life measurements, descriptive analysis and normative theories, through the use of different methodologies (Robeyns, 2018). Capabilities fulfil different roles. Thus, the selection of a relevant list of capabilities will differ according to the content and specifications of the goals to be achieved in each discipline (Walker, 2018). Second, there may be limited knowledge about the phenomenon of interest. Third, due to legitimacy concerns, researchers should include the people to whom the list of capabilities is applied. This is to ensure that the people in question do not feel that the list is imposed on them, so the list does not lack the legitimacy it needs to make a political impact (Yanhui & Ziyu, 2017).

3.5.2 Criteria for selecting capabilities

A criterion is a measure that the process of selecting capabilities should meet, and helps to avoid epistemological biases and ensure quality. Robeyns (2005) proposes an approach which includes the set of criteria that the process of selecting capabilities should meet.

The criteria for selecting a list of capabilities as suggested by Robeyns (2005):

- **Explicit formulation:** Discuss and defend the capability list explicitly.
- **Methodological justification:** Explain and critique the method used to generate the capability list.

- **Different levels of generality:** Capability lists used for empirical application or for implementable policy proposals are compiled in two stages. In each stage, the capability list is generated at different levels ranging from ideal theory to a practical list.
- **Exhaustion and non-reduction:** The capabilities on the list should include all fundamental elements.

The proposed criteria are a “check and balance” to aid in preventing biases in the selection of capabilities. When selecting capabilities to measure the quality of life, one should consider that there are diverse categories of quality of life measurements – large-scale policy design, large-scale empirical assessments and small-scale projects (Robeyns, 2018). Each category requires different methodologies. With this study assessing the well-being of a small group, discussions will be limited to small-scale projects. The selection of capabilities may be carried out using a participatory method, with members of the group discussing relevant capabilities. Thus, the decision-making process may be carried out by a capable local agent and through democratic participation (Fragoso, 2017). This helps to conduct assessments on ICT access and its integration into schools’ curricula that is not only focused on whether ICT exists but rather on what people value and how they use the opportunities offered by ICT to achieve goals.

The study draws on Sen’s approach to aid the selection of appropriate capabilities because it allows for democratic participation and enables the researcher to capture the lives people perceive as valuable in a given context. The important capabilities were obtained from research participants during the semi-structured interviews. Since the study seeks to understand how the use of ICT enables teachers to generate educational outcomes, the focus of the list of capabilities is on the education context.

3.6 Rational to supplement CA with Individual differences conceptual framework

With CA being a broad and complex framework it is difficult to create precise measurements for application in different contexts. Operationalisation of an analytically rich theory such as CA should be done in an informed manner. Moving from abstract concepts to detailed modes of application of concepts in practical situations. Measurements using CA framework should have relevant elements that shape, monitor and assess responses in a normative manner. The focus of CA on different aspects of human well-being and its aim to enhance opportunity and freedoms help to develop a comprehensive picture of empirical situations. However, there are methodological challenges (Binder, 2014). Since CA is an open framework for analysis it lacks guidance on how to empirically measure its key concepts such as conversion factors (Binder, 2014). While the abstract categories of conversion factors can act as a guide physical, social, environmental – the specific factors in a particular location must be identified. Conversion factors, which are key components of the CA and fundamental determinants of outcomes that policy makers should be made aware of often, remain hidden within the aggregate data. Therefore, there is a need to go beyond the averages and to consider deeper the individual conditions context.
In capability approach an individual can converts commodities into achieved outcomes. The conversion depends on the personal, social and environmental factors (Robeyns, 2018). These conversion factors are important because they enable or inhibit the achievement of capabilities (Hatakka et al., 2014). When it comes to teachers the conversion factors allows one to capture the situated context of the teachers. CA presents a tool and a framework to conceptualise inequality and well-being (Madon, 2004) and, therefore, does not explain and evaluate poverty, inequality and well-being. Explanatory theories are required to supplement CA to explain aspects of policy and social transformation. There is a gap in the conversion factors view of the capability approach that needs to be explored. Micro data contains answers provided by each individual respondent to specific inquiries.

The individual difference's framework is a micro-level conceptual framework. It aids in understanding the impact of institutional and cultural factors on the individual (Lee,

Trauth, & Farwell, 1995; Trauth, 2017). In this study, the role of a teacher is important. A teacher's professional activity is influenced by their characteristics (for example, ability, knowledge, willingness to work, interest, teaching styles) (Stronge, 2018). These characteristics differ from one teacher to another – individual differences. Information of how individuals differ in their knowledge and skill provide a background to adaptation to new technologies (Rogers, 2003). Teachers are distinct personalities experiencing a range of socio-cultural influences that lead to a range of behaviours (Tzafilkou, Protogeros, Karagiannidis, & Koumpis, 2017).

In this study the individual difference conceptual framework captures differences amongst teachers. The individual difference conceptual framework enables identification of the implications of diversity amongst teacher. Individual differences conceptual framework deals with constructs such as personal, shaping and influencing and environmental factors. An individual has personal experience that influences their identity. The explanatory power of the individual differences conceptual framework concerning the use of ICT helps to gain a better understanding of how teacher capabilities are enabled and educational outcomes are generated through ICT. An adaptation of the elements of the individual differences conceptual framework by Trauth, Quesenberry, and Morgan (2004), is summarised in Table 3-2.

Table 3-2: Definitions of key individual differences concepts

Construct	Description	Examples of attributes
Personal data	Demographic data characteristics of the teacher	• Age • Gender • Religion
	Lifestyle data	• Family background • Children
	Workplace data	• Career characteristic • Level of education
Shaping and influencing factors	Personal characteristics	• Education • Personality traits • Abilities
	Personal influences	• Mentor and role model
Environmental context	Cultural attitudes & Values	• Geographical data • Cultural beliefs • Attitude • Values
	Geographical data	• Location • History
Social factors (Robeyns, 2006)	Characteristics of the society which one lives in	• Rules • Public policies • Governmental laws

The functionalities of the commodity may lead to capability-sets (freedom of choice to be an active participant in society). However, individual differences influences how the commodity is used to generate opportunities for an individual (See Table 3-2). Consequently, individual differences influence an individual choice to convert the capabilities into desired outcomes.

Considering the use of ICT in teaching, personal factors such as ICT literacy may affect an individual's ability to adapt and use software applications in their teaching (Schiller, 2003). Due to their influence on an individual's identity supervising mentors influence teacher-trainees' use and attitude towards ICT (Dexter & Riedel, 2003). Environmental factors such as lack of infrastructure, telecommunication, classrooms, skilled teachers, and finances present a challenge for the use of ICT in teaching. Due

to social arrangements such as ICT access and use policy, a limit on Internet data usage may influence the level of ICT use in teaching in the study.

3.7 Operationalisation of Capability Approach

Researchers within and outside of the field of ICT4D have operationalised CA with some incorporating choice or empowerment frameworks (Alsop & Heinsohn, 2005; Kleine, 2010). Other studies focus on the capability deprivation aspect of CA. Despite some methodological difficulties, studies that have operationalised CA by designing a framework or that have simply applied CA concepts directly for analysing empirical concepts have made evident the exploratory and explanatory strength of CA (Alampay, 2006; Hatakka & De, 2011; Robeyns, 2006; Zheng & Walsham, 2008). With the focus of this study being the use of technology in teaching, social, cultural factors, capabilities and achieved functionings as well as the importance of context, this study will draw on Hatakka and De (2011) operationalisation of CA and the individual differences conceptual framework (Trauth et al., 2004) as well as ICT affordances taxonomy (Conole & Dyke, 2004). Figure 3-1presents the framework of the study.

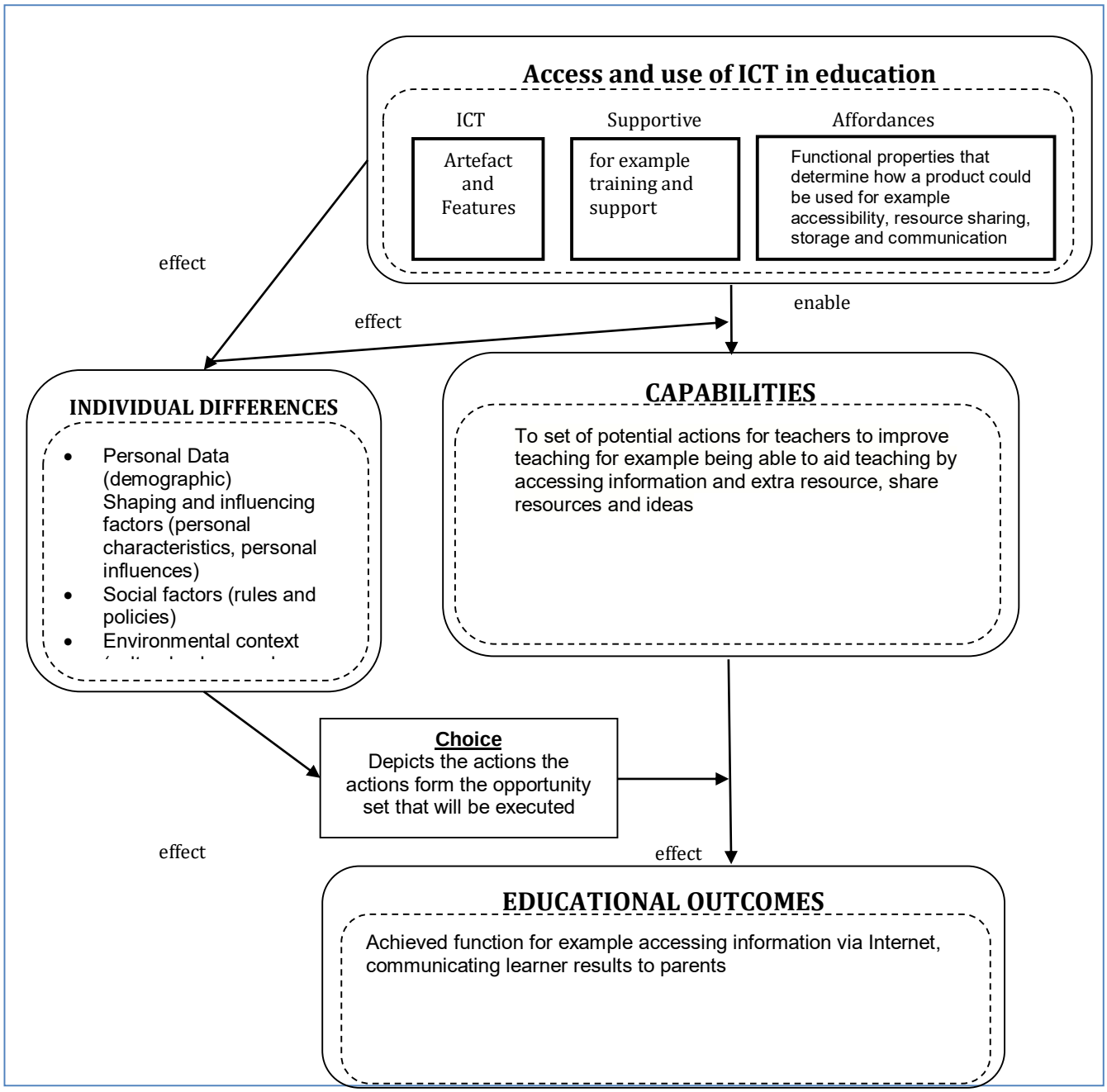

Figure 3-1 conceptualisation of education technology in teaching using CA adapted from Hatakka and De (2011)

ICT integration into schools' curricula needs to be complemented with supportive functions. These supportive functions include IT skills training, training of technical staff and monitoring as well as maintenance of ICT. Although access to ICT is essential for its use, CA acknowledges the importance of *individual differences* on

whether teachers will use ICT, how they use it and how it is valued. Individual differences may affect a person's choice to use capabilities at hand to achieve an outcome. Personal characteristics (such as income, literacy, age and gender) influence a person's ability to use ICT and on the choice to convert the features of ICT (such as supportive and affordances) into achieved functionings (such as simpler ways of teaching).

The characteristics of social context comprise characteristics of the society in which one lives, these are social norms (such as rules that govern behaviour, values, teacher roles), social institutions (such as, public policies, governmental laws, education) and social structures (such as political structures, organisations) (Zheng & Walsham, 2008a). Environmental context of a teacher (cultural values, attitudes, geographical elements) influences how a teacher uses ICT and on his/her choice to convert the features of ICT into functionings.

3.8 Use of the Capability Approach in research

CA is increasingly used in ICT in education research (Chigona & Chigona, 2010; Fertig, 2012; Rubagiza, Were, & Sutherland, 2011; Sarkodie, Agyei-Mensah, Anarfi, & Bosiakoh, 2014; Unterhalter, 2012; Walker & Unterhalter, 2007; Wood & Deprez, 2012). Studies have operationalised CA or applied its concepts directly for analysing empirical concepts. Table 3-3 summarises sampled research that has used CA in ICT research. The majority of these studies focus on ICT in education since this is in line with the research topic.

Table 3-3: Examples of Capability Approach in research

Author(s)	Research title	Area of focus
Alampay (2006)	Analysing socio-demographic differences in the access & use of ICT in the Philippines using the Capability Approach	Evaluates real opportunities available for households to access ICT; the characteristics of people who use and not use these facilities; and their reasons for using them
Bass, Nicholson, and Subhramanian (2013)	A framework using Institutional Analysis and the Capability Approach in ICT4	The relationship between enhanced capabilities and institutional change
Chigona and Chigona (2010)	An investigation of factors affecting the use of ICT for curriculum delivery in the Western Cape, South Africa	Limited access and use of ICT as a deprivation of capabilities
Hatakka and De (2011)	Development, capabilities, and technology – an evaluative framework	Evaluation of ICT4D projects by including technology
Hatakka et al. (2014)	Capability outcomes from educational and ICT capability inputs – an analysis of ICT use in informal education in Kenya	Investigate the capability outcomes enabled through ICT in education as well as the factors that enabled and restricted the outcomes.
Hatakka et al. (2016)	A Framework for understanding the link between ICT and Development: How affordances influence Capabilities	Combines two theoretical lenses, the choice framework (that is based on the Capability Approach) and affordances, to increase our understanding of the role of ICT in the development process
Kivunike, Ekenberg, Danielson, and Tusubira (2009)	Investigating the perception of the role of ICT towards the quality of life of people in rural communities in Uganda	Opportunities offered through ICT to enable goals and the actual achievements
Olatokun (2009)	Analysing Socio-Demographic differences in access and use of ICT in Nigeria using the Capability Approach	Socio-demographic differences in access and use of ICT
Rubagiza, Were, and Sutherland (2011)	Introducing ICT into schools' in Rwanda: Educational challenges and opportunities	Evaluates access to ICT capabilities
Sarkodie, Agyei-Mensah, Anarfi, and Bosiakoh (2014)	Education and employment outcomes in Ghana through the lens of the Capability Approach	Types of employment available to individuals with the same/similar opportunities (educational attainments) to lead the kind of lives they have reason to value

The focus of the studies presented in Table 3-3 is on the real opportunities for ICT use and expansion of capability through the use of ICT in education. Education itself is a basic capability that affects the development and expansion of other capabilities. Having the opportunity for education and the development of education expands human freedoms (for example, to be literate and numerate). Key questions in education are, *inter alia*, what are the valuable capabilities (combination of abilities to be achieve). The underlying values and concerns through which one distinguishes which functionings are valuable (Walker & Unterhalter, 2007).

ICT is a means of development rather than an end in itself. This is because the potential benefits of ICT in improving modern-day living need to be achieved. For example, through e-Governance citizens may have access to government services within the comfort of their own home. Through e-Commerce the process of buying and selling is made more efficient, and through e-Learning teaching and learning may be done anywhere and at anytime. The provision of technology alone does, therefore, not lead to development: what matters is the effective and actual use of ICT to achieve desired outcomes (Coeckelbergh, 2011). It is not enough to determine whether people have capabilities to access and use ICT (Alampay, 2006). Instead, the *reasons* why people use ICT and the *ends* they may achieve need to be understood (Alampay, 2006).

3.9 Application of the capability approach in ICT research

While some studies have substantiated the significance of CA in ICT research as shown in Table 3-3, Hatakka, Thapa and Saebo (2016) seek to understand the link between ICT and development. Consequently, the relationship between the design, delivery, use, and impact of ICT in organisations and society that define the IS field needs further exploration on ethical and critical issues regarding how ICT improve individuals' lives.

The transformative potential of ICT is over-emphasised. People have to learn to use technology to transform their actions (Rubagiza et al., 2011). There is a need for a

framework to examine issues related to the challenge of introducing ICT into schools from a social justice perspective, to shift the focus of the digital divide, discourses from questions of technological access to those of opportunities for participation. In considering ICT in terms of resources, what is important is how people convert these resources into capabilities, where capabilities are potential functionings, or opportunities to achieve valuable 'beings and doings' (Jenkins, 2009). A person's capability set provides freedom of choice to be an active participant in society. The conversion of resources into capabilities and then outcomes relates to individual difference and choice. The socio-cultural view relates this to the personal history of an individual as well as the history and affordances of the technology. A key focus is not what access to ICT resources is available but what access to ICT capabilities.

Studies demonstrate the link between the capability input (such as ICT) and the capability outcomes; how different factors may restrict the link is indicated by Hatakka, Ater, Obura and Mibei (2014). The role of technology is recognised by Hatakka and De (2011) as an intervention and a commodity. Commodities are products and services; with features that enable people to achieve their developmental goals. A developmental goal may include the opportunity to access to quality education so as to improve the standard of living. The provision of technology alone does not lead to development (Hatakka & De, 2011). Rather, the enabling aspects of the technologies are the features of the technology (such as educational software, Internet access). Priority of ICT in education studies should be on how ICT is used and how it enhances capabilities for teaching and learning processes

Studies have focused on the choice aspect of CA (Kleine, 2010). Here, operationalisation was an expansion of the dimension of choice by Alsop and Heinsohn (2005). From Kleine (2010) perspective, the main contributors to the expansion of individual freedom are structure and agency. Similarly, Zheng and Walsham (2008) based their operationalisation of CA on Robeyns' (2005) interpretation, focusing on capability deprivation, well-being and agency freedoms.

CA is considered vague, in some academic circles. In addition, it emphasises key concepts that are not clearly defined. CA is based on dialogue between philosophy and economics alone, ignoring key subjects such as psychology, sociology and anthropology.

Studies have used CA in several ways. The freedom-centred view of development included the analysis for basic social institutions and processes. So to solve deficiency in Sen's approach, an aspect of the theory of structuration is used to account for the influence of social structures and institutions exerted on freedom (Lunat, 2009). Madon (2004) investigates the impact of e-Government projects in India. By thinking about development in terms of capabilities, the researchers were able to get behind the superficial indices of access and usage often used in research. Based on CA, in ICT in education research, real availability of opportunities and real achievement of functionings are what matters, in the same way as people have different capacities to translate a given food bundle into nutrition (Madon, 2004).

3.10 Relevance of the Capability Approach to this study

The evaluation of social policy, including education, is done in the "space" of capabilities – valued beings and doings. An "evaluative space" refers to the process of selecting objects of value (Sen, 1993). This section discusses the relevance of CA to the study. It discusses well-being, agency, ICT affordances, individual differences and commodity.

With regard to education, teacher well-being is crucial, but teacher agency freedom and agency achievement are also essential components of quality education (Wood & Deprez, 2012). Quality education may enhance pupils' capabilities for agency and well-being; nevertheless, these capabilities may be constrained by social and educational cultures within the school (Unterhalter, 2012, 2013). What teachers choose to pursue and achieve in their work contributes to these cultures and impacts on learners' capabilities. Teachers are in an unusual position as they navigate official and local expectations of their roles and different approaches to understanding

education quality (Buckler, 2015). At any time they are working within a human capital paradigm driven by the pursuit of high grades for pupils in national examinations, a human rights approach driven by policies around inclusion and respect, and a social justice approach driven by the needs and desires of the community.

This study considers ICT as a commodity and focuses on what teachers may 'do and be', given ICT, that enable opportunities and the teachers' freedom of choice to use these opportunities to achieve desirable outcomes. Affordances as defined by Conole and Dyke (Conole & Dyke, 2004) provide an explanatory lens on how material properties, and an individual's agency and social structures, may improve an individual's capability and choices. This allows for a better explanation of how ICT enables capabilities. Affordances are rarely used to understand the interplay between ICT goal-directed actors in fostering development. Affordances allow the researchers to examine how individuals interpret material properties of ICT with the objective of enhancing capabilities.

3.11 Summary of chapter

This chapter described CA and its application in the analysis of how teachers use ICT to generate outcomes. CA was identified as an appropriate framework to discuss concepts of the opportunities offered by ICT for teachers to generate outcomes. The freedom-centred view from CA was used in this study as the ontology. Fundamental to Sen's CA is the ontological question of what is well-being, what are functionings, what is capability, amongst others. These questions help to provide taxonomy or an analysis of the underlying categories of some reality. This forms the basis of the explanatory nature of the study. CA is considered a complex theory with concepts that are vaguely described. The study uses existing frameworks (taxonomy of ICT affordances and individual differences framework) to expand on constructs, to provide a methodologically sound theoretical framework for the study.

CHAPTER 4 : RESEARCH METHODOLOGY

4.0 Introduction

The chapter describes the philosophical assumptions and outlines the research methods that flowed from that assumption. It provides reasons for choosing the ontological and epistemological stances chosen to achieve the research aims and objectives. This research falls within the interpretive paradigm since it seeks to gain in-depth insights into teachers' use of ICT to generate educational outcomes within the social-cultural context of the teacher (Walsham, 1995). The chapter discusses the methodological stance of the study, data collection and data analysis of the study.

Section 4.1 presents a brief discussion of the research paradigm of the study and Section 4.2 the methodological stance of the study. Section 4.3 sets out the approach to theory in the study. Section 4.4 provides case study strategy, Section 4.5 denotes the sampling of respondents while Section 4.6 details the data collection techniques. Section 4.7 presents the data analysis of the study, section 4.8 evaluates the research design, section 4.9 provides ethical consideration for the study and section 4.10 summarises the chapter.

4.1 Research paradigms

Research paradigm is a set of concepts or pattern (including framework, hypothesis or theory) in which the research theories that influence one's perspective and world-view are formed. It helps to form an understanding of the interconnectivity of real-life elements. Essential questions such as the ontology, epistemology and methodology help explain a specific research paradigm. From the ontological aspect, the researcher has studied the nature of being. This is followed by the epistemological question where the researcher is concerned with the policies that help identify what is known about the world (Henning, Van Rensburg, & Smit, 2004). Finally, the

methodological paradigm deals with the principles used to obtain valid knowledge (Henning et al., 2004).

The investigator adopts philosophical assumptions to guide the research process. These range from ontological realism to relativism as well as the positivist, critical, interpretivist theoretical epistemologies and are discussed in the subsequent sections.

4.1.1 Ontological assumption of the study: Relativism

Ontology is a philosophical discipline that studies the nature of reality (Gruber, 1993). It serves as the basis on which ideas are developed to explain, and make claims and assumptions about reality (such as, its existence, features, characteristics and conditions) (Loreman et al., 2016; Myers, 2013). Ontology seeks to explain the basic categories and relationships of reality (Lawson, Latsis, & Martins, 2013) which may be realism or relativism. Realism is a philosophical theory based on the belief that there exists an authentic physical world that is independent of the perceiver or observer (Hirschheim & Klein, 1989; Lawson et al., 2013). Therefore, there is a distinction between the way the physical world is and an individual's meaning and interpretations of that world. Realism seeks to provide rational explanations for human experience. The realism viewpoint sees reality as objective. On the other hand, relativism views reality as subjective, knowable through the human mind and through socially constructed meanings (Ritchie, Lewis, Nicholls, & Ormston, 2013).

Relativism is the ontology of choice for this study because it emphasises theories of human behaviour which reflect a complex reality characterised by many different aspects or features (Fletcher, 1996; Goles & Hirschheim, 2000). In relativism, theories are viewed as alternative ways of construing the world to be described or analysed rather than evaluated in terms of their predictive power, explanatory value or truth value (Fletcher, 1996). Relativism was selected because it helps the researcher understand and interpret the meaning of the phenomenon to inform improved practices (Lincoln, Lynham, & Guba, 2011). In relativism an individual's

experience and behaviour is emphasised (Pirker, 2009). An individual may be understood by studying their multifaceted nature. For example, in the context of the study, research on ICT in education tend to overlook the opportunities generated from ICT use and how teachers use the opportunities to achieve desired outcomes as well as how teachers are influenced by the local conditions and the socio-cultural factors (Schuh & Barab, 2008).

From the relativist viewpoint, reality is dependant on contextual factors, social circumstances, and individual experiences. Reality is further dependant on the observer and the situated context (Oduor, Alahäivälä, & Oinas-Kukkonen, 2014). As such, knowledge of the world is based on understanding, which arises from experience and from reflecting on social occurrences (Pirker, 2009). There is, therefore, no shared social reality on a series of different individual constructions (Wright, 2008). With relativism, relationships between practical and physical events provide meaning (Schuh & Barab, 2008). Relativism is concerned with subjective meaning, symbolic structures influencing the process of meaning making and sharing of meanings and metaphors (Hirschheim & Klein, 1989). From the relativist perspective, reality and the way in which living occurs is relative to a specific viewpoint (Johnston, 1993). Therefore, the point of view differs from one individual to another and within groups of people john (Johnston, 1993). In this study, relativism views ICT as an enabling tool for teachers to generate outcomes. ICT affordances determine the way in which ICT may be used and the outcomes generated for teachers are influenced by the affordances of ICT and teachers' personal, social, environmental and shaping and influencing factors. A summary of the common characteristics of most relativist approaches is by Robson (2002, in Fletcher, 1996) set out below:

- Instrumental values play an essential part choosing a theoretical framework,
- Reality is represented through the eyes of participants,
- The role of language is the central instrument by which the world is represented and constructed,

- It is important to view the meaning of experience and behaviour in context, and in its full complexity,
- The research process consists of developing a working hypothesis rather than on developing unchangeable empirical facts,
- Theorising focuses on the emergence of concepts from data rather than on imposing earlier theory, and
- Qualitative methodologies are used.

4.1.2 Epistemological stance of the study: Interpretivism

Epistemology is the study of the nature of what is known. Epistemology may be positivist, critical or interpretive.

4.1.2.1 Positivist epistemology

In positivism, reality is usually explained and observed from an objective viewpoint. Positivism is a philosophy of science that aims to create statements that are true, by objectively describing the world in which the existence of objects is separate from our consciousness of them. IS research is positivist if there are set variables that may be measured quantifiably with hypothesis testing and conclusions drawn about the phenomenon of interest from a representative sample of a given population (Orlikowski & Baroudi, 1991). Creating variations within a single independent variable controls reality. This permits identification of regularities and formation of relationships between elements of the social world. Studies that fall within the positivist's paradigm include survey studies, verification of hypotheses, statistical analysis, and quantitative and descriptive studies.

4.1.2.2 Critical research epistemology

Critical research questions social norms. (Klein & Myers, 1999). This is achieved by describing restrictive and alienating conditions that exist in day to-day living (Alvesson & Willmott, 1992). Critical research aims to bring into awareness the societal problems and assist remedial efforts to eliminate these problems (Howcroft &

Trauth, 2008). The critical viewpoint sees *"information systems in their wider social context, attending to issues such as power, domination, conflict, and contradiction" (Kaplan, Truex, Wastell, Wood-Harper, & DeGross, 2006, p. 199)*.

Critical research aims to understand a phenomenon of interest within its historical socio-cultural, economic and political context. It challenges the status quo and encourages disagreeing with social ills. Critical research is often applied to question the alienating and dominating power relations in a socio-technical context (Niehaves & Stahl, 2006). Through use of a dialogical method, dialogue between the researcher and the subject is encouraged (Niehaves & Stahl, 2006). From a critical perspective, a study focuses on critiquing social influences. Consequently, it focuses on questioning existing practices with the goal of fostering emancipation (Howcroft & Trauth, 2008). Critical research seeks to foster change by questioning social injustices such as gender, race or economic inequalities.

4.1.2.3 Interpretive epistemology

Interpretivism assumes that knowledge of reality is gained through social constructions of human actors (Walsham, 1995). Knowledge is viewed as an observable event, a personal belief, an experience, a value, an opinion, or reasoning. Social constructions include shared meanings, sense making, perceptions, documents, tools, and other artefacts. Therefore, interpretivism seeks to gain an understanding of a social problem.

Interpretivism assumes that as people interact with their situated context, they develop subjective meaning (Orlikowski & Baroudi, 1991). Therefore, researchers in the interpretive paradigm seek to understand the phenomenon by looking at the meaning people attach to them. The researcher interacts with human subjects guided by the researcher's preconceptions. The researcher and the human subject's perceptions transform through constant interaction. Thus, the selected research method aims to make explicit the influence of the subject.

> *"What we call data are our own constructions of other peoples' constructions of what they and their compatriots are up to"* (Geertz, 1973, p. 9).

The types of studies conducted within the interpretivist paradigm include field research and case studies focussed on understanding. This study aims to understand how teachers use ICT to generate educational outcomes within their socio-cultural contexts. This research, therefore, falls within the interpretive paradigm for the reason that it seeks to gain in-depth insights into the effects of teacher's socio-cultural context on the use of ICT to generate educational.

4.2 The methodological stance of the study

This study is qualitative. Qualitative studies focus on the meanings and interpretations of what is observed (Holloway & Galvin, 2016). The nature of reality in qualitative research is based on interactions between the researcher and the researched phenomenon of interest. The emphasis of data collection is on collating and analysing characteristics that are descriptive and not numeric in measurements (O'leary, 2004). On the contrary, quantitative research is numeric in measurements, and it is a systematic empirical enquiry that seeks to understand a phenomenon by making computational methods. Qualitative methodology is often employed in interpretive studies, due to its acknowledgement of the importance of information and meanings attached to the phenomena and/or their context.

Qualitative research was suitable for the explanatory nature of the study. Qualitative research seeks to understand human systems, be they small (such as a technology-using a teacher and his or her students and classroom) or large (such as a socio-cultural system, which consists of elements that guide the way people behave and think). In this study, the qualitative research approach helped to understand the opportunities ICT enables and how teachers use these opportunities to generate improvements in education.

This study sought to understand behaviour from the view of the participants. Interacting and observing the participants within the educational environment

achieved such understanding. The study focused on the perception and experiences of respondents and how they make sense of their lives. Qualitative data, which is in the form of words, gave descriptive insights and helped to unveil the personal experiences of the teachers and to document the world from the point of view of teachers. In this study, the researcher sought to learn the meanings that teachers held about how they realise the benefits of ICT in education.

4.3 Approach to theory in the study

There are different functions of a theory in a study. As indicated by Gregor (2006) five different types of IS theories exist:

1. Theory for predicting – what will be the outcome,
2. Theory for explaining – why and how a phenomenon occurs,
3. Theory for analysing – what is the reason,
4. Theory for design – how can it be done, and
5. Theory for explaining and predicting – what is, how, what will be, why and when.

Along with the different roles of theories, there are different strategies to carry out research, inductive, abductive, retroductive and deductive. Inductive strategies aim to describe the social norms and standards that exist in society (Bell, Bryman, & Harley, 2018). It seeks to answer “what” questions. The research process begins with data collection, from which generalisations are developed based on inductive logic. Retroductive research strategy seeks to provide explanations to the underlying mechanisms or structure responsible for the development of the social norm and the circumstances (context) in which it happens (Saunders et al., 2018). It begins by observing a social norm. The abductive strategy involves explaining the causal mechanisms of the observed phenomenon. A theory is developed when the researcher is assisted by the participants to develop a model in layman’s terms.

The study follows the deductive strategy based on the interpretive principle of abstraction and generalisation. Generalisability is achieved when the theory is empirically tested in a new context successfully (Lee & Baskerville, 2003). In

deductive research theories and general concepts are used to describe the nature of human understanding and social behaviours.

The theoretical constructs (commodity, capability, functioning, agency, choice, well-being and outcomes) used in the study were suitable for answering the question in the study: *"How are educational outcomes generated for teachers through the use of ICT in teaching in a developing countries".* These theoretical constructs were used to develop the research instrument. The data was interpreted by applying theories and general concepts that describe the nature of human understanding and social action. In the current study, the author used CA along with constructs of the individual differences conceptual framework and ICT affordances taxonomy to answer the research question.

4.4 Case study approach used in the study

The case study is a mode of observations that may be used to gain descriptive and explanatory insights into the research phenomenon of study (Babbie, 2013). It is an in-depth analysis of individuals or events, which represent or explain the phenomenon of interest in a setting within a social context with the use of a variety of data sources (Benbasat, Goldstein, & Mead, 1987; Yin, 2011). The use of multiple data sources to explore a problem within a social context enables different aspects of the phenomenon to be analysed from which explanations are derived (Flick, 2018) . It enables researchers to investigate individuals or organisations through interventions, communities, relationships or programmes (Baxter & Jack, 2008).

The case study method seeks to inquire into the social context to highlight the theoretical constructs being studied (Yin, 2017). The research phenomenon is, therefore, not independent of the context; it forms the focus of interest to understand the processes that influence the context. The case study is appropriate for research questions that require an in-depth understanding of the social context. It, therefore, aids in answering "how" or "why" questions.

In a case study, the unit of investigation may be an individual, a group or even multiple individual units such as teams or communities (Ledford & Gast, 2018). In multiple case studies, several cases are examined to understand the similarities and differences between the cases (Ridde, Yaogo, Zongo, Somé, & Turcotte-Tremblay, 2018). These cases may include, various educational institutions across a country.

The units of investigation in this research fit this description. This thesis presents insights into the opportunities generated from ICT and how teachers use these opportunities to achieve valuable 'beings and doings'. It also looks at the importance and variations of local conditions and the socio-cultural factors from the perspective of the teacher that affect the transformation of education technologies into achieved 'beings and doings'. This is achieved by focusing on multiple stakeholders (teachers, principals, ICT coordinators/IT technicians) in seven schools as well as stakeholders of education districts in the Western Cape (two e-School coordinators).

South Africa is a culturally, historically and educationally diverse society. The transforming landscape is a reflection of inequality as well as culture and economic fragmentation (Donohue & Bornman, 2014). The institutionalisation of discriminatory practices based on race led to extreme discrepancies in the delivery of education. Thus, DBE attempted to redress inequalities between ethnic groups by allocating low-income groups with higher government subsidies (Engelbrecht, 2006). Financing of educational institutes ranges from the poorest schools, Quintile one to the least poor schools, Quintile five (DBE, 2017). Generally, schools are better resourced in more affluent provinces such as Gauteng and Western Cape.

The study explores the opportunities generated from ICT use and how teachers use these opportunities to achieve valuable beings and doings. It also looks at the importance and variations of local conditions and the socio-cultural factors from the perspective of the teacher that affect the transformation of education technologies into achieved 'beings and doings'. In this instance, the case study method allows for the selection of schools from regions to ensure that insight into the factors of ICT in schools is representative of the varying environments of the schools.

The choice of schools was based on these considerations and convenience to the researcher. In the Western Cape, 34.6% of schools fall under Quintile 5 category of least poor schools (DBE, 2017). The Khanya project, one of the major government-funded initiatives which provided a large-scale implementation of ICT in Western Cape schools, was deemed as remarkably successful (Louw et al., 2008; Van Zyl, 2011). The demographics of the Western Cape varies dramatically from affluent schools in major urban centres such as Cape Town to poor schools in isolated rural villages with inadequate infrastructure (SMART, 2011). Schools in urban parts of the Western Cape offered a larger pool of schools to select from which is convenient for the researcher. Seven schools were selected based on their relevance to the phenomenon under study.

As would be expected, this study used multiple sources and methods to solicit data and information about ICT in education. Its primary interest was to understand how ICT enables teachers to generate educational outcomes in teaching. A case study method was used in the research due to its ability to aid the researcher in understanding the factors that affect a specific situation (Maree, 2007). With a case study method, the researcher determines in advance the information to be gathered and the data analysis techniques to be used to answer the main research question (Maree, 2007).

4.4.1 Unit of analysis

The significance of establishing the unit of analysis is to help the researcher verify the phenomena under study, and what falls in and outside the scope of the study (Makoza, 2017). The unit of analysis defines for the researcher the focus or case of the research such as individual, group or organisation (Berg, Lune, & Lune, 2004). The unit of analysis refers to the person or object being studied. In case of study research it is important to differentiate between the case and the unit of analysis . The case consists of different layers that surround the unit of analysis. The case is a research subject (a historical and practical perspective) under investigation (Yin, 2017).

The unit of analysis is the object (theoretical focus) of the study (Flyvbjerg, 2006). Units of analysis are selected based on their knowledge that is purposeful to the aims and objectives of the study (Babbie, 2008). Unit of analysis contains information that is relevant and will aid in enlightening the phenomena under study. The unit of analysis forms a low level of abstraction compared to the different case layers. In this study, the case was ICT integration, and the unit of analysis was the teacher.

4.5 Sampling of respondents

Sampling may be based on probability or non-probability. This study used non-probability sampling techniques (Maree, 2007; Jackson, 2011). Probability sampling refers to the method of selecting a workable number of participants from a population whereby the exact number and location of the population elements are known to and reachable by the researcher (Babbie & Mouton, 2001). Unlike probability sampling, individual members of a population do not have an equal likelihood of being selected in the sample as random sampling method are not used in non-probability sampling (Maree, 2007). Depending on the type of population and the particular details of an investigation, the researcher may choose any one of the four types of non-probability sampling techniques. They are a convenience, quota, snowball and purposive sampling.

The study used purposive sampling to select research participants. Purposive sampling is a method of selecting a small subset of a population based on the suitability of their characteristics for the study (Babbie & Mouton, 2004). In this research, a purposive sampling method was used to understand the opportunities generated from ICT and how teachers use these opportunities to achieve valuable beings and doings. It also looked at the importance and variations of local conditions and the socio-cultural factors from the perspective of the teacher that affect the transformation of education technologies into achieved beings and doings. The research used population elements such as provincial coordinators of ICT programmes in schools, teachers, principals and school coordinators of ICT programmes in the Western Cape, South Africa as a representative of the larger

population. The schools were selected based on the availability of teachers and ICT infrastructure.

The criterion for the selection of the participation samples for the study should be relevant to the research question and the theoretical framework as summarised in Table 4-1.

Table 4-1 Criterion for selection of participation samples

Component	No. of respondents	Criteria
ICT technical support or Coordinator per school	7	Teachers who have been appointed to coordinate ICT facilities in the schools. ICT coordinators were interviewed to examine their competency level
Teacher not teaching ICT related subject	12	Teachers who do not teach ICT related subjects
Teachers teaching ICT related subject	3	Teachers who teach ICT related subject, for example, IT or CAT
School Principals	7	A leader of the entire school community who is responsible for managing the school administration and supervising students and teachers.
e-Learning coordinators in Western Cape education Districts	2	Advisors that provide guideline for implementation of ICT in schools in rural and urban districts in the Western Cape

Each school's planning and conduct of observed ICT-mediated teaching constituted a case in this study. Across the seven schools, interviews and observations of ICT-mediated teaching were carried out with fifteen teachers (see Table 4-1). The seven schools were selected based on their integration of ICT in schools. Each school then selected two or more teachers who had demonstrated the frequent and purposeful

use of computers in their lessons. The study examined the peculiarities and complexities of the cases obtained by descriptions and analysis of the school and teachers in their, cultural, geographical and influencing contexts.

4.6 Data collection techniques

Based on qualitative research approach strategies the current study used an understanding of background information and primary data from affected parties (Creswell, 2013). In a case study research, data gathering techniques include reading and analysing documents, participant-observation, direct observation, the analysis of physical artefacts, and the conducting of interviews (Yin, 2011). The reading and analysing of documents were used to gather information on background and methodologies. In cases where researchers require direct experience within a specific situation, participatory observation is applied. Similarly, in cases where a researcher's own understanding and interpretation is required, a researcher would make a direct observation of a situation, without taking an active part. Finally, to gain insight from the knowledge that is held by and only obtainable from a participant, interviews as well as questionnaires were used (Mlitwa & Van Belle, 2010). Therefore, background documents, semi-structured interviews and direct observations were the appropriate data collection techniques for this study.

The study sought to understand how teachers used ICT to generate educational outcomes in teaching developing countries. It also looks at the importance and variations of local conditions and the socio-cultural factors from the perspective of the teacher that affected the transformation of education technologies into achieved beings and doings. As a primary data source, information was obtained from coordinators of ICT in schools, teachers, school principals, and e-Learning coordinators of Western Cape education districts, using semi-structured interviews, direct observations and questionnaires. This was to gain an understanding of the phenomenon from the perspective of the research participants the subsequent sections expand on how and why information was obtained (Yin, 2011).

4.6.1 Semi-structured interviews

To gain insight from the knowledge that is held by and only obtainable from a participant, semi-structured interviews were used (Mlitwa & Van Belle, 2010). Semi-structured interviews were considered appropriate for the study because it helped the researcher pose follow-up questions on new issues that emerge from the participant's responses (Štrach & Everett, 2008). Semi-structured interviews, allow a researcher to divert slightly from the pre-arranged structure of the questionnaire so that they may dig deeper into emergent issues during the interview (Baumbusch, 2010). The structure helps in ensuring that the response to interviews is relevant to the phenomenon of study. At the same time, the flexibility allows for probing to gain more insight into emergent issues (Baumbusch, 2010). Semi-structured interviews were used in instances where the researcher needed to obtain the ideas or opinions of a principal in a school with regards to their relationship with the staff, learners and parents. It was within such instances that semi-structured interviews were used in this study.

The seven principals were interviewed to gain insights on the policies and decisions that govern ICT use in teaching. The seven IT technicians/ICT coordinators were interviewed to gain evidence of the status of ICT deployment in the schools. The two e-Learning coordinators in Metro Central and Metro South education districts were interviewed to gain insights on the status of the provincial ICT initiatives and implementations.

Fifteen teachers were interviewed to take a detailed account of how ICT was used in teaching. The interview sought to uncover the enabled capabilities that are generated through ICT. An account of the personal, shaping and influencing factors, social and environmental factors that influence the transformation of ICT into capabilities outcomes were obtained through the interview process. Depending on the responses of the teachers and whether further probing was needed the period of the interviews ranged from 35 minutes to 1.5 hours. This was to ensure that response to the

interviews were relevant to the phenomenon of the study. It further allowed for new insights and understanding of the phenomenon of interest.

The number of interviews needed in a research project depends on the number of resources and time available, financial provision for the research project, supervision, and considerations for ethics. As an indication of the adequate number of interviews required for this study, the concept of saturation was used. The research instruments consist of the key theoretical constructs (commodity, capability, functioning, agency, choice, well-being and outcomes) and variables of the characteristics and behaviours to be observed. Therefore, I related the data obtained from the respondents with the theoretical constructs of the study. Data collection and open coding continued until new information produced little or no change to the data categories (for example. until theoretical saturation). The theoretical saturation occurred after 31 semi-structured interviews and sixteen observations. The number of interviews was considered adequate when no new insights were discovered.

4.6.2 Direct observations

In the study, observations were performed as a tool for collecting data. It was used as a means to understand the behaviours and activities conducted in the classroom setting. Through the observations, the researcher noted the teacher's teaching and observed how the sampled teachers manage their classrooms. It enabled her to view the technologies used in the classroom and how those technologies were used. Consequently, the researcher observed the interaction between teachers and learners. The research purpose and question provided a direction for the focus and the duration of the observation.

The time spent in the field was determined by how much information the researcher gained from the field. It was determined by the variability of the teachers teaching. In other words, she observed classroom practices to the degree that she was able to gain a full perspective on teacher classroom practices. To generate insights from

observations the researcher acknowledged their perspective and positioning as a researcher.

4.6.3 Research instrument

The theoretical framework provided for the development of the key constructs and variables that determined the behaviours and the characteristics to be observed or assessed. The researcher developed interview questions that were guided by the Capability Approach framework operationalised by Hatakka, Ater, Obura, and Mibei, (2014).

A set of questions that the researcher wanted to raise was generated in preparation for the interview. The questions in the interview were raised to identify, ICT used for teaching, how ICT was used for teaching, rules on ICT use, opportunities obtained through ICT, the choice to use of opportunities obtained through ICT and the needs of teachers. The concepts of conversion factors within the capability approach were expanded upon with the aid of the concepts such as personal factor, shaping and influencing factors, environmental factors. These are key constructs from the individual differences conceptual framework. To understand the influence on the socio-cultural-environmental factors on ICT use for teaching the teachers were given a questionnaire to complete. The questionnaire sought to find out the demographic detail of the teachers, teacher experience and how these influence their use of ICT for teaching. Shaping and influencing factors such as personality type, ability, and mentors were assessed to identify how they influence the use of ICT for teaching. The environmental context of the teacher was assessed to understand how the values, religious beliefs and the place of stay influences the use of ICT for teaching.

As part of the developmental process of the research instrument the researcher conducted a pilot study to help define the constructs in the empirical setting and to test the research instrument for accuracy.

The school principals were interviewed to gain insights into the policies and decisions that govern ICT use in teaching. The IT technicians/ICT coordinators were interviewed to gain evidence of the status of ICT deployment in the schools. The e-learning coordinators in Metro Central and Metro South education districts were interviewed to gain insights on the status of the provincial ICT initiatives and implementations. After transcribing the interview data, the data analysis process was carried out.

4.7 Data Analysis

Data analysis is the process whereby the researcher transcribes and make meaning of the data (Miles, Huberman, Huberman, & Huberman, 1994). To aid in creating codes and themes and the organisation of interview transcripts in a single repository, the qualitative data analysis software Atlas.ti was used. Although several options for qualitative data analysis software are available, Atlas.ti was selected because the researcher was trained on using the software.

There are a variety of methods of qualitative data analysis such as content analysis and thematic analysis. The type of data analysis method used depends on the research question, the aims and objectives of the study. Thematic analysis was used since it emphasises the organisation and the rich description of data sets for the study (Spencer et al., 2003). Thematic is appropriate because it may be used to identify themes and patterns of meaning across a dataset about a research question (Braun & Clarke, 2006). Based on Braun and Clarke (Braun & Clarke, 2006) the researcher followed the following steps in the thematic data analysis process:

Defining and naming themes: Using a theoretical framework, the analysis was guided by existing theoretical concepts. Since the theoretical framework informed the coding process the main themes of the study were, capability inputs, capabilities, functionings and conversion factors.

Familiarising with data collected: Initially the researcher transcribed the verbal data (recorded interviews), typed out notes for observation and field notes. With the thematic analysis process, the transcription of the interview data enabled her to conduct an initial reading of the transcripts. This helped the researcher to become familiar with the data. Upon the completion of the transcribing process, she read through the transcripts until a general understanding of the data was gained.

Generating initial codes: After reading and familiarising herself with data, the data uploaded into Atlas.ti. Phrases were developed to highlight statements that were relevant to the research question and objectives. These phrases were then coded based on the constructs (commodity, capability, functioning, agency, choice, well-being and outcomes) of the theoretical framework that were operationalised to identify behaviours, characteristics or variables to observed. The codes were then grouped into categories to develop themes and identify existing frequencies within the themes (Joffe, 2012).

Searching for themes*:* After the initial coding and collating of data, a list of codes was generated. The codes were arranged into potential themes as guided by the theoretical framework. The relationships between the themes were presented graphically. In this process, the researcher examined and recorded patterns within the data that were important to research phenomenon and appropriate to the research question.

4.8 Evaluation of research design

The quality of the research design is determined by logical tests that consist of four major approaches. The four main approaches are constructed validity (definition of key concepts), internal validity (causal relationships), external validity (generalisability of the study) and reliability (repeatability of the operations of the study) (Yin, 2009).

Qualitative research provides insight into a research problem. The reliability and validity assessments are carried out during the data collection and analysis.

Consequently, it seeks to ensure the legitimacy of the research results. Parallel to quantitative measures of the construct, internal, external validity and reliability are qualitative techniques of trustworthiness. This section discusses the validity of qualitative research, member checking and evaluation of interpretive research in IS.

4.8.1 Validity in qualitative research

The focus of validity and reliability of qualitative research is on its trustworthiness of the research results. This determines whether the research results may be applied to a different context. The trustworthiness of qualitative research may be developed through techniques including credibility, transferability and dependability (Lincoln & Guba, 1985). Credibility refers to whether the data obtained address the research problem and is believable (Lincoln & Guba, 1985). The dependability considers the process throughout the study and whether the findings are consistent and repeatable (Makoza, 2017). Transferability is the degree to which the research approach may be applied in a different context (Yin, 2009).

To ensure validity in qualitative research, techniques proposed by Creswell and Miller (Creswell & Miller, 2000) include a detailed description, peer reviews, member checking, and triangulation. The selection of the validity technique is determined by the researcher's paradigm assumptions (Creswell & Miller, 2000). Given the interpretive paradigm, this study used triangulation, member checking, thick description and peer reviews. Triangulation is the process of observing the research phenomenon from more than two different perspectives (Flick, 1992). It is achieved through the application of different methodological approaches (Flick, 2017b). In this study, the use of triangulation amongst data sources was achieved by combining different perspectives on ICT integration, based on multiple sources of data (Flick, 2017a). These sources of data include field notes obtained from observations, interviews and documents. The multiple data sources were used to enrich the research results and to offer a comprehensive picture of the socio- cultural context of respondents.

The validity of the results was ensured through the use of theoretical frameworks. To avoid biases and for purposes of being objective, the interview questions were based on a combination of constructs of the CA, ICT affordances taxonomy and the individual differences conceptual framework (commodity, capability, functioning, agency, choice, well-being and outcomes). The content of the research instrument was confirmed by a peer-reviewed journal publication.

The researcher applied member checking in this study to improve the accuracy of validity and credibility of the recorded interview (Creswell, 2014). At the end of the interviews process, the researcher summarised and checked the key points with the research participants. Since the research participants were selected based on their knowledge of the subject content, the interview question and process were intelligible to the respondents (Clonts, 1992). To ensure validity, the researcher was cognisant of the socio-economic status of the schools, whether it was affluent or disadvantaged. She took note of the potential influences of socio-economic factors of the schools on what the interviewees say and do.

Field notes were developed during the data collection process, and were similarly generated during the observation to determine what the researcher saw, felt, and experienced during the observations. The content of the observation captured was based on pre-determined questions along with added information that she found useful to the context of the study.

Reliability is concerned with the consistency of the research results across time and across different researchers and projects (Gibbs, 2018). To ensure reliability the research process needs to be documented. The researcher followed a systematic process during the data collection of the study and used a brief guide for the steps to follow in an interview. The guide for conducting interviews is in Appendix 6.

The study used peer debriefing to ensure the relevance and persistence of the research topic, the legitimacy of the research instruments and to gain an expert opinion on the research results. The researcher presented the paper derived from

preliminary findings of the study and the research topic at the African Conference of Information Systems and Technology in both 2015 and 2016. The proposal of the study was presented at the doctoral consortium for the International Conference of Information Systems in 2015. Consequently, the researcher discussed the research findings with an expert in the field of ICT4D. Table 4-2 summarises the profiles of experts that contributed to the study.

Table 4-2: Summary of personnel for peer debriefing

Event	Experts description	Organisation	Contribution to the study as
African Conference of Information Systems and Technology (2015 and 2016)	Dean	Business School, Ghana Institute of Management and Public Administration	Academic
	Dean	School of Technology, Ghana Institute of Management and Public Administration	
	Lecturer	Ghana Institute of Management and Public Administration	
Doctoral consortium for the International Conference of Information Systems in 2015	Professor	Information Technology and Operations Management, Southern Methodist University	Academic
	Professor	College of Management, University of Cincinnati, United States	
	Professor	Department of Information Technologies, HEC Montréal	
	Dean	School of Technology, Ghana Institute of Management and Public Administration	Expert in the field of ICT4D
	Deputy Director	The University of Sheffield	Expert in the field of ICT4D

4.9 Ethical Consideration

The University of Cape Town ethics committee gave ethics approval for the study. Once permission was obtained emails were sent to a list of schools obtained from DBE for interviews with teachers, principal and ICT support or coordinator. The schools, which responded positively to the emails, then became the sampled schools for the study. The schools were selected based on the availability of teachers and ICT infrastructure. Due to the busy schedule of teachers and the closing of the school for vacation, the field research was prolonged. The schools' identities as well as those of the respondents were anonymised and are referred to as School A_HSS, B_HPL, C_CG, D_AC, E_BR, F_CS and G_LP for confidentiality.

The study used codes to identify schools and respondents. Codes helped to maintain anonymity and confidentiality of the respondents as they were informed that their individual names would not be recorded or published. Codes refer to schools, interviewed respondents and respondents who completed an online questionnaire. Each code for schools consists of an alphabet, representing the order in which the field research was conducted in the schools. The continuum of the code is a rearranged acronym of the school. An example of the code for school is A_HSS.

In a similar way the code for the interview consists of an acronym of the school name and an acronym of the subject taught by the respondent. The line number of the quote in the interview transcript follows this. An example of the code for interviewed respondents is CA_P8.

Another set of codes was developed to represent the respondents that filled in an online questionnaire anonymously over Google Forms. The researcher does not know the respondents' affiliated schools because the respondents completed the online questionnaires anonymously. Therefore, the codes were given based on the order in which the online questionnaire was completed. The codes begin with a T, an acronym for teacher, followed by a number that represents the order in which the

online questionnaire was completed. An example of the code for the respondents of the online questionnaire is T1.

The respondents were given consent forms to sign. The contact persons who assisted with gaining an appointment with teachers were given the letter of approval from WCED as well as the proposal of the study. The research participants were informed of the study and were given the opportunity to sign consent forms, which stated the following:

- *Participation is voluntary.* Research participants were informed that their participation is voluntary.
- *Anonymity and confidentiality.* Research participants were informed that all information would be used exclusively for the study. No individual names will be recorded or published. To ensure identifiable anonymity information would not be requested.
- *Freedom to withdraw.* Research participants were informed that they could withdraw from the research at any time for whatever reason.
- *Willingness to participate*. Research participants were interviewed based on their willingness to participate. A copy of the consent form signed by research participants is kept for proof of consent.
- *Exclusivity of information.* Participants were informed that the research would be purely for academic purposes. Therefore, the information gathered will only be used toward the completion of a university Doctoral degree.

4.10 Summary of chapter

The chapter highlighted the methodologies used to carry out the study. The research design used in the study considered the elements needed to ensure the quality and rigour of scientific research design. The chapter provided details of the ontology, epistemology and methodological stances, data collection techniques, data analysis, the ethical consideration for the study. In this chapter, the methodologies used to investigate the research problem the generation of educational outcomes through the use of ICT in teaching were discussed. While the chapter discusses the research

approach used for the study, there is a relationship between research methodologies in **Chapter 4** and the theoretical approach as well as framework adopted for the thesis in **Chapter 3**. Capability Approach provided a focus lens that aided in understanding the research problem and the context within which the study was conducted. Qualitative data was used to gain descriptive insights from teachers, ICT technical support or coordinators, school principals and e-Learning coordinators in the Western Cape education district on the use of ICT to generate educational outcomes. Semi-structured interviews and direct observation were used to collect data. The data was analysed using thematic data analysis. Comparison between the data sets helped to increase the quality of the research results. Table 4-3 summarises the research design of the study.

Table 4-3: Summary of the research design of the study

Research domain	Generation of teachers' teaching outcomes through the use of ICT
Research contribution	Explanatory (to understand why and how a phenomenon occurs)
Generalisation	Theory may be empirically tested in a new context successfully
Approach to theory	Deductive
Ontology	Relativism
Theoretical framework	Capability approach theory with concepts from individual differences framework
Research Design	Case study
Research Methodology	Qualitative methodology
Units of observation	Organisation and lecturers
Units of analysis	Generation of ICT enabled teaching outcomes for teachers (individual)
Data collection methods	Background documents, direct observations, as well as semi-structured informal conversations
Data analysis	Thematic analysis

CHAPTER 5 : CASE DESCRIPTION

5.0 Introduction

The chapter describes the context of the study. In this chapter the sampled schools in the study are described. The chapters examine the particularities of the case obtained by the descriptions and analysis of the schools and provide the demographic characteristics of the teachers.

Section 5.1 highlights education system in South Africa. Section 5.2 discusses how ICT has been implemented and faired in the education system in Western Cape, South Africa. Sections 5.3 through 5.7 focus on the cases used in this study and the respondents. Section 5.3 outlines the case description of the sampled schools while Section 5.4 presents the deployment of ICT into sampled schools. Section 5.5 presents how ICT was integrated of ICT into schools' curricula. Section 5.6 details the conduct of ICT-mediated instruction. Section 5.7 details the characteristics of teachers in sampled schools. Section 5.8 summarises the chapter.

5.1 Education in South Africa

In South Africa, the education sector is split into Basic Education and Higher Education. DBE is responsible for schools from Grades R through 12. The General Education and Training Certificate (GETC) forms level 1 of the National Qualification Framework (NQF) which is the classification system used to ensure the quality of the qualification offered in South Africa (SAQA, 2014). The GETC includes:

- A four-year foundation phase from Grade R to 3,
- A two-year intermediate phase from Grade 4 to 6, and
- A two-year senior phase from Grade 7 to 9.

The Further Education and Training (FET) level includes a three-year training stage, from Grade 10 to 12. The national school-leaving examinations assess learners' abilities for placement in higher education institutions. The FET level facilitates the transition of students from educational institutions to the workplace.

A Postgraduate Certificate in Education (PGCE) is a one-year qualification. Graduates who wish to become teachers are trained. PGCE is a qualification that recognised by the South African Council for Teachers. Table 5-1 offers a summary of the level of education of the fifteen teachers. Teachers' level of education

Table 5-1: Teachers' level of education

Education level	Teachers
Degree in BSC Honours	5
PGCE, FET education	5
B.Ed.	2
B.Ed. (FET specialisation or Primary Education)	1
MCSE + I	1
BA music	1
Masters in Geography	1

The sampled teachers either had a four-year Bachelor of Education (B.Ed) degree or a one-year PGCE. In line with the level of education of respondents in this study (see Table 5-1), research on the supply and demand of teachers in South Africa shows that student teachers obtain either a four-year Bachelor of Education (B.Ed) degree or a one-year PGCE. A PGCE is after a three-year undergraduate degree. These qualifications, do not, however, translate to quality teaching. In South Africa teachers lack skills and competencies for effective teaching (Bernstein, 2013).

Table 5-2 summarises schools, and the number of teachers and learners in South Africa.

Table 5-2: Number of teachers, learners, and schools

South Africa		Learners	Teachers	Schools
Public Schools	Primary	6 525 788	194 672	14 373
	Secondary	3 848 824	139 336	5 810
	Combined[1]	1 626 340	52 794	3 667
	Intermediate	116 063	3 806	210
	Total (Public)	12 117 015	390 608	24 060
Independent Schools	Primary	129 383	7 001	554
	Secondary Combined	61 819	4 654	258
	Intermediate	325 335	21 061	825
	Total (Independent)	21 884	1 766	44
		538 421	34 482	1 681
Total (Public and Independent)		12 655 436	425 090	25 741

Source: EMIS (2014)

5.1.1 School classification system in South Africa

The South African government provides schools in or near the poorest communities the highest school allocation of funds. Schools are, therefore, ranked into one of five Quintiles (Romero, Hall, Cluver, & Steinert, 2018). These Quintiles are based on the rates of income, unemployment, and illiteracy within the designated location of the schools. The Quintile, to which a school is assigned, is based on the rates of income, unemployment, and illiteracy within the school's catchment area. Quintile 1 schools were designated as the poorest institutions and five of these denoted the least poor

1 A combined school offers a minimum of one grade in each of the following four phases: foundation phase, intermediate phase, senior phase and FET.

public schools (Collingridge, 2013). Even with these efforts to promote equality there is a clear marginalisation between the rich and the poor. As a result, the poor schools in Quintile 1 and 2 are no fee-paying schools. Learners in Quintiles 1, 2 and 3 received a larger subsidy from the government (R1010 per annum) (Collingridge, 2013). These schools are compensated with a higher allocation of expenditure. Compared with learners from Quintile 4 schools who received half (R505 per year), learners in Quintile 5 received roughly only 10% (R174 per annum) (Collingridge, 2013). The sampled schools were predominantly Quintile 5 schools, which were better resourced (NECT, 2016). This can be seen in the low learner-to-computer ratio. A majority of the sampled schools relied on school fees to support the acquisition of ICT (Motala & Sayeed, 2009). (See Table 5-3).

Table 5-3: National poverty distribution table - percentage of schools in Quintile 1 to 5

Province	Quintile					Total
	1	2	3	4	5	
	Poorest				Most affluent	
Eastern Cape	27.3%	24.7%	19.6%	17%	11.4%	100%
Free State	20.5%	20.9%	22.4%	20.8%	15.4%	100%
Gauteng	14.1%	14.7%	17.9%	21.9%	31.4%	100%
KwaZulu- Natal	22.1%	23.2%	20.2%	18.7%	15.8%	100%
Limpopo	28.2%	24.6%	24.2%	14.9%	8%	100%
Mpumalanga	23.1%	24.1%	21.5%	17.7%	13.5%	100%
Northern Cape	21.5%	19.3%	20.7%	21.4%	17.1%	100%
North West	25.6%	22.3%	20.8%	17.6%	13.7%	100%
Western Cape	8.6%	13.3%	18.4%	28%	31.7%	100%

Source: (Department of Basic Education, 2017)

Provinces that are considered poor based on rates of income, unemployment, and illiteracy have the majority of learners in Quintile 1 (poorest, no-fee-paying) (see Table 5-3). Limpopo and Eastern Cape provinces have 56% of their schools in the first two Quintiles (Motala & Sayeed, 2009). The Western Cape and Gauteng provinces have a small percentage (6.5% and 10.2% respectively) of schools in Quintile 1 (Motala & Sayeed, 2009). The income levels in these provinces are much higher than the national average. The Western Cape Education Department (WCED) is responsible for public schools in the province.

5.1.2 Schools in the Western Cape, South Africa

There are an estimated 2155 schools in the Western Cape (NEIMS, 2014). Out of these schools, 2072 are regular, and 83 provide special-needs education. There are eight education districts within WCED (WCED, 2008). Schools in these districts are sub-divided into the rural and urban as depicted in Figure 5-1.

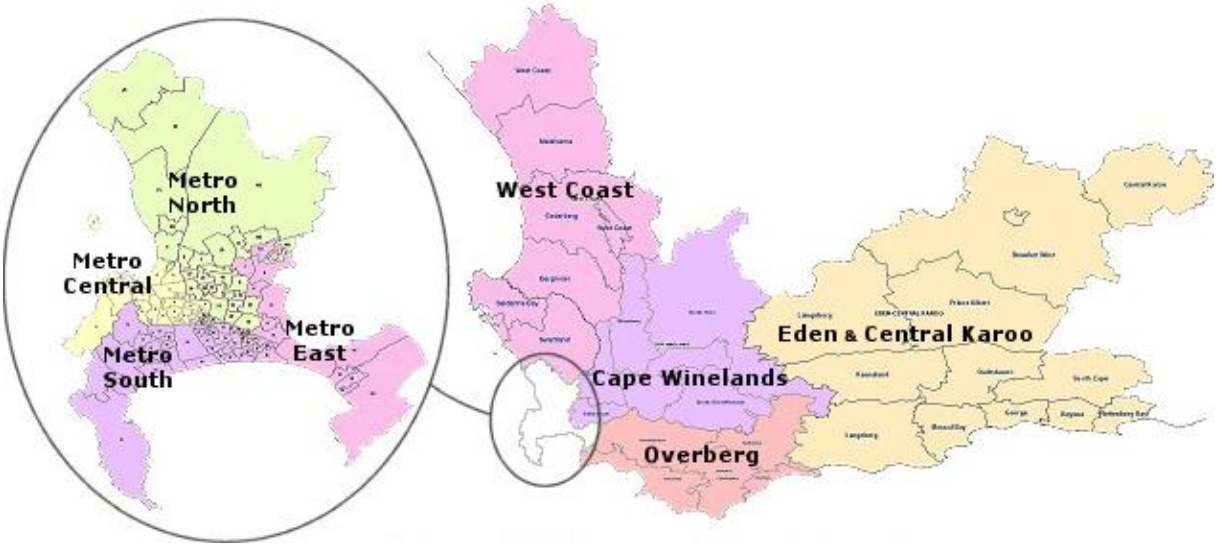

Figure 5-1: Education districts in Western Cape, South Africa
Source: WCED (2008)

Table 5-4 provides a summary of the education districts and schools in the Western Cape. Seven schools across the urban districts (Metro South and Metro Central) formed the sample of the study.

Table 5-4: Education districts in Western Cape, South Africa

Urban education districts	**Rural education districts**
Metro North	West Coast
Metro South	Cape Winelands
Metro East	Overberg
Metro Central	Eden and Central Karoo
Number of schools: **2155** (2072 ordinary & 83 special needs)	

5.2 ICT in education in Western Cape, South Africa

In line with the goals of the e-Education policy, WCED developed educational policies (for example, WCED vision for e-Education policy) in 2012. The policies aimed to improve access to learning resources to enable a quality-learning environment. The policies stipulated terms of the usage of computers and guidelines for learners and teachers on best uses of ICT. On whether province has achieved its goal of improved access to learning resources:

> *"Whilst we could say that every school has a computer lab which was provided in the previous project* [the Khanya Project]*. All of those computer labs are not functional in that some of them are as much as 15 years old and they have not being refreshed. So have the technology needs being resolved? My response would be no".* (EC_S7)

Regarding the progress on the implementation of such policies, there seemed to be a mismatch between policy goals and the existing realities within the schools. For instance, the computer laboratory provided by initiatives such as the Khanya Project is not functional (EC_S7). The reason for this is that the computing facilities are up to 15 years old and are not being renewed. Many schools lack the financial capacity to acquire ICT equipment and maintain sponsored ones. For the goals stipulated by the e-Education policy (ensuring that every learner is ICT-capable) to be achieved, learners need access to computing facilities for an extended period. It is not possible

to achieve this goal when 400 to 1200 learners are allocated one computer lab consisting of 25 to 35 computers that are not maintained (EC_S7).

5.3 Case descriptions of sampled schools in the study

Of the seven sampled schools, five were public schools governed by the education department. Two schools were independent, governed privately. Five schools were co-education, while schools E-BR and F_CS were for boys only and girls only respectively. The average age for the primary schools learners was between 7 and 13 years and between 12 and 18 years for the high schools. Most of the sampled schools fall in Quintile 5, which is considered as well-resourced schools. Some schools received support for the purchase and maintenance of ICT resourced from the Dinaledi schools initiative. Table 5-5 summarises the sampled schools and the dates when data was collected from the schools.

Table 5-5: Categories of schools sampled

Type of school	School	Dates for data collection		No. of students	Average class size	Capacity of teachers
		Start date	End date			
Public school	School A_HSS	25 August 2015	21 October 2015	1231	31	58
	School B_HPL	17 September 2015	5 November 2015	948	34	60
	School C_CG	25 May 2016	31 May 2016	550	32	23
	School D_AC	27 May 2017	15 June 2016	411	30	21
	School E_BR	12 May 2016	18 October 2016	948	30	50
Independent school	School F_CS	5 May 2016		920	26	80
	School G_LP	20 May 2016	19 October 2016	500	24	50

The Dinaledi schools initiative is a programme co-ordinated by DBE. The Dinaledi schools initiative was a national strategy to improve learner marks in Mathematics, Science and Technology subjects by improving the quality of teaching (Tikly et al., 2018). The Dinaledi schools initiative was implemented in specific schools. These schools were subsidised with a three-year conditional grant from the Dinaledi schools initiative. The conditions for the Dinaledi initiative school grant was that schools had to meet the threshold level of good Mathematics and Physical Science pass rates as specified by DBE (Tikly et al., 2018). The Dinaledi schools initiative gave support to schools for the purchase and maintenance of ICT infrastructure, educational resources and equipment. Other support offered by the Dinaledi schools initiative was teacher ICT skills training, learner support and school management support.

Focus schools aimed to redress and provide access to education for learners in various educational fields. These fields included Arts and Culture, Engineering, Business, Commerce and Management studies and Mathematics, Science and Technology. These educational fields were previously not accessible to many learners.

- **School A_HSS description**

The total number of ICT facilities in School A_HSS was 73. School A_HSS had two computer labs with 38 and 20 computers respectively and a mobile laboratory with 15 laptops. Some computers were given to the teachers, others were deployed in the computer labs and classrooms. ICT facilities in the classrooms included a data projector, an interactive whiteboard, and an Internet connection. The school had a mobile laboratory with fifteen laptops that could be used by both teachers and learners. School A_HSS was a Dinaledi school initiative that means the school prioritises Mathematics and Physical Science subjects.

On average, School A_HSS received a government subsidy of R250 000 per annum. The government subsidy was used to fund the salaries of 35 out of 58 teachers and six administrative staff. Since the school's annual budget was R20 000 000, a subsidy of R250 000 was inadequate to meet its financial demands. Therefore, School A_HSS relied on financial support from parents.

- **School B_HPL description**

ICT facilities at School B_HPL were deployed in the computer laps and in the classrooms. The school had three computer labs, each equipped with 30 computers, a data projector, a pull-down projector screen and a white-board. There were also a mini-lab 16 computers, as well as 34 sets of iPads and laptops for use within the classroom by both teachers and learners.

The software applications within the school included Computer-Aided Design (CAD) and cloud storage services, and Microsoft Office Suite programs for subjects such as Engineering and Graphic Design. A large number of the staff members used cloud storage services (such as Dropbox and Google Drive) for collaboration, data storing and file sharing. The iPads contained up to 25 applications that were used to aid the teaching and learning process. School B_HPL had a technical assistant for the support and maintenance of ICT. In terms of funding, School B_HPL received 50

computers from the Dinaledi school initiative to support Physical Science and Mathematics subjects.

- **School C_CG description**

School C_CG was equipped with ICT facilities which could be accessed in the computer labs, library and in the classroom. In School C_CG there were two computer labs, each equipped with 40 computers. The library had 15 workstations, and every classroom had a computer.

WCED contributed C_CG R3 000 000 to the school towards the acquisition and deployment of ICT infrastructure. Following from the initial funding of R3 000 000 the school allocated a budget for the support and maintenance of ICT infrastructure. The cost of ICT support and maintenance at School C_CG was R200 000 per annum. Since the school is a low-fee-paying school, it did not have enough funds to support and maintain the existing ICT infrastructure.

- **School D_AC description**

The mission of School D_AC was to provide learners with a high-quality primary and secondary education. The categories of learners the school showed interest in were those with potential in Mathematics, Science and Information Technology. The school sought to provide these learners with a good foundation for the successful completion of tertiary education. At the school there were various ICT facilities. These included four computer labs – each equipped with 32 computers, a data projector, a pull-down projector screen and a white-board. The school had a technical assistant to support and maintain ICT facilities. The school received funds from the public private sector to acquire half of its ICT infrastructure.

- **School E_BR description**

School E_BR had ICT facilities that could be accessed at the computer labs and in the library. The three computer labs at the school were equipped with 32 computers,

a data projector, a pull-down projector screen and a white-board. ICT facilities in the library consisted of ten iMac computers containing applications such as the iMac music-editing suite. In addition, the library also had 30 iPads available for teachers and learners to use. Every staff member had a laptop. Two full-time employed technical assistant staff was available to support and maintain ICT facilities.
School E_BR was categorised as a Quintile 5 school it received only R200 per pupil annually. In total, School E_BR received R160 000 per annum. The expenditure items of the School included electricity, water and staff salaries. The amount of R160 000 was sufficient for water bills only for up to three months. With the lack of funds from the government, the school was able to function due to large amounts of financial support from parents.

- **School F_CS description**

ICT facilities at School F_CS varied in hardware and software. The school had two computer labs, each equipped with 26 computers, a data projector, a pull-down projector screen and a whiteboard. There were also 130 iPads at the school. Microsoft donated a total of 26 Microsoft surface computers to the school.

The applications integrated into the schools' curricula included, Microsoft Office 365, One Note, PowerPoint, Scratch programming language, Photoshop, Notepad++ for editing HTML, JavaScript and Cascading Style Sheets (CSS). School F_CS was a privately funded school.

- **School G_LP description**

School G_LP had 1 370 Apple MacBook and iPads in year 2015. For the learners the ratio of access to ICT was one learner per computer. To ensure that all learners had their own Apple device, parents were required to buy the device, which was part of the stationery list for the teaching curriculum:

> *"Yes, parents buy the devices for* [the learners]. *It's part of our stationery list. When* [learners] *enrol in the school they get items that they need and iPad is part of that list.* [The school] *supplies technology to the teachers".* (PL_C6)

The school was a privately funded school. The school funded its own support and maintenance costs.

> *"We are a high fee paying school so we have a budget [for] maintaining infrastructure".* (PL_C32)

5.4 Deployment of ICT into sampled schools

The term ICT deployment is used in this study to include installing, setting up, testing and running of computers. Quantitative measures are used to measure access to ICT (Alampay, 2006). Access can be quantified at different levels, including individual, household and community. Measures at individual level include indicators such as ICTs per individual and in the case of this study, learners per computer.

In summary, discussions on ICT deployment into schools in the study included information on learner-computer ratio, Internet connectivity and funding for the acquisition of ICT. Table 5-6 summarises the status of ICT deployment and its integration into schools' curricula.

Table 5-6: Status of ICT deployment and its integration in the sampled schools

School	Approximate No. of students	Approximate No. of computers working	Learner-per-computer ratio	Subjects with ICT	ICT used for teaching
A_HSS	1231	200	6:1	Economics, History and English	**Hardware:** Desktop computer and Data Projector **Software:** YouTube, Internet, search engines and PowerPoint
B_HPL	948	238	4:1	Mathematics and Science	**Hardware:** Interactive Tablet PC, iPads, Data Projector and Desktop computer **Software:** iTunes University, iMovie, Keynote, Quick Response (QR) Codes, Edmodo, Evernote, Microsoft Office Suite, Computer-aided Design (CAD) and Cloud Computing (such as Dropbox and Google drive)
C_CG	550	130	7:1	Mathematics, Science, Computer Application Technology (CAT) and Economics	**Hardware:** Desktop computer, Data Projector, Smartboard and Smart Notebook **Software:** Cami Maths
D_AC	411	130	3:1	IT and Mathematics	**Hardware:** Interactive Whiteboard, Desktop computer and Data Projector **Software:** HeyMath!, HeyScience!, Delphi and Java applications and Microsoft Access
E_BR	948	186	4:1	Geography, Science and Economics	**Hardware:** Desktop computer **Software:** Google Earth, CAD, Google Maps, Geographic Information System (GIS) and Podcast
F_CS	920	227	4:1	IT and Afrikaans	**Hardware:** Smartboard and iPad **Software:** Note Pad Plus, Photoshop, Flash Adobe Suite and Scratch
G_LP	500	150 + 500	1:1	All subjects	**Hardware:** Apple TV, data projector and MacBook **Software:** Quizlet, Quizizz and Book Creator

5.4.1 Learner per computer ratio

As can be seen in Table 5-6, the level of ICT access across the sampled schools ranged from a learner per computer ratio of 7:1 to 1:1. Of the seven sampled schools, one school had a one-to-one learner-computer ratio. Well-resourced schools had a learner per computer ratio of 4:1. Schools that were not high-fee-paying were able to achieve a low learner-per-computer ratio of 3:1 through government subsidy and donations from private institutions. For example, WCED provided tablets and other technologies:

> *"Education department provides ICT (for example, Tablets). I call it a Seagull approach where* [ICT is] *dumped,* [without] *professional development.* [The technology] *is not used and gets stolen".* (CA_P8)

The primary level learner computer ratio in South Africa was 90:1. Computers were more frequently available in secondary schools (Wallet, 2015). Deployment of ICT was often a higher priority for secondary education curricula compared to primary education (Wallet, 2015). As a result, secondary level learner per computer ratio is lower at 54:1 (Wallet, 2015). Compared to the general learner computer ratio, which was 54:1, it was inferred that the low learner computer ratio of 7:1 in sampled schools was a result of the high level of resources as the majority of the sampled schools were high-fee-paying. The government or local projects subsidised the acquisition of ICT in schools that had learners from poor backgrounds.

Schools with a majority of learners from disadvantaged backgrounds lacked the budget to cover the cost of support and maintenance of ICT. This included training, technology support, and device replacement. On-going training was required to cater for new staff members.

5.4.2 Access to, and use, of Internet in schools

Access to and use of Internet differed across the sampled schools. For some schools access to the Internet for learners was not limited: *"No, we don't have a limit on what*

[learners] *can or can't download or upload"* (PL_C26). In other schools there were time-based limitations for Internet access: Learners at some schools could only access the Internet via Wi-Fi during break times and immediately after school. This was so as to not slow down the Internet speed at the school:

> *"We have [Internet] available at break times during the day in the afternoon straight after school in that way we find that we can actually manage the load".* (RB_IT7)

In some schools, however, there were no limitations to the access of Internet learners to social media. Websites such as Facebook could only be accessed during designated times: "*We don't allow Facebook during the course of the day but at the second break it's allowed"* (SC_IT26). In some schools learners were limited in the size of files they could download. For example, learners were asked to refrain from downloading big files during school hours because it slowed down the network speed.

5.4.3 Type and speed of Internet connectivity at the sampled schools

All seven schools had Internet connectivity. Table 5-7 provides the type of Internet connectivity in the sampled schools.

Table 5-7: Internet connectivity at the sampled schools

School	The quality of Internet Connectivity
A_HSS	Relatively fast with a limit on the size of the downloadable content (SHS_H13)
B_HPL	Good quality network
C_CG	Slow speed
D_AC	Slow speed
E_BR	Good quality network (RB_IT8)
F_CS	100Mbps
G_LP	100Mbps

Across the sampled schools the type of connection was mainly network cable and Wireless (see Table 5-7). The quality can be determined by the reliability and speed

of Internet connectivity. The quality of Internet connectivity across the sampled schools includes, non-functional, slow, or fast Internet Speed. For example, in some schools the Internet connection was either slow or occasionally not functioning: *"Our Internet access is pathetically bad. We are at a disadvantage it is impossible for learners to carry out tasks using the Internet in the Labs"* (CA_ITB15). In some schools the infrastructure was good and the Internet connection speed was fast, with a speed of 100Mbps: *"Our infrastructure is strong.* [We] *have 100Mbps up and down* [learners] *may connect their iPads, MacBook and phones onto the network"* (PL_C26).

5.4.4 Types of funding for acquisition of ICT in sampled schools

ICT acquisition was subsidised either by the government, national, projects or school funding. Some schools funded their acquisition of ICT facilities from school fees. High-fee paying schools had a dedicated budget to fund the acquisition and maintenance of ICT facilities. In some schools iPads were stipulated as part of the stationery requirements for the learners:

> *"Parents buy the devices (iPads) for* [Learners]*. It's part of our stationery list. So when* [learners] *enrol in the school they get items that they need and the iPad is part of that list. We supply the technology to the teacher just for the teachers yes".*
> (PL_C6)

Some schools received technologies from government-funded initiatives (for example Dinaledi): *"We're a Dinaledi school so we get some government support in terms of Science and Maths"* (PLH_LS17). Funds obtained from WCED contributed to either partial or half of ICT facilities needed at the schools. A financial service provider sponsored the Notebook computers used by teachers: *An Optimum Trust pays for a Mathematics teacher; they also pay for the notebook most of our Mathematics teachers use".* (PLH_LS17). For some schools, the funding provided was to acquire ICT for only specific subjects such as Engineering and Graphics Designs required desktop computers and software such as CAD. It was, therefore, seen as inadequate. For example, subjects such as Engineering and Graphics Designs required desktop computers and software such as CAD.

One school required 186 workstations. WCED subsidised the hardware component by providing a full laboratory of approximately 32 workstations for Engineering and Graphics Design for Grades 10 to 12. Another two workstations were provided for IT programming for Grades 10 to 12 (RB_IT12). The shortfall of 152 computers at the school, therefore, was acquired through school fees:

> *"We are a government-subsidised school but that subsidy is* [only for] *specific (for example, Engineering, Graphics and Design) that requires desktop computers as well as auto CAD software. The government would subsidise the hardware component. They supply a full lab (a processor screen, keyboard and 32 workstations) for engineering graphics and another 2 workstations in IT programming for the rest of the technology that the school invested. It predominantly comes from parents' fees paying and also from special fundraising. Either the school trusts and sponsors". (*RB_IT12)

For some schools, the government subsidised half the acquisition of ICT facilities. For example, IT and CAT were compulsory subjects at School D_AC. This presented a challenge for the school in ensuring that there was adequate ICT infrastructure. Since the school was a public school with learners from the disadvantaged background, it depended on sponsorship to aid the acquisition of its ICT infrastructure. WCED sponsored the acquisition of half of the existing ICT at the School.

For some schools, almost all their ICT facilities were sponsored by WCED. These schools were selected as part of the focus schools in the Western Cape. For example, C_CG was a commercial school (with the curriculum consisting mainly of Business, Commerce and Management studies and Mathematics subjects) and was part of the list of focus schools selected by WCED (GC_P12). Therefore, the department initially supported the acquisition of ICT by allocating R3 million towards infrastructure at the school. However, the cost of maintenance of ICT facilities was approximately R250 0000 per year. Since learners at the school were from an underprivileged background, inadequate funding made maintenance of ICT a challenge:

> *"The department* [gave] *R3 000 000 to put in infrastructure (hardware, Network cabling). Since then the school allocates an annual budget of between R150 000 and*

250 000. We have a contract for the maintenance [company] *where a company comes and services the computer".* (GC_P13)

5.5 The integration of ICT into schools' curricula – opportunities afforded by ICT

The affordances of ICT (content presentation and creation, assessment, cloud storage and communication) offered opportunities, which teachers could choose from to carry out their teaching. These provided the functional properties, which determined how ICT could be used. Across the sampled schools, teachers used ICT mainly for content presentation and creation, assessment, cloud storage and communication. These are summarised in Table 5-8 and discussed in the subsequent sub-sections.

Table 5-8: Education technologies affordances, properties and examples

Affordances of education technologies	Functional properties of education technologies	Examples of education technologies
Content presentation	This is software for editing and creating content. The major functions include an editor that allows text to be inserted and formatted, a method for inserting and manipulating graphic images and a system to display the content	PowerPoint, YouTube, Interactive Tablets PC, iPad, Doceri, iMovie Apple, Keynote and Apple TV
Content creation	This is software program for creating and organising content.	Doceri, Evernote, Google Earth, Google Maps, Notepad++ and Java, Scratch, HeyMath!, HeyScience!
Assessment tool	This is the use of multiple modes of representation to demonstrate the understanding of concepts and/or synthesis of new information. Multimodal representation means the inclusion of two or more of these formats: image, diagrams, graphs, numerical and mathematical representations, text, sound, gestures, animations, videos, 3D models and others.	Kahoot and Socrative Go Formative, Quizlet and Quizizz QR Codes Notability and Book Creator Excel Spreadsheet
Cloud Storage	This enables the use of files and applications over the Internet. Personal may be stored “in the cloud” and accessed from any computer that is connected to the Internet.	Dropbox, SharePoint and Google Drive
Communication	This is for dialogues for educational purposes between teachers. LMS facilitates discussions on the discussion board and has embedded tools for student collaboration, file- sharing and assessment.	Email, Edmodo and WhatsApp

5.5.1 Use of education technologies for content creation, lesson planning

According to the sampled teachers, the work demands of teaching, required them to plan their time well to ensure their success as teachers. Teachers used ICT (such as Calendar) to plan lessons:

> *“Have an iPad, for that it might be worth it and that is how many teachers use it sort of email, calendar. My calendar is also my lesson plan*. [Demonstration of the calendar research] *here are my lessons for today and here is what I use them for and with a*

breakdown of what happens and then exercise topic everything is in there". (PLH_M15)

In addition, Evernote, an application for the personal and professional organisation of projects, was used *"to keep track of lesson note".* (PLH_M14)

Teachers used ICT such as PowerPoint and YouTube to access to information for lesson and assessment preparation:

> *"I use* [ICT] *(PowerPoint, YouTube videos of ted talks) to prepare examinations and lessons".* (GC_B1)

In the sampled schools, subjects such as Geography, Programming, Mathematics and Science were taught using education technologies specific to the subject.

Table 5-9: Subject specific education technology

Subject	Education technology	Description
Geography	Google Earth and Google Maps	Mapping tools used for exploration, creation and collaboration.
Programming	• Animation software, such as Scratch • Notepad++ and Java	• Used to create animation and games through manipulation of digital images and text. Animations are created with game-like formats offering interactivity with the ability to score points as the learner moves through the animation. • These applications included a programming language and a source code editor for teaching IT.
Mathematics and science	• *HeyMaths* • *HeyScience*	These comprise animated visuals and interactive activities that are meant to empower teachers. As a result, it enabled the understanding and memorising of concepts.

Through Google Earth, *"learners could have fun and zoom in and out and play around (with mapping tools)"* (RB_G11). Through Scratch, students learned how to

program without realising it: " [learners were] *focused on how to score in the game* [whilst] *learning* [a programming language]*" (SC_IT1).* Applications such as Notepad++ were used as an editor for HTML, JavaScript and Cascading Style Sheets:

> *"I use Scratch, all the* [Microsoft] *Office programs. For the senior girls I use Atlas, note pad plus plus for web design. As an editor for HTML [I use JavaScript] JavaScript and CSS, Photoshop and Adobe Flash Suite programs with Grade 8 and 9".* (SC_IT2)

As part of the IT class teachers provided instructions on how to develop a database, which involved the creation of tables along with relationships among the tables (CA_IT2). Educational software in the sampled schools was aimed at simplifying complex ideas for Mathematics and Science. Some of the teachers used applications (HeyMath! and HeyScience!) (CA_MA26) for Mathematics and Science: *"This new thing on the block it's called HeyMaths, HeyScience"* (CA_MA26).

5.5.2 Use of education technologies for content presentation

This section discusses the ICT used for content presentation. They include presentation tools and video-sharing websites.

5.5.2.1 Use of presentation tools for content presentation

The study showed that teachers used presentation tools to synthesise information on subject content to learners. Presentation software enabled teachers to create electronic presentations consisting of a series of pages or slides. A large number of teachers (ten out of fifteen) used presentation software such as Microsoft PowerPoint for presenting subject content in their teaching. Teachers used slides to convey information-rich multimedia. Some of the features of presentation application, for example, Microsoft PowerPoint, enabled the presentation of dynamic content in that it offered a pop-up window presenting further explanations whenever a word was clicked. This enabled presentations to be more interactive:

> *"* [Taught with] *PowerPoint slides* [which was] *interactive. When* [the teacher] *clicked on* [a] *word (for example, line by line analysis), if you click, it gives you the line that pops up". (SHS_E17).*

Although the presentation applications enabled teachers to prepare lesson notes in advance, teachers needed to control how quickly to go through the slides and when to backtrack to ensure effective teaching and learning (SHS_E17). Some teachers struggled with using a mouse to annotate and draw through the presentation application.

As a tool for presentation of subject content, Interactive Tablet PC is a portable computing device that looks like a detached screen from a notebook computer (Steegen, Hasendonckx, & De Cock, 2018). The teacher entered data on the tablet PC using a stylus. Using the stylus, teachers could easily create handwritten notes. This enabled the flexibility for the teacher to edit the notes in real time, thereby offering similar functionality as the lecture-writing notes on the traditional whiteboard. Except that with the Interactive Tablet PC, teachers could make the lessons more dynamic by displaying multimedia. Teachers could project the screen of the Interactive Tablet PC onto the whiteboard via a Data Projector. This allowed learners to follow what the teacher was writing on the tablet PC (PLH_MS15). Teachers perceived the tablet as easy to use:

> *"The tablet is just so easy. It's a computer with a wonderful pen technology. There is no delay, there is no touch sensitivity with the screen so it's so easy [to use]. It's basically a glorified overhead projector".* (PLH_MS16)

Some teachers used tools such as iPads for their instruction because "*I can take a picture and project* [it] *on to the screen for the children"* (PLH_MS15). Teaching was done using Doceri an application which could be downloaded from the Apple App Store or iTunes on the iPad. Doceri was used to create notes for presentation in the classroom lessons:

> *"I have got it on the PC, I have got it on here, and I make all my notes I do all my teaching I mean these are my class notes".* (PLH_M14)

Other applications such as iMovie and Keynote were used to demonstrate subject content. Teachers felt that *"it gave an element of excitement for [the learners]. Grade 2 did basic animation"* (PL_B3). The iPads were cost-efficient compared to the Interactive Tablet PC, some teachers struggled to use them. This could be attributed to the touch sensitivity feature of the iPad. Not only was it difficult to use an iPad, but

it also took an effort to learn. This could have been because there were frequent new updates available for both the applications and the operating systems. Teachers felt that they were too busy trying to be competent in their teaching and lacked adequate time to explore all of the hundreds of applications that were available for teaching:

> *"iPad has been more difficult because its more versatile but its sensitive* [to touch]*, and it's difficult to write. It just changes so fast, I mean I am young and so I should be able to change with the times but it's a new app and it's a new this and then it's a new IOS. It's constantly changing.* [The] *sad thing with teaching is that you are too busy trying to be on top of the teaching that you don't actually have the time to explore all the hundreds of apps they have for teaching for example Mathematics, ITunes university and iMovie so I found I have had more challenges".* (PLH_MS16)

5.5.2.2 Use of video-sharing website for content presentation

Teachers used a video-sharing website such as YouTube to access the educational videos to present subject content to learners. Through video-sharing services, teachers could present videos on novels and poems to assist with explanation of English literature contexts and ideas. To carry out the instruction, teacher SHS_E used video clips of English playwrights and poetry (such as Macbeth play, Maya Angelou poetry) found on YouTube. These video clips presented a contrast between the formal performance (such as BBC edition) and the adaptation of the play (such as YouTube video clip). In some of the adaptations found on YouTube, the formal play was converted into parody.

Empirical evidence in this study on the use of video-sharing websites in teaching English corresponds with studies that suggest that video-sharing websites enable exposure to spoken English, presents a resource for developing writing skills amongst learners and makes teaching sessions fun and effective (Baker, 2018).

Technology was an essential part of teaching for some teachers. The benefit of ICT such as YouTube was that it enabled access to shared educational videos. The videos simplified complex subject content (SHS_EC7). To aid the teaching of complex topics such as Platonic Solids the multimedia enabled the presentation of 3D figures: *"I have a wonderful set of sounds and videos to show platonic solids in three- dimensional figures".* (SHS_EC12)

A set of pie charts was presented through YouTube videos to provide step-by-step explanations. It enabled the explanation of concepts by providing real-life examples. In other words, a teacher was able to explained concepts such as pressure calculus to learners through real-life examples.

> *"When I* [teach] *water pressure I can show them a myth busters video of a geezer popping through a roof because the water pressure got too much".* (RB_S17)

The significance of video-sharing websites for both teachers and learners was that teachers could upload recorded lessons. Learners who missed a lesson could re-experience the lesson as opposed to watching a video carried out by an unknown teacher. An application such as Doceri was used to create the videos for uploads, and is available on iPads. The timespan of the videos was between 15 to 20 minutes. The videos were typically a description of theorems and how they could be proven, along with examples.

> *I have a YouTube channel and I have the video* [created with] *Doceri on my iPad. I input the pictures; they range from 15 to 20 min.* [The] *videos* [are] *of what the theorem says, what it means and how to prove it, and then an example.* (PLH_MS27)

The video-sharing website enabled the creation of a flipped classroom whereby the lecture and the homework element of the course are reversed. Typically in Mathematics, learners were given exercises in their booklet consisting of a list of theorems. They were then required to complete the exercises in their booklet by watching videos uploaded on YouTube. In describing the use of video-sharing websites such as YouTube RB_S and GC_M22 stated that

> *"Like a kid is absent and now he has to play catch-up on all nine subjects. Just taking that pressure off him* [and] *makes* [the learner] *go I* [can focus on class] *right now I don't have to worry about the last lesson 'cause there is a video at the end that I can just go and watch, that my teacher explains the lesson in. It's not a 'go do this' YouTube video where an American will explain it, it's my teacher explaining as he explained it to my class in the lesson. It makes a big difference".* (RB_S17)

Some teachers were able to achieve their goals such as equipping learners to compile an executable application through video-sharing websites (CA_ITB25). It helps the teacher explain things better:

> *"I can explain more things at a later stage and through technology and then I can download* [a] *YouTube video at the end of the day the learner is equipped to achieve the goal that I have to develop an application a fully fledged application and a fully fledge".* (CA_ITB25)

A finding was that with access to video-sharing websites the teacher felts some learners could not appreciate the reason to pay attention in class. This is because the learners felt they could Google or watch a YouTube video of the concept explained in class, at a later stage. For those who needed further explanations, even after school hours the teacher was available on social media platforms such as WhatsApp for learner queries until midnight (CA_ITB29). Therefore, learners were not under pressure to pay attention in class instead they would revise concepts addressed in lessons via video-sharing websites or search engines such as Google while directing queries to the teacher:

> *"I think having the technology and knowing that in class learners don't pay attention because they know that* [they] *can Google this;* [they] *can get YouTube to explain this thing better than what is being explained".* (CA_ITB29)

5.5.2.3 Use of education technologies for content presentation: Omni dimensional classroom

With ICT teachers could display different educational activities on different technologies (such as Apple TV and Mac-Book TV) within the classroom setting. Highly resourced schools such as School G_LP focused on ensuring that the classroom set-up was Omni-dimensional. In other words, learners were grouped according to the different tasks carried out at a time and teaching was carried out from all aspects of the classroom. With ICT, lessons could be projected on various integrated platforms (i.e., Apple TV, data projector, iPad, and Mac-book) to enable learners to move from one point of the classroom setup had to the other in a rotation format (PL_B1). Typically, a classroom consisted of Apple TV, data projector: "*My*

classroom has one wall which has the Apple TV. We are heading towards Omni-dimensional teaching" (PL_A16). This resulted in:

> *"Two screens on the side the screen on this side which is a massive projector and we have got the small screen, and we project on both and so that the children can have a surround feeling".* (PL_B1).

In explaining the classroom set up, PL_A stated that*:*

> *"I've done lots of different layouts, so I've constantly changed so at the moment I got my* [Mathematics] *subject against the wall were and* [another] *wall that we can write on so there is one area that* [learners] *can write. I've got a lovely little working area".* (PL_A16)

5.5.3 Use of education technologies for assessment

As a key element of teaching, assessments informed teachers on how well the learners performed as compared to projected outcomes. Some teachers used formative assessments to gain and an idea of how well the learners understood what was taught. In a conventional lesson:

- Learners are presented with a quiz or test
- Learners are to quickly state their answers
- Teaching takes place and then
- Another assessment is conducted using paper

However, with ICT teachers could test the learners who could quickly select options. This increased their learners' excitement. Table 5-10 summarises the types of ICT used for learner assessment in the sampled schools.

Table 5-10: Types of education technologies used for learner assessment in the sampled schools

Types of education technologies used for assessment	Reasons for use of educational technologies for assessment
Kahoot and Socrative	To create a game show effect, for better information access, learner excitement and interest
Go Formative, Quizlet and Quizizz	For record keeping of learner performance
QR Codes	To enable anonymity in question and answer sessions between teacher and learners in the classroom
Notability and Book Creator	To create a storybook form
Excel Spreadsheet	To capture learner results on the Spreadsheet.

Applications such as Kahoot and Socrative were used for live learner assessments (see Table 5-10) (RB_S2). As a game-based learning platform, Kahoot enabled a game show effect. The fast-paced assessment style drove competition amongst learners and sped up the thinking process:

> *"Kahoot is just a fun way [teach] because I work in a boys' school so competition drives them, it also speeds up their thinking process".* (RB_S2)

The goal of using these assessment technologies was for better information access, learner excitement and interest: *"My goal with the use of all those technologies is to get better information and to get* [learners] *interested and excited about the subject"* (RB_S2).

Through ICT-enabled formative assessments, teachers could identify the areas, which the learners struggled with and offer remediation. The teacher could evaluate quickly how all the learners were performing on a specific topic and focus on learners that needed attention in real time: *"My goals, like I said there are two things that I try to get their attention get good information"* (RB_S24).

Teachers used QR Codes for learner assessments. To enable anonymity in question-and-answer sessions in the classroom, teachers used QR Codes. Through the QR Codes teachers assigned a unique code to every learner. Possible answers are classified in the multiple-choice form listed A, B, C and D: "[With] *QR Codes every child has a unique QR Code and depending on the orientation of that QR Code, it gives answer A, B, C or D"* (PLH_LS47).

The teacher used the QR Codes either at the end of the lesson or during the lesson. During the lesson, for example, the teacher would pause the lesson and ask a question; the learners would then select the possible answer and scan it with a mobile device. Each learner was assigned a unique code. The teacher could identify students and their answers through a unique code. Due to the anonymity in which learners answered the questions using the QR Codes, the teacher could control the class during the assessment and prevent learners from copying each other's answers. Since the learners could answer anonymously, they were at liberty to participate in the classroom assessment: *QR "Codes allows me to get the answer without* [anonymously] *it gives them freedom"* (PLH_LS48). Some teachers used Notability and Book Creator for Mathematics.

Some teachers used Notability and Book Creator for Mathematics (PL_G1). Through applications such as Notability and Book Creator teachers could create assessments in the form of a storybook for completion by learners. The App Smashing functionality on iPads allowed for multiple applications to use for the completion of one project. For the completion of a storybook through Book Creator, learners were required to insert a digital time. Therefore, the Simple Time app was used, or a pen tool was used to capture a digital timer for this purpose:

> *"They have to show the time by using that clock, putting it there and putting the time in digital time, so there is a whole activity revolved around the time just on their iPads".* (PL_G1)

Completed tasks were saved to Notability for marking (PL_G3). Records of assessment results are developed with the aid of Excel. Some teachers used Excel to capture learner results on the Spreadsheet. Concerning the administrative task of

keeping learner records, the electronic worksheets made tit easier to calculate the final assessments results. Some teachers used word processing applications such as Microsoft Word as part of their teaching:

> *"You just punch in the names and you punch in the numbers and it automatically calculates on Excel. Yes, it* [is] *much easier* [to use]. [For] *Grade 8 and Grade 9 they basically have set work worksheets and you just punch in the numbers and it comes with the names and it comes with everything that has been much help when it comes to paperwork and setting up things".* (GC_M24)

5.5.4 Use of education technologies for storing educational resources

Cloud storage facilities presented teachers with the opportunities to store and retrieve educational materials. Through cloud storage such as Dropbox and Google, teachers could access to a shared set of Internet-based resources anywhere and anytime. Additionally, teachers could share large files such as videos and other multimedia materials with other teachers and or learners. Similarly, educational resources are uploaded to the Google Classroom platform. The resources included video clips. These video clips enabled absent learners to have access to lesson plans:

> *"I use Google Classroom or Blended learning approach for History* [to] *put up resources (for example, videos). The absent kids have access to my lesson plans".* (RG_G1)

Through Google Classroom teachers could make lesson plans and educational resources available to learners. This improved the class to be more structured (RB_G3). The Google Classroom was a useful tool for classroom management: *"* [I was] *relying on Google Classrooms to manage that kind of virtual classroom"* (RB_G7). The assessment functionality of Google Classroom also aided teachers in developing learner assessments and testing learners: *"Google Classrooms to ask the right questions and test* [Learners]*"* (RB_G10).

5.5.5 Use of education technologies for communication

Communication with technology between teachers and learners or other teachers was carried out by email, through telephone, LMS and social media. Through email,

teachers could communicate learner results to parents *“Like being able to quickly email a parent* [learner results]*” (PLH_M15).* LMS platforms, for example Edmodo, had embedded tools for collaboration, communication and file sharing. As an LMS, Edmodo worked like social media platform. It enabled teachers to upload educational resources (i.e., worksheets videos) and also communicate with the learners to clarify instructions provided or to aid in preparation for assessments. PLH_MS felt that with Edmodo the diligent learners could access educational resources from anywhere: *“Your hard-working child has access to stuff anywhere “* (PLH_MS23). For example, for CA_ITB social media platforms such as WhatsApp enabled him to explain concepts to learners even after school hours (CA_ITB25).

5.6 Conduct of ICT-mediated instruction

Table 5-11 summarised the classroom 16 observations conducted in the study.

Table 5-11: Types of ICT mediated instruction

Types of ICT mediated instruction	No. of teachers	Role of ICT	Role of teacher	Role of student
Constructivist elements	2	Information sources	Interacting with the learners by answering questions	Making meaning of data
Predominantly constructivist	2	Exploratory software for problem-solving, data searching and as a tool to aid assessment.	Aiding learners in developing an understanding.	Developing own understanding and achieving social learning through working in pairs.
Traditional	3	Tool to present subject content	Teachers simplified the play in narrative form and tried to make a generally difficult literature simple to understand. The teacher then asked questions and learners responded.	Wrote notes from the PowerPoint slides using a notebook and pen.

Off the 16 observations, one had constructivist elements (see Table 5-11), two were predominantly constructivist, the other 12 observations were predominantly traditional. The constructivist elements observed in the two classes can be categorised into types of instruction, the role of learners, types of activities and the role of technology.

The constructive element in the History class was seen through activities such as information searches online using a laptop. In these lessons, the role of ICT (such as iPads and computer) was to provide an information source. The students played the role of making meaning of data and interacting with the teacher by asking questions.

The constructivist classes were for Geography and Mathematics. In these classes ICT fulfilled the role of being exploratory software for problem solving, data searching

and as a tool to aid assessment. The constructivist style of instruction was categorised into types of instruction, the role of learners, types of activity and the role of technology. Under *types of instruction,* the teacher guided the learners in problem-solving tasks.

In the Geography class, teachers aided learners to develop an understanding of coordinates by exploring how to find a geographical location using mapping tools. Social learning was enabled with some learners carrying out tasks in pairs.

Similarly, during the Mathematics lessons, three groups of learners rotated between three different Mathematical measuring tasks assigned by the teacher. Additionally, one group observed a demonstration on measurement carried out by the teacher.

The traditional teaching that was observed may be categorised into teaching style, curriculum and role of student. The lessons were mainly Mathematics, Science and English. For the English class, the computer and projector were used to display a PowerPoint slide of a bullet-point summary of the English book, *Othello*. The teacher then asked questions based on the Shakespeare play, *Othello,* and learners responded. Learners also wrote notes from the PowerPoint slides using a notebook and pen. ICT was mainly used to present subject content: the teacher simplified the play in narrative form and tried to make a generally difficult work of literature simple to understand.

The other ten lessons were similar. In the Mathematics lessons, the teacher wrote Mathematics sums on the iPad, and as she wrote this, it was displayed on a whiteboard. The teacher used the Doceri desktop application. She explained the sums by demonstrating the calculation on the whiteboard how they were calculated. The learners took notes. Similarly, for the Science lesson, learners were being prepared for examinations. The teacher began the lesson by reviewing the homework completed by the learners. The teacher then continued the lesson by discussing the topic of Theoretical Yield. The explanations were carried out on the iPad whose screen was projected onto the whiteboard.

5.7 Characteristics of the teachers in sampled schools

This section presents the characteristics of the teachers, which form the background to the research result in Chapter 6. In this section the demographics, teachers' goals and lives they value are highlighted. Table 5-12 summarises the demographic characteristics of the 15 teachers interviewed.

Table 5-12: Demographic characteristics of teachers in the sample

Category	Teachers
Age	
<21	1
22 - 24	0
25 – 29	5
30 – 35	0
36 – 39	1
40 – 44	0
> 45	3
Gender	
Male	5
Female	11
Marital Status	
Married	6
Single	2
Divorced	1
Monthly income	
K5000 – K9, 999	0
K10000 – K14, 999	3
K15, 000 – K19, 999	3
< K20 000	2

The average age group of the teachers was between 25 and 29 years (see Table 5-12). One teacher was less than 21 years. One was between 36 and 39 years. Two teachers were above 45 years. The majority of the respondents (10 out of 15) were female. Approximately 66% of the respondents were married. The income level for teachers ranged from R10 000 to R20 000 with only two teachers earning above R20 000.

5.7.1 General age group of teachers in schools

In South Africa the number of teachers between the age 45 and 49 is 45% of the teaching population. This percentage (45%) is four times higher than the number of teachers aged between 30 and 34 (Bernstein, 2015). In converse the findings reflect the respondents were predominantly young (between the ages of 25 and 29).

Respondents felt that younger teachers used ICT more frequently than their older counterparts. Younger teachers (between the ages of 25 and 29) were more comfortable with using ICT in their teaching. This is because they were exposed to ICT earlier on in their lives. They were more confident to experiment with new technologies or new ways of teaching.

Table 5-13 presents respondents' level of education (such as Bachelor of Arts degree in music, a Master's degree in Geography, and an Honours degree in Business Science (BSC)).

Table 5-13: Teachers' level of education

Education level	Teachers
Degree in BSC Honours	5
PGCE, FET education	5
B.Ed.	2
B.Ed. (FET specialisation or Primary Education)	1
MCSE + I	1
BA music	1
Masters in Geography	1

Some respondents had built up their teaching qualification by obtaining a certification in Microsoft Certified Solutions Expert (MCSE). Studies indicate a significant increase between 2012 and 2013 in the number of teachers that upgraded their qualifications (Bernstein, 2015). The majority of teachers built up their qualifications on the job, often over many years.

5.7.2 Goals of teachers in the study

The main goals of the teachers in the study were to improve their teaching. Teachers sought to equip learners with the necessary skills needed for the successful completion of final examinations at Grade level and the school leaving the stage. The goals of the fifteen teachers are summarised in Table 5-14.

Table 5-14: Goals of teachers in schools sampled

Goals of teachers	No. of teachers
Ensure that learners pass at the end of the year and the school leaving the level (GC_MT36, CA_MA50, CA_ITB25)	3
To cover the syllabus by giving the learners an understanding of the subject content (CA_I_59:31; CA_ IT45)	2
Be a better teacher (PL_A12)	1
Make learners happy (PL_G3_45:4)	1
Ensure that learners were good at and are passionate about the career they wished to follow (GC_B41)	1
Emulate the teaching practices of her previous physics teacher (GC_M41)	1
Improve teaching	
Improve the human capital of the country by ensuring that learners were equipped with skills to enable them to complete examinations	

The goal of some principals was to provide a good education for learners and to ensure that learners had access to good education. The goals of respondents that is centred on improvement in learner performance were in line with the goals of the schooling system in South Africa (Moodley, 2013). The aim of the schools was for improved learner achievement, especially in Language and Mathematics (Moodley, 2013). Teachers were seen as the centre of the education system. Quality of the education delivered had a direct impact on the performance of learners (Moodley, 2013).

5.7.3 The lives teachers valued and have reason to value

The lives teachers valued and had reason to value relates directly to the teacher and learner (see Table 5-15).

Table 5-15: Lives teachers valued

Category	Lives teachers valued
Learner related values	• Teaching for learner enjoyment and happiness • Learner successful completion of examinations • Learner success
Teacher related values	• Lifelong learning • Teaching basic life skills • Easy ways of teaching • Change • Teaching and learning

Some teachers valued student's enjoyment of their lessons and the successful completion of examinations: *"I really enjoy the lesson when I see students enjoying my lesson and I see they do well in the examination – then I am happy"* (CA_MA55) (see Table 5-15). Similarly, some teachers valued making their learners happy to attend school. Some teachers valued seeing learners succeed.

Some teachers indicated that they valued teaching basic life skills such as good manners and discipline: *"I value education, teaching manners and how to behave, and discipline"* (CA_ITB19). Some teachers valued teaching and learning as well as being able to achieve lifelong learning. Some teachers valued finding easy ways to work. Some teachers valued change (PL_B10).

By gaining accessing to ICT, teachers were provided with different opportunities to achieve their goals. ICT gave teachers the freedom to live a life they value and have reason to value. Although basic human values such as change, life-long learning, and learner enjoyment were important, teachers highlighted successful learner completion of examinations as a core value. This aligns with the goals of the schooling system in South Africa.

5.8 Summary of chapter

The chapter described the situated context of the study. The chapter presented a profile of education and ICT in education in South Africa. This chapter discussed the sampled schools whose ICT-mediated teaching constituted a case in the study. The status of ICT deployment and its integration into curricula in the sampled schools were examined. The demographic profile of the teachers was summarised.

CHAPTER 6 : RESEARCH RESULTS

6.0 Introduction

The chapter presents the results of the analysis of the empirical data for the study. The structure of this chapter is based on CA (Sen, 2017a), individual differences conceptual framework (Trauth, 2002) and Conole and Dyke (Conole & Dyke, 2004) taxonomy of ICT affordances. CA is used in this study to understand how ICT enable opportunities for teachers to generate educational outcomes. CA is used to conceptualise inequality and well-being. Explanatory theories may be used to supplement the explanatory power of CA. In the study individual differences framework was used to help identify the implications of diversity amongst teachers. It offered a better understanding of how teacher capabilities are enabled and educational outcomes are generated through ICT. The chapter describes ICT skills training and its effect on ICT use in teaching. Based on the theoretical framework of the study (Figure 3-1) the effects of individual differences on the use of ICT in teaching are highlighted. The concept of agency is summarised. In this chapter, opportunities offered by ICT in teaching are substantiated. The choice is an important element of the study, which is dealt with in Chapter seven because it aligns with the research question, and novelty of the study.

The rest of the chapter is organised as follows: Section 6.1 presents the influence personal data on teaching with ICT. Section 6.2, specify shaping and influencing factors. Section 6.3 details the influence of environmental context Section 6.4 denotes the influence of social context on the use of ICT in teaching while Section 6.5 highlights the capability enabled through ICT to form educational outcomes. Section 6.6 presents the Agency – actions that enable an effect. Section 6.7 summarises the chapter.

6.1 The effects of personal data on use of ICT to enable capabilities

This section discusses the individual differences of teachers and how they affects the way teachers use the commodity and on their choice to convert the opportunities

generated from a commodity (such as education technologies) into achieved functionings. Table 6-1 summarises individual differences identified in the study.

Table 6-1: Influence teacher individual differences use of ICT to enable capabilities

Factor	Details	Explanation
Personal Data	Age	Exposure to ICT from a young age enabled teachers to be comfortable with its usage
	ICT skills training	Specialised ICT skills training encouraged the integration of ICT into schools' curricula
	Education and level of expertise in the subject	Increase in the level of expertise in subject improved the use of ICT for teaching.
Shaping and influencing factors	Personality data	The personality of teachers influenced the use of ICT for teaching
	Role models	Role models and mentors fulfilled a supportive role and guided ICT usage in teaching
Environmental context	Habits, customs and beliefs	ICT was used to maintain habits, customs and beliefs in teaching
	Cultural values	Cultural values guided teachers on ways for ICT use in teaching
	Demographic and historical characteristics of the place of stay	Urban areas and school environments translated to easy and ready access to ICT/electronic devices.
Social factors	Government level policy	Governmental specifications on how assessments should be carried influenced the degree to which teachers used ICT
	School level policy	School specifications applied to both pupils and staff to help meet the goals of the school

The individual differences explored in the study (see Table 6-1) are further discussed in the subsequent sections.

6.1.1 Influence of ICT skills training on ICT use in teaching

ICT skills training equip teachers with skills to help them integrate ICT into teaching and learning. The types of ICT skills training received by the respondents varied. Some were either *self-trained, given basic ICT literacy training, given exclusive training* (such as learning how the iPad functions), *or given extensive ICT skills*. Skills training that were exclusive to learning about ICT functionalities made it possible to use certain functionalities of ICT such as those on the iPads. Extensive ICT skills training offered at the school presented opportunities for teachers to grow in their knowledge and skills as well as become creative in the classroom. Further, it enabled the teacher to be up-to-date with new developments in the field of ICT for teaching:

> *"We have had extensive ICT* [skills] *training at my school. This has given me opportunities to grow as a teacher and to continue being up to date with the changes that are taking place in ICT and education.* [ICT] *has helped me grow into the teacher I am now and it has helped me change my way of thinking and helped me to become more creative in the classroom".* (T8)

ICT skills training provided teachers the opportunity to learn different ways of teaching with ICT: *"Through ICT skills training I get to learn different ways I can use ICT to teach"* (T4). ICT skills training improved their skills and aided initial adoption and use of ICT enabled them to start using ICT in their teaching: *"It gave* [equipped me to] *start using the tools"* (T5). ICT skills training made innovative teaching possible. It opened ideas and thoughts on how to carry out new lessons and projects. It created an environment for the development of new ideas for teaching:

> *"*[ICT] *opens ideas* [of how to carry out] *new lessons and projects. It creates a space for ideas to develop and to take already established ideas to a new level".* (T6).

6.1.2 The effects of personal data on use of ICT to enable capabilities

The differences in personal data affected how teachers used ICT. Personal data include age, gender and level of education. ICT use decreases with age and teaching experience and younger teachers integrate ICT in their teaching more than veteran (Bebell, Russell, & O'Dwyer, 2004; Inan & Lowther, 2010; Van Braak, Tondeur, & Valcke, 2004). In the sampled schools young teachers were confident in experimenting with new technologies or finding new ways of teaching. The

respondents felt that a younger age increased the likelihood of having computer efficacy - younger teachers had a positive perception of their ability to use ICT to accomplish (Compeau & Higgins, 1995; Shen, Ho, Ly, & Kuo, 2019). Younger teachers were enthusiastic about using ICT. Computer efficacy enabled teachers to be more confident in carrying out tasks such as trouble-shooting technical faults. Difficult problems presented a new solution building opportunity for the teacher: *"I use ICT without the worry of it not working - there is always a way around the problem. If not, it is a lesson learnt".* (T6)

Teachers' had different views on the impact of age on ICT. Differences in views of how age impacts ICT use may be attributed to differences in teachers' perception of use and actual use of ICT in teaching. This finding is supported by studies that show a mismatch between teachers' beliefs on the one hand and actual teaching practices on the other hand (Judson, 2006). For teachers being young (such as between age 25 and 35) affected the use of ICT *"positively, … I have observed senior colleagues … tend to use ICT to a rather lesser extent"* (T4). Middle age teachers (such as age 36 and 55) used ICT less frequently in teaching compared to their younger counterparts. In contrasts, a senior male teacher felt that being old (such as between age 55 and above) had no impact on ICT use for teaching. On the contrary at the middle age of between 36 and 55, a teacher felt highly competent in using ICT

> *"I have high level computer skills. I use ICT: PowerPoint presentations, Excel Spreadsheets, Physics and Mathematics Desktop* [applications]*, Mobile applications and Web Development tools, in various ways at school".* (T9)

With regards to gender, in this study, for most teachers, differences in gender had no influence on ICT use in teaching. Previous studies on the relationship between gender and teacher ICT use reflect mixed results (Shapka & Ferrari, 2003; van Braak, Tondeur, & Valcke, 2004). Some studies have noted that male teachers have significantly high levels of ICT usage for teaching compared to their female counterparts (van Braak, 2001). In contrast, Shapka and Ferrari (2003) found no gender differences in ICT use for teaching.

The increased use of ICT may lead to potential misuse (irresponsible use) of the technology. Examples of misuse of ICT include unauthorised access to computer files, unauthorised deletion of pupils' work on schools' network and misuse of school facilities (NUT, 2018). However, a middle-aged female felt that although age did not affect their ICT use, being between 36 and 55 meant that she was mature and used ICT more responsibly in their teaching and was aware of its effects on people.

> *"I do not think my age affects the way I use ICT except for the fact that I am a more responsible user and I am more aware of the effects ICT has on people."* (8)

6.1.3 The effects of education and subject expertise level on use of ICT to enable capabilities

Teachers' education and expertise level in the subject taught influenced their adoption and use of ICT. The Technology Pedagogical and Content Knowledge (TPACK) framework stipulates that teacher's knowledge (content knowledge) about the subject being taught may ensure effective teaching with technology (Koehler & Mishra, 2009). Knowledge of content and pedagogy influenced teaching efficacy. Therefore, with a strong teacher efficacy teachers could teach confidently with ICT and were resilient to ICT failures: *"I feel more confident* [to teaching] *as I know the [subject] content and I am not as worried if* [it] *something* [ICT] *fails in a lesson, because I know the* [subject] *content"* (T6).

An expertise which is pedagogical and content knowledge, is knowing which method to use with which subject content, for the types of students and in which setting (Hobbs, 2019). As their pedagogical and content knowledge grew the techniques and methods, teachers use to teach with ICT improved. Due to a degree and high level of expertise (in a variety of subjects) some teachers knew their content well. A teacher with a B.Ed degree and an average expert in teaching IT stated:

> *"My expertise does, by a larger extent, affect the way I use ICT. I have observed improvement in the use of ICT to teaching as my level of expertise grow every year".* (T4)

An expert level in the subject taught improved teachers' confidence and level of comfort with using the technology. A teacher with a BA and PGCE as well as an expert in teaching Mathematics and English indicated: *"I am confident in my teaching, so I am confident to try new things* [for my] *class"* (T10). An expert in the subject taught further enabled the development of age-appropriate educational content that aligned with the competency levels of learners. A teacher with a four-year degree and an expert in teaching Foundation Phases felt that through age-appropriation of educational resources, learners had the opportunity to reach their full potential:

> *"I can create activities that are age-appropriate and that enable the learners to reach their full potential. It enables me to create content that is suited to the level that the children are at".* (T8)

The level of expertise enabled the development of a learning culture where individuals share and apply new knowledge and skills. The teacher with a PGCE and an expert in teaching Life Science indicated that ICT *". Allows me the freedom to identify positive ways develop a culture of learning"* (T7).

An expert level of expertise helped with the development of presentations and interactive lessons with the use of Forms. A teacher with a BSc and an expert in teaching Mathematics and Science stated: *"I can develop my presentations, interactive lessons, Forms* [and] *etc."* (T9)

6.2 The effects of shaping and influencing factors on use of ICT to enable capabilities

The differences in personality traits and role models of teachers affected how teachers used education technologies and on their choice to convert education technologies into educational outcomes.

6.2.1 The effects of personality on use of ICT to enable capabilities

The personality traits of teachers influenced their ICT use behaviour in the classroom. Table 6-2 presents a summary of personality types among respondents

Table 6-2: Influence of personality on ICT use in teaching

Personality type	Description	Examples of influence personality on ICT use
Choleric	Short-tempered, fast, or irritable	Lacked patience and are impatient when ICT do not function well and are slow or faulty
Melancholic	Analytical, wise, and quiet	More methodical in their approach to teaching with ICT. Frequently observe other practitioners' technology usage and modify lessons learned to suit their classroom
Sanguine	Enthusiastic, active, and social	Were willing to try out anything at least once. Open to learning about new technologies.

Teachers with a Choleric personality expressed "[I] *lack patience with* [technology] *if it does not work properly*" (T3). They, therefore, became impatient when ICT did not work, were slow or faulty. They preferred to use technologies that were quick and easy to use. For some teachers their melancholic personality made them more methodical in their approach to teaching with ICT. For some teachers because of the Melancholic personality, they frequently observed other practitioners' technology usage. Further, they modified lessons learned to suit their classroom: "*I can watch others and learn and adjust what I have learned to suit my classes' needs*." (T10). Teachers with sanguine personality were willing to try out anything at least once. This made them open to learning about new technologies. A teacher shared ideas and best usage practices to colleagues:

> *"I am keen to try anything once,* [good or bad] *lessons can be learned. I enjoy sharing the* [experiences with ICT] *with* [other teachers]*".* (T6)

6.2.2 The effects of role models and mentors on use of ICT to enable capabilities

Role models and mentors influence an individual's identity. Previous studies have noted that a supervising mentor in school influences the teacher/trainees' use of and attitude towards ICT (see, for example, Haydn and Barton (2007)). The study noted that the respondents' role models and mentors influenced the way ICT was used for teaching. Table 6-3 summarises teachers' mentors and role models and their influence on ICT use in teaching.

Table 6-3: Teachers mentors or role model and their influence on ICT use

Category	Mentor or role model	Example of influences
Work-related mentor	Colleagues	Use ICT in teaching methods is similar to that of other colleagues. Pressure from colleagues influenced the creation of great lessons using ICT
Family-related mentor	Spouse	Encouragement from spouse influenced the creation of great lessons using ICT
	Parent	Father learnt how to use the computer at an old age, 80s influenced the teacher's wiliness to learn about new things. Parents influenced the acceptance of ICT by introducing ICT early in life from primary school.
	Siblings	New ideas shared by siblings are adapted to the classroom use of ICT
	Mother	Encouragement from mentors and role models helps teacher adapt easily to change for example new ICT and methods of teaching
	Grandmother	
Peer-related mentor	Friends	New ideas shared by friends are adapted to ICT use in the classroom. Pressure from friends influenced the use of ICT to create great lessons

Different people influenced the way the teachers taught with ICT. Role models and mentors came from family, work, and peers. Role models from the family mainly

influenced the teachers' willingness to learn about ICT in general. For example, a father to a teacher learnt how to use computers at an old age (80 years). The impact of this on the teachers is that they were willing to learn how to use existing and new technologies despite their age. In some cases, parents introduced ICT to the teacher at an early age: "*Parents introduced me to ICT, which became part of my life while at primary school"* (T7).

In some cases the mentorship was not directly related to ICT use, but rather about life lessons that had an impact on their perceptions on the use of technology. For some teachers their mothers and grandmothers encouraged them to persevere in everything. The relationship between this and ICT is that being able to persevere made the it easy to adapt: "[mentors and role models] *have always encouraged me to persevere in all that I do which helps me adapt to change more easily"* (T8).

Peers had similar influences on teachers' use of ICT in teaching. Siblings and friends frequently shared new ideas with the teacher on how to use ICT in life. The teachers adapted these new ideas in their teaching: *"Siblings and friends share new ideas with me about how to use ICT in life, which I try to adapt to the classroom."* (T7).

There were similarities in the role that colleagues, spouses and friends played on the teachers' use of ICT in teaching. They mainly provided moral support; the teachers found them to be helpful when they felt overwhelmed. Furthermore, they often encouraged the teachers to create great lessons: *"*[role model and mentors] *help me when I feel overwhelmed and often put too much pressure on myself to create a great lesson"* (T6).

The role models who were past primary and high school teachers exemplified the way ICT should be used in the classroom. The teachers used ICT in similar ways to their mentors and role models: *"The other teachers I have learnt from often use ICT in similar ways to me"* (T10).

6.3 The effects of environmental context on use of ICT to enable capabilities

In teaching, it has been recognised that the response to new technologies is mediated by cultural views (Watson, 1998). Cultural views derive from the understanding applied by a group, based on common beliefs, values, customs, and habits. These influence the teaching practices (Jones & Maloy, 1996).

6.3.1 The effects of values on use of ICT to enable capabilities

Teaching is value-laden (Brady, 2011). Teachers bring different personal and professional values to the classroom. Values that inform professional principles and relationships include caring, respect, professionalism, commitment and cooperation. For some respondents teaching methodologies and ways of teaching with ICT were developed with values in mind: "*values do affect and pave the way I conduct myself, how I view the learners, teaching methodologies and the way I use ICT to teach"* (T4). For some teachers because of their values (such as honesty, hard working, loyalty and integrity), they sought the best way to teach. Therefore, teachers were willing to use ICT if it presented the best way to teach. However, instances, where they felt ICT was a distraction, they opted for other methods to achieve the best way to teach:

> *"I seek the best way to teach, and where ICT provides that, I would rather use ICT than other methods. However, where ICT is just a distraction, I would rather use another method".* (T7)

Some teachers felt that because of their values (such as honesty, kindness, being assertive, understanding and being compassionate) they always develop teaching materials with the learners' ability and performance level in mind. With ICT being an enabler, the teaching curriculum was adapted to suit the pace at which students learned:

> *"I always consider the children's ability when creating a task.* [ICT] *allows me to create differentiated work for learners that need to be* [advanced] *or learners that need work on an easier level to build their understanding".* (T8)

6.3.2 Habits, customs and beliefs and their influence on use of ICT to enable capabilities

Habits, customs and beliefs affected the way in which ICT was used in teaching. For example, some teachers had the habit and custom of keeping up-to-date with current affairs. ICT such as social media afforded immediate access to news and information. One stated that ICT "*Helps to keep up to date with current issues and also to* [find ways on how to] *use social networking to affect my teaching" (T4).*

Teachers felt that their character and spiritual faith dictated the type of person they were. This further dictated how they responded to situations at work and how they chose to teach using ICT:

> *"My character and spiritual faith dictate the type of person I am, which dictates how I respond to situations at work, and how I choose to teach".* (T7)

Another teacher felt that their beliefs helped in creating an environment where students felt at ease to carry out their style of learning. Furthermore, the habits, customs and beliefs guided teachers on teaching learners about the consequences of ICT. The teacher encouraged learners to think before using ICT:

> *"My beliefs have helped me to create an environment where learners are at ease with their learning style and understand that creating something different to the person next to you is acceptable. I encourage learners to be true to themselves and create work they can be proud of. I ensure that they are well aware of the negative side of ICT I make them aware that they must always think things through before using their device".* (T8)

6.3.3 The effects the environment on use of ICT to enable capabilities

Most of the respondents taught in schools located in urban areas and lived in urban areas. This translated into easy and ready access to ICT/electronic devices. The privileged nature of both the schools and environment of stay made teachers well acquainted with ICT:

> *"*[I am] *well acquainted with technology. Having had ready access to electronic devices, I am familiar with them".* (T3)

The affluent schools had easy access to the latest technologies: *"*[we] *have access to all the latest devices and apps. This has a huge impact on the way we use* [ICT] *in the classroom as we do not have any limitations"* (T8).

In the private schools iPad was part of the stationary requirements. This enabled a one-to-one learner computer ratio. This made it easier to integrate ICT into teaching:

> *"*[I] *am in a fortunate position where I teach* [in a] *privileged environment where our learners can access devices in a one to one situation, which makes the use of ICT easier to integrate*". (T6)

The environment in which the teacher grew up also affected their computer efficacy and consequently their use of technology for teaching. Some teachers were exposed to ICT as early as in primary school. By the time they were secondary school, they were able to use ICT confidently. Since ICT was already integrated into the lives of teachers, they made efforts to integrate it into their teaching:

> *"I was exposed to ICT as a primary school child and was using it confidently by high school. I have thus always integrated ICT in my own life, and have always sought to integrate it into my teaching as well".* (T7)

6.4 The effects of social context on the conversion of education technologies into capabilities

This section discusses how social context affected how teachers use ICT and on their choice to convert education technologies into educational outcomes. The characteristics of social context comprised of:

- **Social norms**: for example rules that govern behaviour
- **Social institutions**: for example public policies

6.4.1 Rules to address the risk of ICT usage

To prevent exposure to content that was discriminatory, explicit or of a violent nature and access to harmful content in the sampled schools:

- Learners were restricted from content that was discriminatory, explicit or of a violent nature

- Teachers reviewed software applications and curated them to ensure they met the age and the educational requirements of the curriculum.
- Learners could only access the Internet through child safe browsers such as K9 web protection, which is an Internet filter that enables parental control.

6.4.2 Government policy for ICT implementation into school

At a provincial level WCED provided a set of requirements for assessments for teaching and learning Schools were encouraged to have an ICT committee to build their own policies.

Types of school policies include:

- ICT user policy
- User acceptance policy

WCED did not interfere in the work of the committee or dictate how they should function. The flexibility given to schools on their policy making means that WCED had no control over the content and implementation of the policy. However, schools could ask for assistance from WCED. In general, the aim of policies (such as Western Cape E-learning policy) was to provide clarity to the reader when dealing with the accountability of activities.

This brings to question whether policies at the school level were aligned with the goals stipulated by those of the government. Besides the possible misalignment, a lack of control of what goes into a policy makes it difficult to make schools accountable for their policy goals.

6.4.3 Social norms and social institutions

The characteristics of the social context that impacted the educational outcomes included social norms (such as rules) and social institutions (such as public policies). A surprising finding was that although ICT had the potential to eliminate the extensive administrative load including the marking learner assessments, DBE required

learners to be assessed formally. A formal assessment in this regard referred to tests that are handwritten and under test conditions characterised by discipline and control. Even projects that were completed using ICT had to be presented to curriculum advisors in printed forms. This took away the freedom for teachers to use ICT as a tool that enabled them to eliminate or halve the administrative burden of marking. The inability of teachers to use ICT to assess learners also inhibited them from achieving their goals/value of improving learner competence:

> *"I would love to use* [ICT] *as a formal assessment because it will take off my marking load or half my marking load.* [ICT is] *better because it gives instant feedback and you can find out immediately where* [the learner] *made a mistake.* [This] *is what you want out of an assessment not what we end up with the handwritten tests. Where it takes a week to mark* [and] *give it back by then* [the learner] *has forgotten what his taught process was*". (RB_S_3:4)

6.5 Capabilities enabled for teachers through ICT

This section discusses the capabilities enabled to form capability outcomes for teachers in the study. Capabilities are enabled through capability inputs. They may be non-material such as culture, customs and societal structures or material such as technology. Enabled capabilities may be considered as realised functioning (doings and beings of teachers). The Capabilities enabled through ICT depended not only on individual differences of teachers but also on what teachers valued and had reasons to value (Hatakka et al., 2014). In line with Section 5.7.2, the main goals of teachers were to become better teachers in equipping learners to complete their school leaving examination. The lives teachers valued related to both the learner (such as learner enjoyment and successful completion of school leaving examinations) and teacher (such as achieving life-long learning, easy ways of teaching and ability to teach basic life skills). ICT enabled teachers to be and to do (see Section 5.7.3). The capabilities enabled for teachers through ICT are subdivided into education, basic human and community capabilities (see Table 6-4). Through ICT teachers were able to achieve their goals and in effect, their agency freedom in teaching. The capabilities will be discussed in subsequent sub-sections.

Table 6-4: Capabilities enabled for teachers through ICT

Capability outcomes	Examples
Enabled teaching capabilities	**Content delivery** - Being creative as a teacher - Being able to teach easily - Being a good teacher - Being able to access information - Being able to teach efficiently **Communication** - Being able to communicate learner results to parents quickly - Being able to communicate with learners **Lesson preparation** - Being able to save time during lesson preparations - Being able to have more time to practice subject content with learners - Being organised - Being able to make life less complicated - Being able to provide easy access to education
Enabled basic human capabilities	- Being confident to teach - New ways of communication - Keeping up to date
Community capabilities	- Being able to follow the exemplary teaching style of past teacher - Being able to greatly collaborate and share resources

6.5.1 Capabilities

Capabilities are the opportunities teachers may choose from to improve their lives. The opportunity to access extra resources for teaching (see Table 6-4), enabled teachers to help learners understand the subject content better. The empirical findings established that the role of ICT in teaching included enabling access to simplified explanations for complex topics. This enabled teachers to help learners understand the subject content better.

An English teacher valued the opportunity to access different versions of plays; in this particular case of Macbeth playwrights where there was the BBC version and the South African version. Through ICT lessons were more interactive and the learners

were more involved. With the ability to access information through the Internet learners could share information on the subject content and engage critical discussions. For the English teacher ICT, enabled her to be creative:

> *"…The BBC version* [of] *Macbeth* [is] *the more modern version. I can show* [learners] *a South African* [adaptation of Macbeth]. [I can show them] *how things have been adapted. What worked and what didn't work. I think it allows more creativity* [in teaching]*".* (SHS_E16)

Furthermore, during the lessons delivery ICT aided the presentation of graphical images. Since the graphical images aided learners in visualising what was being taught, the time spent providing a detailed explanation to learners was reduced. ICT, therefore, helped teachers to be efficient in content delivery, reduce teaching time and increase the time for teachers to attend to learner queries.

Teachers saw communication with learners outside school hours as a good opportunity for outcomes to be generated. Through a WhatsApp group, a teacher could convey important announcements to learners. The WhatsApp facility also enabled teachers to assist with questions raised by the learners during the completion of assignments. ICT, therefore, aided teachers to communicate with learners. These findings are in agreement with studies which states that communication through Social Network(ing) Sites has an important role to play in extending the scope and setting which teachers and students communicate beyond the school boundaries regarding time and space (Forkosh-Baruch, Hershkovits, & Greenhow, 2017). Instant messaging applications, for example, WhatsApp enable quick, interactive multimedia communication in one on one teacher-student interaction. As a popular application, it is regularly used by both teachers and students for group communications (Rosenberg, Ophir, & Asterhan, 2018).

Effective teacher communication is important for classroom management and the transmission of education (Khan, Khan, Zia-Ul-Islam, & Khan, 2017). Good communication includes the ability to listen and clearly explain concepts. The findings in the study are in agreement with the literature, which indicates that ICT aids teachers to communicate with learners and other teachers anywhere and at anytime.

This study established that although teachers valued face-to-face communication, they saw ICT as the middleman that connected the teacher to the learner. Teachers encouraged learners to interact with them at the staff room during school hours, however after school hours ICT (such as Google Classroom) enabled question and answer sessions between teachers and learners for clarification of topics or communicate.

> *"…It's strictly an after hours thing students know after hours I use Google Classroom platform to allow students to ask a question".* (RB_G28)

For teachers, ICT enable them to break down social walls created through the limitations of the four walls of the classroom. Gaming technology for teaching architecture, for example, Mind Craft gave the freedom for new communication channels to open, new ways of thinking, new ways of talking and new ways of understanding.

> *"…* [At] *the moment we use simple gaming technology for example, Mindcraft to teach Architecture and SimCity to teach urban management. The moment that different technology was introduced that the* [learners] *find relevance* [through] *new communication channels new ways of thinking".* (RB_G28)

Teachers valued opportunities to organise their schedule and lesson plans through ICT. Applications such as Evernote and Notability were used to keep track of notes. These applications aided the preparation of teaching. This enabled teachers to be more organised and have a less complicated life. Opportunities to prepare lessons in advance through ICT are valuable. This helped teachers to be efficient during lesson preparations.

With the short time available to complete the curriculum teachers found opportunities for lesson recordings through ICT valuable. They utilised applications such as Doceri on the iPads to record lessons and create Flipclass screencast videos. In this way, students could learn outside of the normal school hours then work (complete exercises) in the classroom. The flip classroom process enabled teachers to gain more time to help learners carry out practical exercises in the classroom and resolve difficulties with subject content:

> *"…Movement in education called the flip classroom. The mathematics curriculum is so full that we teach a topic in class I say to* [the learners] *right go home and practice it. I do not have time the next day to spend the whole lesson on helping you. So we would do a couple* [of lessons] *and then move on* [to a new topic] *because otherwise, they are not going to finish* [the curriculum]*. So* [with] *the flip classroom they learn at home and practice in class. So* [the teacher is] *helping [the learners]".* (PLH_MS27)

6.5.2 Basic human capabilities

Basic human capabilities are the freedom to do basic things necessary for survival to eradicate poverty or avoid serious depravations (Sen, 1992). It refers to an individual's fundamental and crucial functions associated with their well-being (Sen, 1992). This includes literacy, ability to communicate and confidence to teach. For example, being literate is essential because it enables more choices for teachers (Kannan, 1999).

The benefit of ICT (such as Internet) is that it exposes teachers to diverse resources on the Internet and enables the teacher to improve their ICT literacy and programming knowledge. This finding is in agreement with those of Hatakka, Ater, Obura, and Mibei (2014) whereby the benefit of ICT training for the research participants was that it helped them to gain IT knowledge and IT literacy. Increased use of ICT enabled the teachers to familiarise themselves with the technology and deal with technical issues. With time, teachers gained better ICT skill and knowledge. Continued learning enabled through continued interaction with ICT increased teachers' confidence to teach.

> *"… The more you work with ICT,* [the more] *confidence* [you gain]*. [You] are never too old to learn".* (CA_ IT54)

An interesting finding on the effects of ICT on teacher confidence is that teachers felt a computer is like a companion (friend). For teachers, having a computer in the classroom was comparable to having a friend. These made them feel less intimidated. Through ICT the teachers felt less vulnerable. This is because when learners asked difficult questions, teachers used ICT to access information for clarity purposes. This increased the confidence of teachers.

> *"I think I would feel a lot more intimidated if I was standing* [in front of the class] *and teaching. As weird as it sounds that computer it is almost like a friend that you have over there. You are not alone, so you are not so exposed".* (GC_MT46)

Previous studies on teacher confidence relate to their knowledge acquisition and classroom practice (Vartuli, 2005). Teacher confidence is directly affected by levels of personal access to ICT, levels of technical support and the quality of training available (Nikolopoulou & Gialamas, 2015).

6.5.3 Community capabilities

The capabilities enabled not only relate to the teacher alone but also the teaching community. The teaching community is a professional learning community (Ryymin, Lallimo, & Hakkarainen, 2007). It consists of teachers that share resources and expertise. They work collaboratively to improve teaching and learner academic performance (Ryymin et al., 2007). For GC_M (a Physical Science teacher) ICT enabled the achievement of the goal to become as good as her High School Physical Science teacher. The past Physical Science teacher set a good example of teaching, and ICT assisted with obtaining test papers compiled by the past Physical Science teacher (GC_M25).

ICT enabled some teachers to improve their teaching by enabling them to share content. This is because ICT enabled a collaborative and sharing environment. It opened opportunities for learning.

> *"we are using the iPads. There are constant updates* [and new applications to discuss and share information on]*, I think it's a wonderful learning opportunity for any teacher".* (PL_A12)

With access to data projectors, Wi-Fi and Cloud storage platforms, teachers collaborated more with one another. This was achieved by a continuous discussion on subject content, relationship building and resource sharing (PLH_LS40).

6.6 Agency – actions that enable an effect

ICT played a role in supporting teachers' agency through various choices of educational resources available. Furthermore, through access to vast resources teachers were enabled to take responsibility for their learning. Options of tools used to access to information included the TV. However, with the Internet, teacher's felt that they could access information that was seen as valuable and that enabled meaning making. Therefore, through information searches on the Internet, the teachers gained agency by being able to take responsibility for their learning and develop their meanings.

The choice of the technologies the teachers used depended on their skills level. Some teachers were technologically competent and some lacked the skills to use ICT. Therefore, the level to which ICT was used depended on what teachers could do, their potential, what they were capable of doing and felt comfortable with. For the choice aspect, teachers had the option of choosing between different educational resources. To access to the explanation of specific topics, teachers could find information in their prescribed textbooks. The textbooks also provided examples of how a topic could be explained. Teachers also had the option of gaining resources provided by WCED. However, the resources from both prescribed textbooks and WCED did not have workbook exercise activities. Therefore, the textbook and resources gained from WCED were seen as insufficient. Teachers felt that learners were often uninterested with the books and preferred to use ICT (such as the Internet). To remedy this, the teachers had the option of tasking learners to expand outside of their box and look for information using ICT.

6.7 Summary of chapter

This chapter presented empirical evidence to aid in answering the research question of the study. The results show that the capabilities enabled through the use of ICT include teaching, basic human and community capabilities. Although the majority of the sampled schools were well resourced the administrative load and lack of diversity in educational resources prevented teachers from effective use of ICT in teaching.

Individual differences affected the enabling of opportunities and the choice of teachers through the use of ICT. A choice is dealt with in the next chapter.

CHAPTER 7 : DISCUSSION OF FINDINGS

7.0 Introduction

The previous chapter presented the analysis of empirical data collected. This chapter discusses the thematic outcomes of the research findings focusing on the effects of teachers' ICT use in teaching. The chapter discusses the effects of teachers' ICT use in teaching. This is followed by a discussion of the teacher's choice to use ICT to achieve educational outcomes. Teachers who shared common interests concerning ICT in education formed groups to share ideas, skills and solution-based methods we framed these groups as community of practice. Details on how communities of practice were developed, what practices were carried are discussed.

The main research question in the study is: *"How are educational outcomes generated for teachers through the use of ICT in teaching in developing countries"* The sub-questions along with their answers are summarised in Table 7-1.

Section 7.1 provides the effect of ICT on teachers in teaching. Section 7.2 presents teachers' choice to use the opportunities afforded by ICT to achieve educational outcomes. Section 7.3 presents the effects of communities of practice in the use of ICT on teaching. Section 7.4 summarises the chapter.

Table 7-1 Research sub-questions and answers

Research Questions	Explanation
How do ICT affect teachers in teaching?	The effects of ICT on teachers in teaching
What educational outcomes do teachers generate through the use of ICT in teaching?	The effects of the community of practice on the use of ICT in teaching
What educational outcomes do teachers aspire for?	The lives teachers value (see 5.7.3)
How do teachers' individual differences affect their ICT use to generate teaching outcomes?	How individual-level factors influence the conversion of opportunities enabled for teachers through ICT into educational outcomes (see 6.1)

7.1 The effects of teachers' ICT use in teaching

The findings indicate that ICT enabled teachers to generate educational outcomes. Specifically, ICT enabled teachers to generate community and basic human capabilities to communicate, deliver content and prepare lessons better. Educational outcomes generated through ICT include improvements in lesson preparation, differentiated teaching and improved learner results as summarised in Table 7-2.

Table 7-2: Summary of the effects of teachers' use of ICT in teaching

Category	Summary of discussion
Improvements in lesson preparation	• ICT was used to prepare lessons in advance, this enhanced the teaching by allowing more time for teachers to attend to learner queries
Improvements in learner results	• For top achiever learners, ICT presented extra resources to prepare for assessments. • For the poor performing learners, ICT enabled learners to be conversant with the curriculum.
ICT enable differentiated instruction	• ICT enabled the teacher to achieve differentiated teaching. Thus teachers could teach according to the ability of the learners.

Section 7.1.1 through 7.1.3 will discuss these effects in turn.

7.1.1 ICT helps teachers to improve lesson preparation

The study noted that ICT-enabled teachers to improve the productivity of conducting daily activities such as lesson preparation (Chen, 2010; Comi et al., 2017). Lesson preparation involved preparing presentation slides (such as PowerPoint). The content included images obtained from the Internet. For teachers, multimedia, for example pictures, simplified the explanation of complex concepts. Preparing lessons in advance helped the teacher to save time. Lessons prepared in advance could be quickly displayed for learners. This eliminated the need for teachers to write full lessons on the board. This afforded the teachers more time to attend to learner queries. Furthermore, the images obtained from the Internet may be of better quality than one drawn on board:

> *"First I do not want to go to a class and spend 15 minutes of my time writing notes on the board. I can spend one hour of my time* [at home] *preparing* [lessons for projection in a short period]. *I do not want to spend too much time trying to explain a concept. Technology helps me because all I need to do is Google a picture of what I am talking about. Have it showed so I do not* [have] *to describe it and tell them it is a circle and it looks like this and that and* [learners] *can see* [the picture]*".* (CA_ITB24)

This finding corroborates studies which state that ICT helps teachers to gain further material to prepare lessons (Comi, Argentin, Gui, Origo, & Pagani, 2017). Other studies, however, state that although backstage activities may improve the quantity and the quality of materials used to prepare lessons, the actual use of ICT to achieve an interactive classroom environment may be time consuming (Comi et al., 2017).

7.1.2 Improvements in learner performance

From the empirical findings the teachers highlighted many benefits of ICT use for teaching. The direct relationship between ICT and improved learner results is inconclusive. Studies on the link between ICT and learner performance have mixed results. A link established by researchers is that ICT increases learner performance if it helps teachers gain further materials to prepare lessons or aid the transmission of teaching materials (Comi, Argentin, Gui, Origo, & Pagani, 2017).

The study expands on literature with teachers citing that for both high performers and low performers ICT acted as a resource to aid the learning process. The actual improvement of learner results depended on learner related factors. For example, the performance of a top learner-achiever was influenced by learner related factors (such as diligence, proactive work, discipline and intelligence). These learners performed well with or without ICT. The role of ICT in this regard is that it presents extra resources for these learners to prepare for assessments. For the low learner, achiever, the role of ICT was that it enabled them to be conversant with the curriculum.

7.1.3 ICT-enabled differentiated instruction

A thematic outcome of the study is ICT enabled teachers to carry out differentiated instruction. Differentiated instruction is when a teacher delivers content according to the different abilities and learning styles of students (Eaddy-Busch, 2014; Gibson, 2005). Generally, different students learn in different ways and use different bits of intelligence. Students use their strongest intelligence (Strong, Silver, & Perini, 2001). The teachers need to consider the various bits of intelligence and develop instructions that incorporate a variety of intelligence (Strong et al., 2001). Differentiated instruction is derived from the idea that students learn from different bits of intelligence (Armstrong, 2009):

- Logical/Mathematical,
- Verbal/linguistic,
- Musical,
- Visual/spatial,
- Bodily/kinaesthetic,
- Interpersonal
- Intrapersonal and
- Naturalist intelligence.

The empirical evidence shows that ICTs enabled teachers to cater to the various bits of intelligence. Through ICT, teachers could teach according to the ability of the learners.

7.1.3.1 Strategies for differentiated instruction

In the sampled schools, learners in the Foundation Phase class were given work based on the respective ability level (Purpura, Baroody, & Lonigan, 2013). Teachers could identify the learners' level of understanding in a specific skill and provide activities that were suitable for their respective level (Shanley, Clarke, Doabler, Kurtz-Nelson, & Fien, 2017).

Furthermore, learners that needed extra work in Mathematics were taught at the level in which they understand. For example, the learners that were competent and had completed their activities in Mathematics were tasked to work in pairs in which they could discuss specific topics. ICT, for example, iPads helped teachers to provide less capable learners with tasks that are suitable for their ability level and enable the competent learners to be motivated to learn independently.

> *"In our foundation phase classrooms, every single child gets their work at their ability level. We have the technology so we can make that possible. If* [a learner is] *doing the same concept in Mathematics but is* [a learner is] *working in this number range I can give that to you easily through the use of technology". (*PL_B16)

Differentiated teaching meant that teachers sometimes taught the class as a whole or in small groups of learners and ICT was an enabler. In a lesson, teachers initially conduct an introductory discussion of ideas with the whole class and then arrange small group or pair work (according to learners' competency level) (Suprayogi, Valcke, & Godwin, 2017). This confirms the empirical findings of the study, which indicate that in the beginning of a lesson the teacher, introduced the subject topic to all the learners and then assigned tasks for completion. On some occasions, the teacher grouped learners in small groups and taught them according to their abilities. Through the use of ICT, the teachers could help learners that were behind in their work to catch up and allow the learners that were ahead to proceed and explore different topics of interest:

> *"… It allows differentiating learning which is a big thing it allows me to catch the kids who are slightly behind and also let the ones that are going ahead rush ahead and go and explore any topic that peaks their interest".* (RB_S19)

Table 7-3 summarises differentiated teaching strategies in the study.

Table 7-3: Summary of differentiation instruction strategies

Category	Example
Learners are given lessons according to their level of understanding	
Learners are given lessons based on their competency levels of learners	ICT help teachers to provide low performing learners with tasks that are suitable for their ability. ICT enable the high performing learners to be motivated to learn independently
Teach learners in groups	
Cater for differences in the time learners take to complete tasks	Through the use of ICT, the teachers could help learners that are behind to catch up and allow the learners that are ahead to go proceed and explore related topics

7.1.3.2 Outcomes of differentiated learning

Students that are allowed to carry out the problem-solving task with their preferred intelligence have better opportunities to succeed in their learning (Kovtiuh, 2017). Differentiated teaching was achieved in schools with 1:1 learner per computer ratio. Through a 1:1 learner access to ICT, teachers were able to teach the syllabus in a way that accommodated the skill level of the learner within the classroom context. Teachers in schools that did not have a 1:1 learner-to-computer ratio but were well resourced, were able to cater for the differences in the skill level. For example, teachers emailed class notes to children with special needs who could not learn as fast as the rest of the students in the classroom:

> *"… I have one or two learners with special needs who to whom I email the notes they cannot keep up in class what ever the case may be or if they are absent. That would be difficult with the white board notes".* (PLH_M24)

The findings show that differentiated instruction demands a large amount of work on the part of the teacher. This finding is supported by studies that suggest that

adjusting the instruction to suit the needs of the student becomes difficult as the heterogeneity in classroom increases (Smets & Struyven, 2018). To manage differentiated teaching, additional requirements on teacher skills are needed to adapt content to the needs of individual students (De Neve, Devos, & Tuytens, 2015). The significance of ICT is that the different application helps the teacher to create tasks that suit the ability of the learners. Furthermore, differentiated instruction required teachers to have time management skills and an understanding of the competency level of the learners to manage differentiated teaching properly.

***Proposition 1**: When teachers use ICT they are able to develop teaching and learning environments to assist different learner intelligence levels.*

7.2 Teachers' choice to use ICT to generate educational outcomes

ICT enhances an individual's ability to access information and new knowledge. It creates more opportunities for an individual to choose the life they value. Choice is deciding to act on opportunities available (Hatakka et al., 2016). This means that given the right opportunities and capabilities an individual is free to decide whether they value that opportunity. In contrast, the contextual factors such as personal, social and environmental characteristics such attitude, illiteracy, lack of infrastructure could affect an individual's decision to choose to use the opportunities available.

Various factors affected the choice of teachers to act on the opportunities afforded by education technologies. These factors include:

- Infrastructure,
- Learner engagement and excitement, and
- ICT skills training.

7.2.1 The effects of infrastructure on teachers' choice to use ICT to generate educational outcomes

The choice to use ICT in teaching and to convert it into educational outcomes was influenced by access to working computing infrastructure. Inadequate access to functioning ICT facilities (for instance, poor infrastructures such as out-dated hardware and software) made it difficult to teach with ICT. If a teacher struggled to make a computer work they would be discouraged to use it: "[ICT is] *valuable if it is working otherwise it just becomes a frustration and then we would have used a different method to get the results that we needed"* (GC_B17). For example, poor Internet connectivity makes it difficult to carry out tasks in a productive and efficient manner (Comi et al., 2017). Without the necessary support from school administration and technical support, teachers will be discouraged to use ICT in their teaching (Chen, 2010). This corresponds Lwoga and Chigona's (2020) findings that rural women's choice to convert their capabilities into achieved functions is influenced by specific factors. These factors included inadequate number of computers, frequent power outages, poor Internet speed in telecenters, which inhibited rural women form using the centers.

Proposition 2: *When there is poor infrastructure, teachers are not able to use ICT and to choose to convert ICT into educational outcomes.*

7.2.2 The effects of learner engagement and excitement on teachers' choice to use ICT to generate educational outcomes

Learner engagement and excitement contributed to the choice for teachers to use ICT and to convert it into educational outcomes. Interactive software encouraged students to learn together by sharing ideas, resources and skills (Kao & Harrell, 2017). Game-based applications such as Kahoot encouraged learners to participate and they were excited when answering quizzes in the gaming environment. Teachers chose the applications that helped learners get excited about answering questions. However, to sustain the learners' excitement, the teachers avoided using one application in every lesson. Similarly in Rodrigo et al.'s (2019) study teachers felt that

learners were motivated to learn English through online gaming platforms. Thus the online games (e.g. Defence of the Ancients) were very popular amongst students.

> *"My biggest factor* [for using ICT is] *the reaction of the boys its a crowd reaction thing its a performer thing. You stand there you feed on the reaction. If* [the learner] *are going sit and not react when I do a quiz I do not do it again cause then the enthusiasm is gone and the effect I was going for is lost".* (RB_S22)

Proposition 3: *When learners engage with the teacher and are excited to use ICT, teachers choose to use ICT to generate educational outcomes.*

7.2.3 The effects of ICT skills training on teachers' choice to use ICT in teaching and to convert ICT into educational outcomes

The choice made by teachers to use ICT in their teaching and to convert ICT into educational outcomes is influenced by their ICT. As part of the bodies of knowledge in TPACK technological content knowledge (TCK), technological pedagogical knowledge (TPK) helps to effectively teach with technology. Technological knowledge educators are expected to have at the least basic computer literacy skills in order to integrate ICT into schools' curricula. Technology knowledge (TK), advocates that basic computer literacy alone is not adequate and that ICT skills should transcend beyond the traditional idea of computer literacy to a broader understanding of information technology (Koehler & Mishra, 2009). With technological content knowledge, ICT enabled educational practices, the choice of technology influences (affords or constrains) and the type of content ideas that can be taught (Sahin, 2011). Similarly, decisions on the subject content can limit the types of technologies that can be used. As a result, teachers need to master the subject content in which they teach. Therefore, technology and content knowledge (TCK) signify the understanding of the relationship between technology and content and how they influence and restrict one another. It is the understanding of how teaching and learning can change when particular technologies are used in particular ways. It requires one to know pedagogical affordances and constraints of a range of technological tools as they relate to disciplinary and developmentally appropriate pedagogical designs and strategies. Understanding the impact of technology on the practices and knowledge of a given discipline is critical to developing appropriate

technological tools for educational purposes (Archambault & Crippen, 2009). With technological pedagogical knowledge, due to their transformative nature, certain technologies can alter the teaching and learning process. Technology pedagogical knowledge (TPK) is concerned with understanding how technologies change the classroom practices. It also seeks to understand the pedagogical affordances and constraints of a range of technological tools in developing appropriate pedagogical designs and technologies. Understanding the impact of technology on the practices and knowledge of a given discipline is critical to developing appropriate technological tools for educational purposes (Niess, 2011; Paciga, Fowler, & Quest, 2019).

Teacher ICT training is meant to provide teachers with the necessary competencies to teach with ICT (Tondeur, Aesaert, et al., 2017; Tondeur, van Braak, et al., 2017). A lack of ICT skills training means that teachers cannot use ICT effectively to achieve their educational goals. It further discourages teachers from using ICT in teaching.

> *"I feel like the training is not enough from I would expect it that the department to do more for the teachers to empower the teachers in using technology. Often teachers are given pieces of the technology, but they do not know how to use them, but there is nothing the department does in order to empower those people".* (CA_ITB15)

The technology pedagogical and content knowledge (TPACK) is a framework that seeks to aid effective teaching with technology. It can be used to explain how teachers understand educational technologies and pedagogical content knowledge (PCK). The framework consists of three interrelated components. These are based on teachers' knowledge content, pedagogy and technology.

Proposition 4: *When teachers are not given adequate ICT skills training they choose to not use ICT to generate educational outcomes.*

7.3 The effects of communities of practice on use of ICT in teaching

The study noted that the teachers formed informal (and formal) groupings to support each other's use of technology. We framed this as community of practice. Communities of practice (CoP) are group of people that have an interest in ICT in teaching. CoP enables teachers to improve their use of ICT in teaching. This section

discusses CoP members who interact and learn together. It highlights sharing of ideas for ICT in teaching which are the main purposes of the CoP amongst the sampled schools. Ways in which CoP was developed in the sampled schools are presented.

7.3.1 An overview of the concept of community of practice

A CoP is a group of people with common interests or goals (Wenger, McDermott, & Snyder, 2002). Members of the group interact to share ideas, topics of interest, ability, skills, present problems or solutions and foster learning on an on-going basis (Wenger et al., 2002). Continued interaction amongst members in the CoP helps deepen understanding of mutual areas of interest. The key characteristics of the CoP include domain, community and practice (see Figure 7-1).

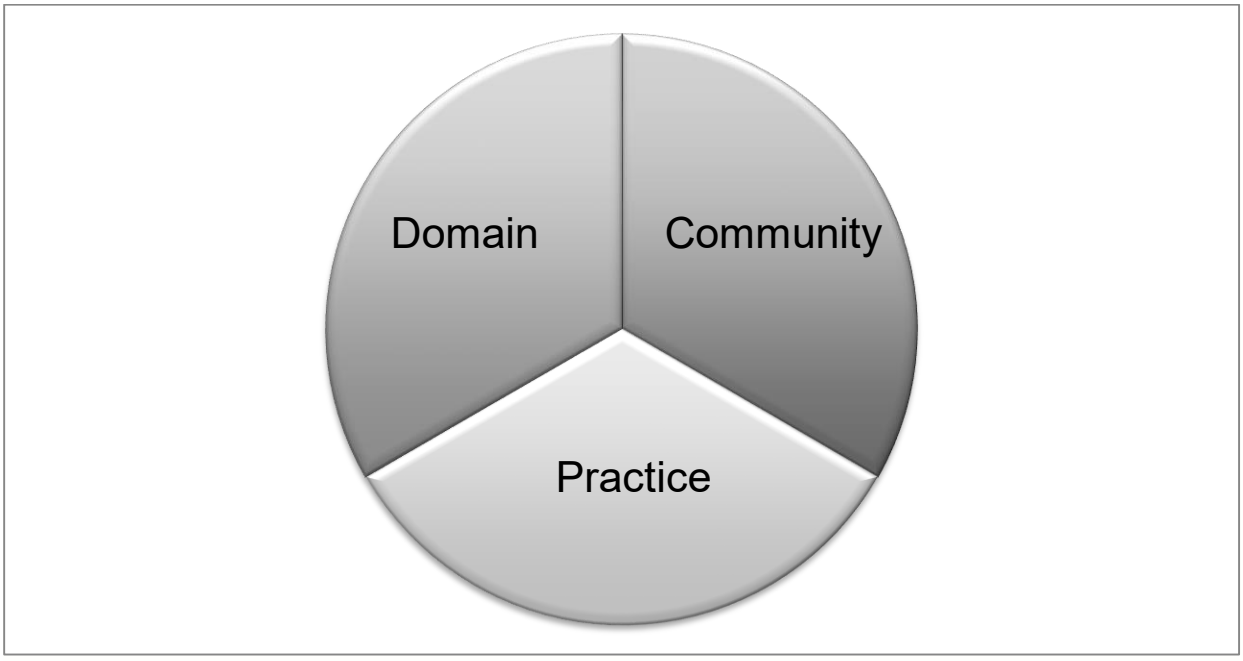

Figure 7-1: The characteristics of communities of practice

Domain: A domain is a shared area of interest. Members of CoP have similar expertise that is unique to the community (Lave & Wenger, 1991). An area of interest and expertise could be using mobile technologies to teach Mathematics.

Community: A community is members of the CoP that are drawn together based on a shared interest and engage in joint activities and discussions. They help each other and share information as well as resources. Relationships amongst the members are built to encourage learning amongst members (Cox, 2005).

Practice: A practice is when members of a CoP engage in the practice of a profession or occupation. Based on experience and knowledge, members of CoP develop a collection of resources that are shared amongst them. The practice is developed over time and through continued interaction. With the practice, members of the community make a collaborative effort to collect and document tips and tricks and lessons are learned.

Table 7-4 summarises the community practice carried out by teachers.

Table 7-4: Community practice of teachers

Types of practice	Examples of practices
Problem-solving	Finding ways to and develop ideas on a teaching and learning design
Share important Information	Finding past examination papers on a computer server
Reusing educational resources	Gaining an old examination paper and adjusting it for reuse
Coordination and collaboration	Developing a schedule for access to ICT in the English lessons
Discuss new developments in educational software	Sharing ideas on a new application for Mathematic
Document problems	Compile the trouble-shooting steps for repetitive problem for future reference.
Organize school visits	View ICT in teaching practices at schools

7.3.2 The sharing of ideas for ICT in teaching

WCED initiated CoP by forming clusters consisting of teachers from different schools. The CoP helped teachers share ideas for ICT in teaching methods that were

practised in some schools in the province. The CoP involved members of the communities who had a mutual interest in improving their teaching in ICT practices. Information sharing and explanations on how to implement existing ICT in teaching methods characterise actions within these communities. Teachers from different schools in the province interacted, communicated and shared information.

The CoP was developed amongst teachers from different schools. CoP aimed to enable teachers to gain ideas and improve their current ICT in teaching methods. The CoP involved teachers who have interests in ICT in teaching. Teachers attended education and training conferences to gain skills for areas such as the deployment of ICT and its integration of into schools' curricula. The conferences also provided opportunities for teachers to share ideas and gain feedback from other teachers on ICT in teaching methods. Examples of these conferences included EdTech Team Summits (www.edtechsummitafrica.com) and iPadSummitZA (www.isasa.org).

Proposition 5*: When teachers share ICT knowledge and teaching methods, CoP is enabled and has the potential to improve ICT use in teaching and learning.*

In general, CoP was established amongst teachers who have common goals to improve teaching practices, for professional development and growth as well as lifelong learning. This learning process is enabled through regular sharing amongst teachers who are interested in ICT integration into schools' curricula:

> *"ICT has opened more opportunities for me to* [be a] *learner. I think that teachers who are passionate about IT integration are sharing and never experienced* [this] *before the exposure to the iPads".* (PL_A12)

Vandeyar (2013) noted that CoP was developed amongst teachers in South Africa. The teachers within these communities had mutual interests in a particular domain. Activities within these communities were characterised by the sharing of concerns about how ICT pedagogy and curriculum integration could be improved (Vandeyar, 2013). Members of the CoP engaged in joint activities and discussions. The aim of these communities was for teachers to help each other and to share information. Additionally, an inventory of resources containing experiences, tools, ideas and

problem-solving techniques is shared amongst members of the community (see Table 7-5).

Table 7-5 Purpose, types and characteristics of COP to share ICT use in teaching ideas

Type of CoP	Characteristics of the CoP		
	Domain	**Community**	**Practice**
Established by WCED	Implement existing teach in ICT methods	Teachers with a shared interest in ICT in teaching.	Problem-solving, request for information, mapping knowledge and identifying gaps. Interact continually, communicate and share information.
Established by DoE amongst teachers in WC	Gain ideas on improving current ICT in teaching methods	Teachers who regularly attend conferences based on shared in ICT in teaching methods.	Problem solving, request for information, experience seeking. To share ideas and gain feedback on ICT in teaching methods.
Established amongst teachers within the school	Improve teaching practices, professional development and growth as well as lifelong learning.	Teachers who wish to improve their teaching. Learning for these teachers is enabled through regular sharing amongst teachers who are interested in ICT integration into schools' curricula.	Request for information, mapping knowledge and identifying gaps.

The purposes of communities of practice were sharing ideas for ICT in teaching (as indicated in Table 7-5) and sharing of ICT knowledge (as can be seen in Table 7-6).

Table 7-6 Purpose, types and characteristics of CoP to Share ICT knowledge

Type of CoP	Characteristics of CoP		
	Domain	**Community**	**Practice**
Sharing knowledge on specific ICT	Teachers who use specific ICT (such as, iPads)	Teachers who have interest in specific ICT (such as, iPads). These teachers share information of latest software continually	Request for information, discussing developments.
Sharing of technical ICT knowledge	Of the community are teachers who use ICT.	When teachers are uncertain on how to use an ICT artefact they are assisted by other teachers who act as IT technicians:	Request for information, seeking experience

The sharing of ideas of ICT in teaching involves teachers who interact continuously to request information, gain solutions to problems and seek knowledge based on experiences. Similarly, CoP is characterised by the continued sharing of ICT knowledge by teachers.

ICT knowledge was sometimes shared during training sessions. Teachers organised sessions to share their ICT knowledge. The information presented in these sessions depended on the questions posed by the teachers. The challenge with these sessions is that ICT skills competency level generally differs from person to person (Zubković, Pahljina-Reinić, & Kolić-Vehovec, 2017). For example, one teacher may struggle with basic computer literacy such as switching on a PC. However, another teacher may understand everything but would want to experiment with a particular application. To ensure that ICT skill training accommodates the competency level of all teachers, the focus is on basic computer literacy. Teachers that are advanced in their ICT knowledge find the basic computer literacy inadequate and frustrating:

> *"Teachers will run* [the training]. *If you thought I am good at doing xyz on the iPad, I am willing to run a course on that and then they will do it. They just ran an iPad course that had no curriculum because it was based on the questions of the people who were in the seminar. Different people with different levels, so this teacher does not know how to switch it on, but that teacher understands everything but wants to try out this particular application.* [Therefore, the training is] *quite flexible we do not have kind of rigid structure."* (PLH_M10)

7.4 Summary of chapter

This chapter has presented a discussion of research results. The chapter sought to describe the significance of the study in comparison to the body of knowledge to explain new understandings and insight into the problem. This was achieved by discussing how the use of ICT improved efficiencies for teachers in their teaching by enhancing lesson preparations and enabling differentiated instruction. Additionally the chapter highlights the choice for teachers to generate educational outcomes.

CHAPTER 8 : CONCLUSION AND RECOMMENDATIONS

8.0 Introduction

This study investigates how teachers' educational outcomes are generated through ICT within the personal, socio-cultural, shaping and influencing factors and environmental contexts. Chapter Six presented findings of the study and Chapter Seven presented a discussion of the themes that evolved from the data analysis process and their implications for theory. This chapter concludes the study.

Section 8.1 provides an overview of the research. Section 8.2 presents the contribution made by the thesis. Section 8.3 gives the limitation of the study. Section 8.4 suggests a possible future research direction. Section 8.5 provides a personal reflection while section 8.6 presents the final words from the researcher.

8.1 Overview of research

The objective of the study was to understand how teachers' educational outcomes are generated through ICT within the socio-cultural context of individual differences. A summary of the findings is presented in Table 8-1.

Table 8-1: A summary of how teachers generate educational outcomes through ICT

ICT as a Capability Input	Affordances of ICT	Lives teachers valued and Goals	Capabilities	Educational outcomes	Individual differences
• Manipulating text and data (such as Word, Excel and Access) • Presentation and dissemination (such as the web, PowerPoint and Adobe) • Personal management (such as Google calendar) • Communication (such as email, chat and bulletin boards) • Evaluation and assessment (such as Kahoot, Go Formative, Flubaroo, Quizlet and Book creator) • Video sharing platforms (such as YouTube) • Cloud storage (such as Drop box, Google classroom) • Lesson recording and video creation (such as Doceri) • Capture, organise and share notes (such as Ever note, Notability) • Social networking (such as WhatsApp and Facebook) • Educational learning network for creation and management of online classroom community (such as Edmodo) • Computer-aided mathematics and science instruction (such as Cami Maths, Heymaths!, Heyscience!) • Programing language for the creation of interactive stories games and animations (such as Scratch) • Integrated development environment (such as Delphi, Java)	• Content presentation • Content creation • Assessment tool • Cloud Storage • Communication	**Goals** • To be better teachers • Cover the syllabus and for learners to understand the subject content • To make learners happy • For the career development of the learners • To become like the previous physics teacher • Enable access to good education • Improve the education delivered • To improve human capital by ensuring learners complete examinations • Learner enjoyment and happiness **Lives of value** • Teaching for learner enjoyment and happiness • Learner successful completion of examinations • Learner success • Lifelong learning • Teaching basic life skills • Easy ways of teaching • Change • Teaching and learning	• To access information and extra resources • To share resources and ideas • To communicat e • To be organised • To prepare lessons in advance • To ensure learners' successful completion of examination s • To ensure learner success	• Availability of immediate access to learner performance • Better information access • Better personal and professional organisation • Better lesson preparation • Anytime and anywhere communication to parents and learners • Easier ways of teaching • Being a creative teacher • Being confident to teach • New ways of communication • Being able to greatly collaborate	**Personal data** • Age • ICT skills training • Education and level of expertise in the subject 1. **Shaping and Influencing factors** 2. Personality types 3. Role model 4. **Environmental context** 5. Habits, customs and beliefs 6. Cultural values 7. Demographic characteristics of the place of stay 8. **Social factors** 9. Government level policy 10. School level policy

The research question for the study is: *"How are educational outcomes generated for teachers through the use of ICT in teaching in developing countries?"* This was evaluated by studying how ICT enables opportunities for teachers and how these opportunities are transformed into educational outcomes within the restriction of individual differences (personal data, social, shaping and influencing and environmental factors). The study demonstrates a link between ICT and educational outcomes. It uses CA to provide a theoretical explanation in cooperation with other theories that fit into the CA ideologies and highlights socio-cultural factors of the individual. Teachers require access to ICT for use in their teaching. Its features and what it affords the teachers to achieve in their teaching drive the way ICT is used in teaching. The study looked at the affordances offered by ICT to enable insights on the opportunities ICT offers. Even though ICT affords opportunities for teaching, the use of ICT is affected by teachers' goals and what they see as valuable. ICT in teaching should be designed to meet the needs of teachers and consider the values and goals of teachers. Teachers value learners' successful completion of school-leaving examinations, learners' understanding of subject content, improved teaching, and learner competency. Teachers perceived access to varied and extra educational resources, personal organisation, lesson preparation, learner assessment, resource sharing, storage of educational resources, immediacy in communication to both learners and parents and of access to learner results, subject delivery and diverse educational experiences as useful; this encourages them to use ICT to aid teaching.

The study found that easy access to ICT has a positive influence on its use. A characteristic of the environmental context of most of the teachers was that they taught in well-resourced schools with ICT infrastructure. The study found that the administrative load and lack of diversity in educational resources prevented teachers from effective use of ICT in teaching. Teachers used ICT to aid presentation tasks, lesson note development, assessments, and communication to learners as well as communication of learner results to parents. Only a few subject-specific educational applications were recorded. For example, subject-specific applications (such as CAD) were used in Engineering and Graphic Design to automate drafting processes and for design as well

as technical documentation. Other subject-specific applications (such as Google Earth, Google Maps and GIS) were used for delivery of Geography. Consequently, applications (such as Cami Maths, HeyMaths! and HeyScience!) were used for the delivery of Mathematics and Science.

The opportunities generated from ICT use for teachers went beyond teaching capabilities and included basic human and community capabilities. The use of ICT in teaching has the potential to:

- Enhance content delivery and creativity, access to information and teaching efficiencies,
- Enhance communication skills between teachers and their learners or parents, and
- Enhance lesson preparation by saving time and enabling the teacher to be organised.

In addition, it can enhance basic human capabilities by helping teachers to be confident in their teaching, providing new ways of communication and being up-to-date with current affairs; consequently it enhances collaboration and resource sharing.

The study illustrates that the opportunities obtained from ICT use in teaching have the potential to improve the abilities and teaching of teachers. However, ICT affect teachers as individuals in various ways. Most teachers have benefited from ICT and achieved positive outcomes. However, others have had difficulties in benefiting from the full potential of the increase in opportunities offered through ICT. This is because of the individual differences of teachers resulting in varied outcomes, for example:

1. Lack of diversity in educational resources prevented teachers from making effective use of ICT in teaching full schools' curricula
2. Specialised ICT skills training enabled teacher's abilities to choose to act on the opportunities afforded by ICT.

3. Age affected the use of ICT in teaching. For example, younger teachers were exposed to ICT from an early age, they, therefore, used ICT in their daily lives and found it easy to incorporate it into their teaching.
4. Mentors and role model had an influence on ICT use in teaching. This is because teachers often followed the teaching example of their mentors or role models.
5. Social norms (such as rules) and social institutions (such as public policies) affected the frequency of ICT use in teaching. For example, research respondents reported that the government enforced pen-and-paper tests (or paper-based examinations). As a result, teachers used ICT sparingly because they felt that an over-reliance on ICT had a negative impact on learners' examination preparation.

A large number of factors from the personal, social, environmental, shaping and influencing field influenced the transformation of ICT into educational outcomes.

8.2 Contributions made by the thesis

The study makes two types of contributions; to theory and to practice.

8.2.1 Contributions to theory

The research makes different theoretical contributions, the use of CA as an explanatory theory of ICT in teaching with the incorporation of different theories helps to enhance the explanatory power of CA and the body of knowledge of teaching in ICT.

Although CA is increasingly being used in ICT in education research, there is a dearth of research on the specific relationship between schools as organisations whose core focus is development of an educational environment in which capabilities may be converted into functionings (Fertig, 2012). Further, there is a dearth of studies using CA to evaluate ICT integration in education. Previous studies focused on: the opportunities for people to use ICT, the characteristics of these people, and their reasons for use or-non use (Alampay, 2006), capability deprivation due to limited access and use of ICT, and how capability outcomes enable use.

The relationship between goods and the functionings to achieve 'beings and doings' is influenced by conversion factors (Robeyns, 2005). An example of the use of conversion factors in ICT in education is to explain how conversion factors led to the insufficient or non-integration of ICT in schools (Chigona & Chigona, 2010). The interpretation of CA in this study may be seen as a contribution. This is because it uses concepts of the individual differences conceptual framework to explain how teachers use ICT to generate educational outcomes. Individuals have personal experience that influences their identity. The concepts of the individual differences conceptual framework are used to illustrate how teachers differ in the way they convert the opportunities of the capability input into capability outcomes. As an individual analysis, individual differences conceptual framework deals with constructs such as personal, shaping and influencing factors and environmental factors.

The study has demonstrated that CA may be used to explain how teachers use ICT to generate educational outcomes in education and in general. CA is considered a complex theory (Chiappero-Martinetti, Egdell, Hollywood, & McQuaid, 2015). Concepts

are vague and abstract regarding such commodity in general and ICT specifically. As such, the study supplements CA with constructs from explanatory frameworks to explain how teachers use ICT to generate educational outcomes. Individual differences conceptual framework and taxonomy of ICT affordances were used to explain the features of ICT as a commodity and provide explanations on socio-cultural factors that influence the conversion of ICT into educational outcomes (Trauth, 2002; Conole and Dyke, 2004). Through this process the study addressed the concerns that CA is too vague to scientifically explain ICT integration factors. As such, the study contributes to the IS field by providing another way of using CA and expanding the scope of theoretical analysis of ICT in education study.

In this thesis, the empirical evidence and theory (Chapters 5,6,7) add to a body of knowledge on ICT in education assessments by offering a better explanation of how teachers use ICT to generate educational outcomes. The study answers the key research question. The question is relevant and persisting to the researcher's knowledge, as a normative framework CA lacks a clear explanation of the relationship between ICT and capability outcomes. Further CA lacks methodological guidelines on the impact of conversion factors on the transformation of ICT into functionings. The study established a relationship between ICT and educational outcomes, and found that individual differences of teachers influence the achievement of educational goals. The significance of ICT is that it produces three types of capabilities for teachers: educational, basic human capability and communication capabilities. This thesis has demonstrated an in-depth perspective of opportunities for participation through ICT integration rather than technological access. ICT integration has the potential to improve teaching and other aspects of the well-being of teachers, It improves teacher confidence, communication and community capabilities of teachers.

8.2.2 Contributions to practice

With regards to the use of ICT, efforts to deploy ICT into schools and integrate it into school curricula, is limited. This is because the continuum of ICT implementation

initiatives regarding maintenance and technology upgrades is left for the responsibility of the respective schools. The financial implications have had a significant burden on schools that were characterised by learners from disadvantaged backgrounds. This has meant that the good efforts of WCED could not be maintained, and consequently affected the deployment and integration of ICT into teaching. As a result, programmes and practitioners should devise strategies to ensure that there are plans in place to periodically maintain and update the existing ICT infrastructure at the schools. Given the clear policy undertakings, however, this may be attributed more to poor coordination of financial resources than to a lack of political will. It is clear, on this basis. That the current model of financing the deployment of ICT resources into schools is not working properly. A recommendation in this thesis, therefore, is that authorities should revise the efforts made to deploy ICT into schools and possibly appoint personnel to audit the process, including the funding model. This may be achieved by appointing personnel to keep a record of the funding process. In instances where schools do not have sufficient financial resources to achieve their goals of ICT deployment, authorities may refer to the audits and confirm whether money has been allocated and if the schools have indeed received it. This will ensure that there is an account of where funds are allocated and for what they are being used.

The significance of the study is that it demonstrates that assessments on ICT integration should go beyond access to ICT. Rather the socio-cultural factors of teachers (such as age, ICT skills training, education, level of expertise in the subject, personality types, role model, habits, customs and beliefs, cultural values, demographic characteristics of place of stay, government level policy and school level policy) influence how teachers use ICT to transform the same resources into enabled capabilities. The study demonstrates that aligning ICT in education efforts to socio-cultural factors increase the understanding of the local realities and provoke revised strategies for ICT implementation policies.

8.2.3 Recommendations

The study provides recommendations for planners and implementers to address issues on the actual realisation of ICT benefits by creating effective strategies that aim at improving implementation of ICT in schools. These strategies should look at the opportunities generated from ICT and how teachers use these opportunities to achieve educational outcomes. The strategies could also highlight the socio-cultural factors of teachers. Socio-cultural factors include what teachers' value, their personal shaping and influencing factors, as well as environmental factors. Knowledge of socio-cultural factors of teachers (such as what motivates them to do something) will help teachers, middle managers and senior managers at the school to develop practical solutions to encourage effective teaching with ICT. For example if managers, are aware of what motivates teachers to teach with ICT they may find ways (such as a reward system) to encourage teacher ICT use. Additionally, recommendations are provided for e-Learning coordinators who wish to deploy ICT and integrate it into schools' curricula to equip teachers with all the components of TPACK (Technology, Pedagogy and Content Knowledge). e-Learning coordinators should provide a space for teachers to experiment, highlighting existing practices and providing support to achieve their personal goals, which are part of their value system.

8.3 Limitations of the study

Based on the fact that this was a PhD research study, there were time limitations. Contextually there are four academic terms in South African schools. The study was cross-sectional and was carried out from 25 August 2015 to 19 October 2016, excluding examination periods and holidays, see Table 5-5. The school schedule limited the time teachers could be accessed for interviews and observations. The research results, therefore, reflect the opportunities for ICT access and use, goals and values of teachers as well as variables (such as age, education and level of expertise in a subject) in relation to ICT use.

Further, since the researcher's background is in Information Systems, and the study draws on diverse disciplines, economy, sociology, psychology, the researcher would like to acknowledge that many ICT-related socio-cultural factors and outcomes could be generated.

Further, with the selection of research participants being controlled by persons of authority in sampled schools, the sample is possibly biased since people were picked according to criteria. The teachers included in the sample were those who were known to make significant use of ICT, hence the data captures this. Ideally, the study requires a more diverse set of teachers to make a comparison of their differences. Despite the limitations highlighted studies on ICT use in education have identified similar capability outcomes and conversion factors. As such, this study may be used as a starting point for other studies that inform decision and policy makers.

The sample of the study was selected from the developing world context. The context might have an influence on the outcomes. Generalisability to the developed world context may be a challenge.

8.4 Possible future research

The limitations highlighted in the previous section present a background for possible future research. The suggestions for future research may be categorised into three parts:

- Since the study has focused on effects of ICT in education from the teaching perspective, future studies may explore the use of the technologies from a learning perspective by interviewing the learners to gain an understanding of how ICT use impacts learning.
- This study uses the case study research method; future studies could use an ethnography study research method that involves a diverse set of teachers (regarding age, gender, race, and environmental factors) who use ICT. This may

present a richer understanding of the conversion factors that influence the transformation of ICT to enabled capabilities.

- The study explores the relationship between ICT and capability outcomes by incorporating the Conole and Dyke (2004) taxonomy of ICT affordances and individual differences conceptual framework by Trauth; future studies may use other behavioural theories to understand ICT adoption and use behaviours in teaching and the relationship between what teachers value and the outcomes generated through ICT.
- Future research could focus on comparisons between the developing and developed world contexts.

8.5 Personal reflection

I began this thesis with an empirical problem in mind, regarding how the difference of teachers influence the way ICT is used in teaching. Having completed a Master's thesis on ***"The access and use of ICT in under-resourced schools in the Western Cape, South Africa,"*** it was evident that, although infrastructure was primitive to ICT integration, a lack of infrastructure could easily be remediated through funding models. Therefore, evaluations on the use of ICT for teaching had to go beyond access measurements and focus on internal factors such as what teachers value and have reason to value. This, therefore, formed the practical problem that I wanted to solve. With a theoretical contribution being an important outcome of PhD degree studies, I looked beyond the practical problem and aimed to identify limitations in theoretical frameworks suitable for the study. The research problem may be viewed from various focus lenses; however, CA allowed me to understand human diversity and how it influences the use of ICT to achieve educational goals. With CA being a grand theory it had been applied in many fields of research. Therefore, I found it challenging to identify limitations that when addressed would make a substantial contribution to the body of knowledge.

I found that CA allowed me to explain why individuals could have the same resources, but because of contextual factors, achieve different outcomes. With individual differences being the focus, the only construct in CA that allowed me to address individual differences was personal factors, which are part of the conversion factors. The limitation in personal factors is that it was restricted to mostly demographic factors of a teacher. It also did not help to explain how age, gender, education level, shaping and influencing and environmental factors affect the achievement of valuable educational outcomes using ICT. I found that the constructs from the theory of individual differences were more elaborate in understanding the socio-cultural factors of the teacher.

I am not a teacher by profession, therefore even though a concepts definitions template was created, I could not properly situate the constructs within the school context in the Western Cape. As a result, I conducted a pilot study to help define the constructs in the empirical setting. After that, I left it to the teachers during the interview process to interpret the construct. This meant that teachers answered the same questions differently. I saw this as an advantage as it allowed me to operationalise the theory further and also to identify when saturation was reached.

Due to the busy schedules of teachers, gaining willing participants was challenging. Even during the interviews, the teachers were time-conscious, so I often felt that I had to rush through the questions. This may have meant that the answers to questions on teachers' individual differences constructs were not in-depth. In addition to the interviews, I relied on research instruments such as questionnaires to gain more input from the teachers. The behavioural characteristics of the teachers may not have been well captured with the research instruments being interviews, observations and questionnaires. Therefore, this study relied more on what the teachers stated in the interviews and observations and not on the personal experiences of the researcher. For a more in-depth analysis of the influence of the characteristics of the teachers on their human computer interactions, an ethnographic study may have been more suitable.

8.6 Final words

Although most countries have invested greatly in the purchase and maintenance of ICT-related educational devices, ICT integration remains a challenging process of educational transformation. In advancing ICT integration there is a need to go beyond resourced-focused studies on whether ICT exist or not. The study established that teachers use the opportunities afforded by ICT. The transformation of these opportunities into educational outcomes is influenced by factors that are personal, shaping and influencing, social as well as environmental. The benefit of ICT for teachers is that it enhances their confidence to teach, their ICT skills and communication and community capabilities. The study illustrates that the opportunities obtained from ICT use in teaching have the potential to improve the abilities and teaching of teachers. However, ICT affected teachers as individuals in various ways. The key lesson in the study is that ICT used in education efforts should be aligned with socio-cultural factors to increase understanding of the local realities and provoke revised strategies to support ICT implementation in achieving successful outcomes.

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APPENDIX 1: INTERVIEW CONSENT FORM

May 2015

Dear <Participant Name>

My name is Kesewaa Koranteng and I am a PhD student in the Department of Information Systems at the University of Cape Town.

I would like to invite you to participate in an academic research case study on influence of teacher of teacher capabilities on the use of emerging technologies for teaching and learning amongst schools in the Western Cape, South Africa.

The study seeks to understand the influence of individual differences on emerging technologies for teaching and learning purposes. The study aims to provide explanations to the lack of innovative use of emerging technologies for improving teaching and learning. The study will look at the micro level factors that affect the successful integration of emerging technologies into the teaching and learning process. In this study micro level factors refer to the individual differences of teachers.

This research has been approved by the University of Cape Town (UCT)'s Commerce Faculty Ethics in Research Committee. Your participation in this research is voluntary. All information will be treated in anonymously and used exclusively for the purpose of this study. No individual names will be recorded or published. You will not be requested to supply any identifiable information so as

to ensure the anonymity of your responses. You can choose to withdraw from the research at any time for whatever reason, in accordance with research ethical requirements.

Interviews will be conducted in schools in Cape Town and they will take approximately 30 minutes. If you are willing to participate in this study, kindly sign the attached form and return to me at your earliest convenience.

Should you have any questions regarding this research, kindly contact me on 072 418 9262 or via email: kesewaajkoranteng@gmail.com

Thank you for your time and participation.

Sincerely,

Kesewaa Koranteng

PhD student (UCT)
Department of Information Systems
University of Cape Town
Email: kesewaajkoranteng@gmail.com
Phone: 0724`89262

Professor Wallace Chigona
PhD Advisor
Department of Information Systems
University of Cape Town
Email: wallace.Chigona@uct.ac.za
Phone: +27 21 6504345

Research Participant Consent Form

I'm participating in this study out of my free will. I may refuse to participate, or can stop participating at anytime, without being penalized for doing so. If I wish, I will be given a copy of this consent form.

I, _____, hereby accept the invitation to participate in this research as outlined above.

_____ _____

Signature Date

APPENDIX 2: ETHICS APPROVAL FOR THE RESEARCH

UNIVERSITY OF CAPE TOWN

Faculty of Commerce
Ethics in Research Committee
University of Cape Town Private Bag
Rondebosch 7701
Email: kincaidharold592@gmail.com
Telephone: 071 823 7573

March 31, 2015

Kesewaa Koranteng
Information Systems

Project title: **Influence of teacher capabilities on the use of emerging technologies for teaching and learning amongst schools in the Western cape, South Africa**

Proposal no. 44-2015
Dear Researcher,
This letter serves to confirm that this project as described in your submitted protocol has been approved contingent upon adding wording to the consent form explaining how the long the interview will take and that the participant can refuse to answer any questions and withdraw at any time.

Please note that if you make any substantial change in your research procedure that could affect the experiences of the participants, you must submit a revised protocol to the Committee for approval.
Regards,

Professor Harold Kincaid

H. Kincaid

Commerce Faculty Ethics in Research Committee

APPENDIX 3: PERMISSION TO CONDUCT RESEARCH IN SCHOOL IN THE WESTERN CAPE

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20141212-41587
ENQUIRIES: Dr A T Wyngaard

Ms Kesewaa Koranteng
Department of Information Systems
UCT
Private Bag
Rondebosch
7701

Dear Ms Kesewaa Koranteng

RESEARCH PROPOSAL: INFLUENCE OF TEACHER CAPABILITIES ON THE USE OF EMERGING TECHNOLOGIES FOR TEACHING AND LEARNING AMONGST SCHOOLS, IN THE WESTERN CAPE, SOUTH AFRICA

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

Principals, teachers and learners are under no obligation to assist you in your investigation.

Principals, teachers, learners and schools should not be identifiable in any way from the results of the investigation.

You make all the arrangements concerning your investigation.

Teachers' programmes are not to be interrupted.

The Study is to be conducted from **01 March 2015 till 30 September 2015**

No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).

Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?

A photocopy of this letter is submitted to the principal where the intended research is to be conducted.

Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.

A brief summary of the content, findings and recommendations is provided to the Director: Research Services.

The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 12 December 2014

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20141212-41587
ENQUIRIES: Dr A T Wyngaard

Ms Kesewaa Koranteng
Department of Information Systems
UCT
Rondebosch
7701

Dear Ms Kesewaa Koranteng

RESEARCH PROPOSAL: INFLUENCE OF TEACHER CAPABILITIES ON THE USE OF EMERGING TECHNOLOGIES FOR TEACHING AND LEARNING AMONGST SCHOOLS, IN THE WESTERN CAPE, SOUTH AFRICA

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

Principals, teachers and learners are under no obligation to assist you in your investigation.

Principals, teachers, learners and schools should not be identifiable in any way from the results of the investigation.

You make all the arrangements concerning your investigation.

Teachers' programmes are not to be interrupted.

The Study is to be conducted from **01 March 2016 till 30 September 2016**

No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).

Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?

A photocopy of this letter is submitted to the principal where the intended research is to be conducted.

Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.

A brief summary of the content, findings and recommendations is provided to the Director: Research Services.

The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 19 February 2016

APPENDIX 4: RESEARCH INSTRUMENT

Motivation	**Commodity**	**Capability**	**Choice**	**Functionnings (Capability Outcomes)**	**Conversion factors and individual differences**
1. What would people be doing with computers anyway? (Internet searches, email, learning programs, learning) 2. For personal use? (what!) 3. For education purposes? (what!) *** (direct the programs to learning programs) 4. Which learning programs do you use? 5. How do these learning programs help the learners with the subjects that they struggle with 6. In general what are the signs that show that a pupil is improving in their subjects? (e.g. marks) 7. Do the learners show these signs of improvement? 8. In your view how important are computers in the school?	**ICT integration** 9. What subjects do you teach? 10. Which of these subjects have a computer facilitated aspect? 10.1. Which subjects require online access to the Internet)? 10.2. What applications exist on these computers? 10.3. How are the computer programmes being used for teaching (e.g. research, assessments, administration) 11. When it comes to teaching these subjects couldn't you just teach without using computers, would you rather teach without learning programs? Why or why not? **Rules on Use of ICT** 12. What are the challenges faced when using computers for teaching and learning? 13. How do decisions from the top influence the use of technologies in the classrooms (i.e. principals, advisory board)? 14. What are the rules in the school with regard to using ICT for teaching and learning?	16. What do you value most as an educator? 17. How does the ICT enable those values 18. What opportunities are obtained through use of ICT for teaching? 19. How does the ICT enable or disable these opportunities	20. Which factors that influence your choice to act on the new opportunity	**Social Justice** 21. Describe your needs as an educator? 22. How does the ICT meet your needs? 23. Describe your goals as an educator 24. How does the ICT help you to achieve these goals 25. How have your teaching practices impacted the lives of the learners? 26. How have your teaching practices impacted the community? **Educational Capability** 27. How does the ICT influence access to education? **Basic Human Capability** **Learners** 28. How does the ICT influence the learners literacy? 29. How does the ICT influence the learners ability to communicate? 30. How does the ICT influence the confidence of learners? **Teachers** 31. How does the ICT influence the your literacy level? 32. How does the ICT influence the your ability to communicate?	**Personal Data** Name: a. Age range: 16 – 18; 19 – 21; 22 – 24; 25 – 29; 30 – 35; 35 - 39; 40 – 44; 45 & above b. Gender: c. Marital Status: d. Education level: e. Monthly income: less than K5, 000; K5,000 – K9, 999; K10, 000 – K14, 999; K15, 000 – K19, 999; Above K20, 000 f. Number of children: g. Where do you live: **Teaching Experience** h. Position: i. Length of service (Experience): j. What is the nature of your job, what do you do? k. Where did you obtain your training? l. Name the programs you use and your competency level i.e. Excel; Basic, b. Rudrich.claassen@rondeboch.com **Influencing Factors** **Personal Characteristics** **Personal traits** 34. How does your personality shape your use of the technology for teaching? 35. How would you describe your personality? 36. How does your personality shape your teaching? **Ability**

	15. What support structure is provided in order to assist with ICT use for teaching?			33. How does the ICT influence your confidence to teach?	37. Describe how you teach? 38. Describe how you manage your classroom? 39. What is your level of expertise in the subject taught? 40. How have your teaching practices impacted the learner results? **Personal Influences** 41. What influenced your decision to join the teaching profession? 42. Who are the significant role model(s) in your life? 43. How have the above person(s) impacted your life? 44. How has the above person impacted your teaching practice? 45. Have you ever had a mentor? 46. Describe more about the mentorship (when, how?) 47. How has the above mentor(s) impacted your life? 48. How has the above person(s) influenced your teaching practices? **Environmental Context** 49. What drives and motivates you in life **Cultural values** 50. Describe your values are 51. Describe your value in teaching? **Cultural Attitudes** 52. Describe your way of life? 53. Describe how your way of life has impacted your teaching practices 54. How do your religious beliefs influence your teaching practices **Geographical** 55. Describe the environment where you stay? 56. What are the history characteristics of

					the region? 57. What are the population characteristics of the region? 58. How does the environment where you stay influence your teaching practices **Teacher Training** 59. Do you have a personal computer? 60. How are you trained to teach with learning programs? 60.1. Who provides the training 60.2. What do they teach 60.3. How successful are the training programs? 61. How are subject materials accessed?

APPENDIX 5: GUIDE FOR INTERVIEW WITH TEACHERS

The questionnaire enquires into the influence of teacher capabilities on the use of emerging technologies for teaching and learning in the Western Cape, South Africa. This enquiry will help fulfil the purpose of the current study, which is to understand the factors that influence teacher capabilities to improve teaching and learning through emerging technologies Western Cape. The main objective of the study is to gain insight into the status quo (lack of ICT integration into schools' curricula) and its causal factors, so as to inform decision-making processes. The questionnaire will make enquiries into the following:

Main Research Question: How do teacher capabilities influence the use of emerging technologies for teaching and learning in the Western Cape, South Africa?

ENVIRONMENTAL FACTORS

1. How long have you being teaching?

……

2. Where did the passion for teaching come from?

……

3. (SCENORIO –if you were in this situation how would you react)

How would you describe your personality traits (actions, behaviours you possess create a scenario, how would you react to situations)?

3.1. How do your personality traits influence your teaching?

Culture

Intro: in society we all have a way we do things, which is generally influenced by what we believe in, our family background, our upbringing and etc.

4. How would you describe your way of life (what influences your way of living)?

……

5. Describe what you value the most and the reasons for this?

5.1. What do you value in teaching

……

6. What are your ***values*** *(a belief or lack thereof, in God and/or an affiliation with a religious institution, good steward of resource, a belief that family is fundamentally important)*?

……

7. Describe your salary range (cost of living)?

……
8. Describe your basic requirements for living i.e. a level of quality, achievement that is considered desirable?

……
9. What are your religious beliefs
10. How do your religious beliefs influence your way of life?

……
11. How do your religious beliefs influence your teaching?

12. What drives or motivates you in life?

……

Geographical and Economic

13. Describe the environment where you stay?

……
14. What are the history and population characteristics for your region?

……
15. How does the environment where you stay influence your teaching?

CAPABILITIES (HOW DO EMERGING TECHNOLOGIES INFLUENCE THE GENERATION OF CAPABILITIES FOR TEACHERS?) opportunities, freedom

1. I have heard from the news and from the government that there is something about computers in schools have you heard about it too? ① Yes ② No

(I am just wandering what would a computer be used for in a school anyway)

2. What would people be doing with computers any way? (Internet searches, email, learning programs, learning)

2.1. For personal use? *(what!)*

……

For education purposes? *(what!)*

……

*** *(direct the programs to learning programs)*

3. Are you talking about learning programs? ① Yes ② No

1. If ***yes*** can you name any learning programs?

…… Do you have these learning programs? ① Yes ② No

2. If ***yes***, do they help the learners with the subjects that they struggle with? ① Yes ② No

3. In general what are the signs that show that a pupil is improving in their subjects? *(for example marks)*

……..Do the learners show these signs of improvement?

…… So do you find computers to be important in schools? ① Yes ② No

*** *(can you clarify why it's important)*

4. Why are they important?

.....

But couldn't you do it with out the computer and why or why not? *(expecting to say you could use it but yes its better).*

…….Since the learning programs are supposed to help the teachers with their learning would you say it ***easy or difficult*** to these learning programs? ……

5. If the learning programs are ***difficult*** to use **why** are they ***difficult*** to use? (is it difficult to use the programs because of lack of training)

…….Do teachers get training to use or teach with these learning programs? ① Yes ② No

6. If ***yes*** where do they get their training?

…….Who provides the training? ……

7. What do they teach you in the training?

……

8. How successful are these training programs?

……

9. Are the learning programmes easier to use after the training? ① Yes ② No

10. If ***no*** training, ask for explanations (also whether they are considered important)

.....

If the learning programs are easy to use then is everyone teaching with them? ① Yes ② No

11. If ***no*** why?

.....

.....

..... Do you have a computer? ① Yes ② No

12. If ***yes***, how did you learn how to use a computer? (*Teach yourself, training, learnt from friend, learnt from colleague etc.).*

……

13. If ***no*** why don't you have a computer?

.....

.....

14. What subjects do you teach?

15. Which of these subjects have a computer-facilitated aspect?

.....

Why ?

Which subjects require online access to the Internet)? ……...

16. What are the applications that exist on these computers?

……

17. How are the computer programmes being used f*or teaching (for example research, assessments, administration)*

.....

.....

18. When it comes to teaching these subjects couldn't you just teach without using computers, would you rather teach without learning programs?
19. Why or why not?

.....

Are you able to make use of computers for teaching and learning?

.....

16. What are the challenges faced when using computers for teaching and learning?

.....

17. How do decisions from the top influence the use of technologies in the classrooms (i.e. principals, advisory board)?

.....

18. What are the rules in the school with regard to using ICT for teaching and learning?

.....

CONVERSION FACTORS

19. What technologies do you use
20. Describe how you use technologies for professional use

.....

21. Describe how you use technologies for personal use

CHOICE

22. What choices do the teachers have in terms of the technologies they use in the classroom and how they are used?

.....

23. The technologies used in the classroom how are they chosen? Explain
24. Are there restrictions (is there a restriction on which technologies one can use) (see)

.....

FUNCTIONINGS

25. How does the technology impact the teaching and learning process?
    25.1. How has the technology benefited you?
    25.2. What are the changes you have seen in the students learning?
    25.3. Describe your goals as an teacher
    25.4. How has the technology helped you achieved your goals?

Learners using computers

20. How do the learners feel about using computers? *(Do learners like using computers)*

.....

How are they responding? (is it good or bad)

.....

21. Do they struggle with using computers?

.....

22. How do they show that they are interested or not interested in computers?

.....

23. How are the learners supported when they have difficulty in using computers?

……

24. Is there someone from government who provides support for learners? *(for example training)*

ICT training for teachers

25. How many teachers does your school have? ……..

26. How many of these teachers are ***able*** to use computers? ……..

27. How many teachers are using computers for teaching?.....

28. What do they do with these computers?

……

……

29. How do they use these computers?

……..

30. Why are others ***not*** using computers for teaching?

.....**other**

INNOVATION

26. If your boss introduced a new concept or system how would you react to it (or change a way of teaching)?

……

27. Describe something new you tried recently?

……

28. How did you feel about trying it (do you like trying new things)?

……

29. What is your favourite technology and why?

……

30. Any technologies that you purchased recently?

……

31. How do you embrace using technologies for both personal and teaching purposes?

……

32. In the case where encounter a problem how do you go about solving (develop new methods to solving the problem if the answer is not clear)?

……

33. Could you teach/live without technology (why or why not)?

……

33.1. why

34. If you think technologies are important how would you ensure that your fellow colleagues use it?

……

35. How do you feel about the current methods use to teach (could they be improved)?

……

36. How can you contribute to the improvement of teaching practices?

……

37. Describe the roles that you generally take in a team, among tasks?

……

38. If your boss introduced a new concept or system how would you react to it (or change a way of teaching)?

……

39. How do you approach new problems?

……

40. Is there a teacher you know of that is innovative? (Ask for details (Name, subject taught, contact details if possible) for future contact)

……

① Yes ② No

41. What makes him/her innovative? (Explain)

……

……

42. How does the school environment influence the teacher to make innovative use of emerging technologies for the teaching and learning process?

……

43. Are there innovative teaching and learning practices that you know of in other schools? ① Yes ② No

……

44. Explain, what are these innovative teaching and learning practices?

……

APPENDIX 6: GUIDE FOR INTERVIEW WITH PRINCIPALS

The questionnaire enquires into the influence of teacher capabilities on the use of emerging technologies for teaching and learning in the Western Cape, South Africa. This enquiry will help fulfil the purpose of the current study, which is to understand the factors that influence teacher capabilities to improve teaching and learning through emerging technologies Western Cape. The main objective of the study is to gain insight into the status quo (lack of ICT integration into schools' curricula) and its causal factors, so as to inform decision-making processes. The questionnaire will make enquiries into the following:

Main Research Question: How do teacher capabilities influence the use of emerging technologies for teaching and learning in the Western Cape, South Africa?

ENVIRONMENTAL FACTORS

1. How long have you being teaching?
2. How long have you being a principal in this school

……

3. Where did you derive your passion teaching?

……

Geographical and Economic

4. Could you describe a bit more about the school?

……

5. When was it founded?

……

6. What are the significant changes that have occurred in the school?

……

7. Describe the area in which the school is located?

……

8. How has the community impacted the school (describe instances where the school has helped the community)?

……

9. How has the school impacted the community?

……

10. What support does the school have from government?

……

11. What are the characteristics of the learners that attend the schools?

……

---

4. I have heard from the news and from the government that there is something about computers in schools have you heard about it too? ① Yes ② No

(I am just wandering what would a computer be used for in a school anyway)

5. What would people be doing with computers any way? (Internet searches, email, learning programs, learning)

5.1. For personal use? *(what!)*

……

For education purposes? *(what!)*

……

*** *(direct the programs to learning programs)*

6. Are you talking about learning programs? ① Yes ② No

31. If ***yes*** can you name any learning programs?

…… Do you have these learning programs? ① Yes ② No

32. If ***yes***, do they help the learners with the subjects that they struggle with? ① Yes ② No

33. In general what are the signs that show that a pupil is improving in their subjects? *(for example marks)*

……..Do the learners show these signs of improvement?

…… So do you find computers to be important in schools? ① Yes ② No

*** *(can you clarify why it's important)*

34. Why are they important?

…… But couldn't you do it with out the computer and why or why not? *(expecting to say you could use it but yes its better).*

……Since the learning programs are supposed to help the teachers with their learning would you say it ***easy or difficult*** to these learning programs? ……

35. If the learning programs are ***difficult*** to use **why** are they ***difficult*** to use? (is it difficult to use the programs because of lack of training)

……Do teachers get training to use or teach with these learning programs? ① Yes ② No

36. If ***yes*** where do they get their training?

……

Who provides the training? ……

37. What do they teach you in the training?

……

38. How successful are these training programs?

……

39. Are the learning programmes easier to use after the training? ① Yes ② No

40. If ***no*** training, ask for explanations (also whether they are considered important)

.....

If the learning programs are easy to use then is everyone teaching with them? ① Yes ② No

41. If ***no*** why?

.....

.....

..... Do you have a computer? ① Yes ② No

42. If ***yes***, how did you learn how to use a computer? (*teach yourself, training, learnt from friend, learnt from colleague etc).*

……

43. If ***no*** why don't you have a computer?

.....

44. Have you heard about the teacher laptop initiative? ① Yes ② No

45. Have any teachers in your school received any laptops from this initiative?

.....

1. Does the school have computers? ① Yes ② No

2. If ***yes***, how did the school acquire these computers? *(for example purchase, rent, donation)*

.....

....

3. What are the rules for acquiring technology?

.....

.... What

4. What sort of support do you get from organizations or government?

……

What are the computers generally used

for? .....

5. How are the technologies used for teaching and learning?

……

12. What are the rules concerning technology usage in the school

……

CHOICE

13. What choices do the teachers have in terms of the technologies to use in the classroom and how they are used?

……

14. How are the technologies used in the classrooms chosen? explain (is there a restriction on which technologies one can use)

FUNCTIONINGS

15. How does the intervention impact the teaching and learning process?

……

Policy

16. Do you know anything about the department of education policy on ICT in schools?

……

17. What are the rules that are projected by this policy

……

APPENDIX 7: GUIDE FOR INTERVIEW WITH ICT COORDINATORS

The questionnaire enquires into the influence of teacher capabilities on the use of emerging technologies for teaching and learning in the Western Cape, South Africa. This enquiry will help fulfil the purpose of the current study, which is to understand the factors that influence teacher capabilities to improve teaching and learning through emerging technologies Western Cape. The main objective of the study is to gain insight into the status quo (lack of ICT integration into schools' curricula) and its causal factors, so as to inform decision-making processes. The questionnaire will make enquiries into the following:

Main Research Question: How do teacher capabilities influence the use of emerging technologies for teaching and learning in the Western Cape, South Africa?

_____

ICT Coordinator

<u>Emerging Technologies</u> (HOW DO EMERGING TECHNOLOGIES INFLUENCE THE GENERATION OF CAPABILITIES FOR TEACHERS?)

7. I have heard from the news and from the government that there is something about computers in schools have you heard about it too? ① Yes ② No

   (I am just wandering what would a computer be used for in a school anyway)

8. What would people be doing with computers any way? (Internet searches, email, learning programs, learning)

   8.1. For personal use? *(what!)*

   ……

   For education purposes? *(what!)*

   .....

   *** *(direct the programs to learning programs)*

9. Are you talking about learning programs? ① Yes ② No

46. If ***yes*** can you name any learning programs?

   ..... Do you have these learning programs? ① Yes ② No

47. If ***yes***, do they help the learners with the subjects that they struggle with? ① Yes ② No

48. In general what are the signs that show that a pupil is improving in their subjects? *(for example marks)*

   ……..Do the learners show these signs of improvement?

   ..... So do you find computers to be important in schools? ① Yes ② No

   *** *(can you clarify why it's important)*

49. Why are they important?

   ..... But couldn't you do it with out the computer and why or why not? *(expecting to say you could use it but yes its better).*

……Since the learning programs are supposed to help the teachers with their learning would you say it ***easy or difficult*** to these learning programs? ……

50. If the learning programs are ***difficult*** to use **why** are they ***difficult*** to use? (is it difficult to use the programs because of lack of training)

……Do teachers get training to use or teach with these learning programs? ① Yes ② No

51. If ***yes*** where do they get their training?

……Who provides the training? ……

52. What do they teach you in the training?

……

53. How successful are these training programs?

……

54. Are the learning programmes easier to use after the training? ① Yes ② No

55. If ***no*** training, ask for explanations (also whether they are considered important)

.....

..... If the learning programs are easy to use then is everyone teaching with them? ① Yes ② No

56. If ***no*** why?

.....

.....

Do you have a computer? ① Yes ② No

57. If ***yes***, how did you learn how to use a computer? (*teach yourself, training, learnt from friend, learnt from colleague etc).*

……

58. If ***no*** why don't you have a computer?

.....

59. Have you heard about the teacher laptop initiative? ① Yes ② No

60. Have any teachers in your school received any laptops from this initiative?

.....

6. Does the school have computers? ① Yes ② No

7. If ***yes***, how did the school acquire these computers? *(for example purchase, rent, donation)*

.....

What are the rules for acquiring technology?

.....

8. What sort of support do you get from organizations or government?

……

What are the computers generally used for? .....

9. How are the technologies used for teaching and learning?

……

IT Support

10. How are the technologies maintained (i.e. IT support)?

……

i. Who looks after them?

……..

ii. Where are they kept?

……..

iii. Are they not misused by the learners or teachers? ① Yes ② No

11. How are the people in charge of the maintenance equipped to maintain the ICT facilities (i.e. is this their course of study, or do they learn on the job)?

……

ICT Deployment

12. How many computers does the school have? ……..

a. On average how many learners per computer?

…..

b. Why does the school only have this number of computer?

……

How many of the computers are working? *(Refer to question 6)*.....

c. If other computers are not working why are they ***not*** working?

……

d. What happens when the computers in the school stop working, who fixes them?

……

e. How long does it usually take for the computers to be fixed?

……

13. When computers are first brought into the school, who sets it up? ……..

a. How long does it this take?

……

14. What are the procedures involved in choosing the technologies to be used for teaching and learning?

……

15. What is the criterion for the choosing technologies (i.e. application, IT artefact)?

……

16. When a new technology arrives in the schools how are they incorporated into the teaching and learning process?

……

17. If ***no computers***, why are there no computers at the school?

.....

.....

a. Is there something been done in the school about the lack of computers and what is it? *(projects, government Initiatives etc.)*

.....

.....

18. **Where there are *no* computers:** where do you go to access computers? *(For example Internet Café, ICT centre etc.)*

.....

Telecommunication Potential and Internet access in schools

61. Does the school have electricity? ① Yes ② No

62. If ***no***, why not?

.....

63. Does the school have a telephone line? ① Yes ② No

64. If ***no***, why not?

.....

Does the school have Internet? ① Yes ② No

65. How many computers have an Internet connection? .....

66. Why only this number?

.....

Are learners allowed to use the Internet or is the Internet only for staff members? .....

67. Is Internet for free or is there a limit? .....

68. What is the limit for learners? .....

69. What is the limit for teachers? .....

70. Is this enough, do the learners and staff members generally complain about not having access?

.....

71. Why is there such a small amount of Internet bytes allocated for learners and staff members?

.....

72. Is the school doing something about the lack of Internet? ① Yes ② No

73. If ***yes*** what is been done? .....

74. On average are staff members and learners expected to make use of the Internet for academic purposes?

① Yes ② No

75. What do the staff and learners use the Internet for?

.....

19. What is the total number of hours per week of ICT use in teaching and learning as recommended in curricular?

.....

20. What is the total number of hours per week for practical exercises as recommended in the curricula?

.....

21. How is the online presence of the school?

.....

22. What online technologies are used for teaching and learning (blogs, facebook, twitter, e-learning)?

……

23. How many teachers are provided ICT literacy training?

……

Integration/Learners at school

76. How many learners are in the school?

……...

77. How many of them are being taught using the computer?

.....

....Why only this number?

.....

.... In what school-grades are computers being used?

.....

78. What is the number of subjects that have a computer-facilitated component?

……...

79. What subjects *(within the school grades mentioned above are these*) are these?

.....

80. Why only these subjects? *(ask – what about the others)*

.....

81. Which subjects require online access to the Internet)?

……...

82. What are the applications that exist on these computers?

……

83. How are the computer programmes being used f*or teaching (for example research, assessments, administration)*

.....

84. When it comes to teaching these subjects couldn't you just teach without using computers, would you rather teach without learning programs?

85. Why or why not?

.....

....

Learners using computers

86. How do the learners feel about using computers? *(Do learners like using computers)*

.....

87. How are they responding? (is it good or bad)

.....

88. Do they struggle with using computers?

……

89. How do they show that they are interested or not interested in computers?

……

90. How are the learners supported when they have difficulty in using computers?

……

91. Is there someone from government who provides support for learners? *(for example training)*

ICT training for teachers

92. How many teachers does your school have? ……..

93. How many of these teachers are ***able*** to use computers? ……..

94. How many teachers are using computers for teaching?.....

95. What do they do with these computers?

……

96. How do they use these computers?

……

CHOICE

24. What choices do the teachers have in terms of the technologies to use in the classroom and how they are used?

……

25. How are the technologies used in the classrooms chosen? explain (is there a restriction on which technologies one can use)

97. Why are others ***not*** using computers for teaching?

.....

26. How do decisions from the top (i.e. principals, advisory board)?

……

27. What are the rules in the school with regard to using ICT?

……

Other

98. Is there a dedicated teacher to manage ICT facilities and to champion the use of ICT?

.....

99. What are the causal factors of the current status of ICT deployment at your school? *(Explanations to the status of ICT deployment, i.e. why no computers)* **(ICT Coordinator)**

.....

28. Do you have a personal computer?

……

29. Do you have access to internet at home?

……

INNOVATION

30. If your boss introduced a new concept or system how would you react to it (or change a way of teaching)?

……

31. Describe something new you tried recently?

……

32. How did you feel about trying it (do you like trying new things)?

……

33. What is your favourite technology?

……

34. Any technologies that you purchased recently?

……

35. How do you embrace using technologies for both personal and profession purposes?

……

36. If you had to discover a solution to a problem how would you go about (develop new methods to solving the problem if the answer is not clear)?

……

37. Could you teach/live without technology (why or why not)?

……

38. If you think technologies are important how would you ensure that your fellow colleagues use it?

……

39. How do you feel about the current methods use to teach (could they be improved)?

……

40. How can you contribute to the improvement of teaching practices?

……

41. Describe the roles that you generally take in a team, among tasks?

……

42. If your boss introduced a new concept or system how would you react to it (or change a way of teaching)?

……

43. How do you approach new problems?

……

44. Is there a teacher you know of that is innovative? (Ask for details (Name, subject taught, contact details if possible) for future contact)

……

① Yes ② No

45. What makes him/her innovative? (Explain)

……

……

46. How does the school environment influence the teacher to make innovative use of emerging technologies for the teaching and learning process?

……

……

47. Are there innovative teaching and learning practices that you know of in other schools? ① Yes ② No

……

48. Explain, what are these innovative teaching and learning practices?

……

……

FUNCTIONINGS

49. How does the intervention impact the teaching and learning process?

……

APPENDIX 8: PRINCIPALS OF INTERPRETIVE RESEARCH

Interpretive studies usually focus on meaning and may employ multiple methods to reflect different aspects of the issue. There are seven principals of interpretive research, the hermeneutic circle, contextualisation, interaction between the researchers and the subjects, abstraction, and generalisation, dialogical reasoning, multiple interpretations, suspicion. These are summarised in Table 8-2.

Evaluation of interpretive research

Principle	Description	Application of principles of interpretive research
Hermeneutic circle	Hermeneutic circle refers to the philosophy of interpretation and understanding by iterating between the meanings of segments of complete research. The circle represents the understanding that is enabled if the whole text and individual parts of a text make reference to one another so as to improve.	The principle of hermeneutic circle is the basis for all interpretive work of hermeneutic (a method of interpretation) nature. An understanding of research as a whole is established by reference to individual segments and an understanding of individual segments is enabled by referring to the whole research. The application of the hermeneutic circle can be seen in in this research whereby the meaning of a text is found within the socio-cultural, historical and literary context
Contextualisation	Review of the situated context of the study. The context may refer to the social and historical background of the research setting. This enables the research audience to understand how the situation in the context described has emerged over time. It also allows for the boundaries condition to be set for analysing the study.	Within this current study the researcher reviews literature to establish the background of ICT integration in South Africa. To understand the context of the individuals, the context of the teacher the environmental factors of both the sampled schools and teachers were investigated. The environmental factors were geographical characteristics of the school and the location of the teachers. They also included the population characteristics and the history elements of the both the school and the teachers' place of stay.
The interaction between researchers and the subjects	A reflection on how the research instruments were socially constructed through interactions between the researchers and the participants needs to be carried out	Both the empirical evidence and literature reviewed sensitised the researcher to the state of schools in Western Cape. However, since the researcher does not have an educational background her interactions with the school teachers and her presence in the school gave her more understanding of the educational context within the Western Cape. The researcher also sorts to gain clarity through interviews and direct observations.
Abstraction and generalisation	Abstraction and generalisation require the process of relating the ideas revealed through the interpretation of data. The data is interpreted by applying theories and general concepts that describe the nature of human understanding and social action.	In the current study the authors used Sen's Capability Approach along with concepts of Trauth's individual differences and the Conole and Dyke (2004) taxonomy of ICT affordances to answer the question of how ICT enable teachers to generate educational outcomes.
Dialogical reasoning	Although the theory might present predefined concepts that guide the research design and the actual findings the data obtained might present information that is contrary to what the theory states.	I was, therefore, sensitive to the possible contradictions of theory to the actual context of the study.
Multiple interpretations	With human beings being different in the way they think and reason, the data collected from different participants about a specific occurrence may differ according to the interview participants.	The researcher was sensitive to the possible differences in the interpretation of research participants. These differences were expressed in the interviews conducted.
Suspicion	The principle of suspicion refers to biases and planed distortions in the interview data collected from research participants.	During the data collection process of the study the researcher sensitive to possible biases from the research participants of perceptions of ICT use in teaching.

APPENDIX 9: AFFORDANCES OF ICT IN TEACHING

Affordances of ICT in teaching

Among the respondents, the main opportunities afforded by the ICT were accessibility, diverse educational experiences, communication, immediacy and resource sharing. The way in which the ICT were used was influenced by the functionalities and the goals the teachers wished to achieve.

Affordances of ICT for teaching

Affordances of ICT	Activities	Types of ICT
Accessibility	• Access the educational resources via the Internet and school servers • Access educational videos through YouTube	• **Internet** • **YouTube**
Resource sharing	• Enabled the sharing of new applications and teaching practices	• **iPads**
Storage of educational resources	• Cloud storage facilities enabled the storage of educational resource (for example past exam papers)	• **Google classroom** • **Dropbox** • **Common drive** • **SharePoint**
Communication	• Communication between teachers and learners via social networking platforms (for example WhatsApp, Facebook)	• **WhatsApp** • **Facebook** • **Email**
Immediacy	• Email for immediate form of communication Kahoot: a game-based assessment tool that offers immediate information on learner performance	• **Email** • **Assessment tool: Kahoot**
Diverse educational experiences	• Website to enable learners to carry out personality tests so as to identify strengths and weaknesses	• **16personality.com**

ICT provided opportunities for accessibility to educational resources

ICT offered access to a large amount of information through online. Through educational resources accessed via the Internet and school servers, less experienced teachers could gain guidance on different teaching and assessment styles. For example, the goal

of GC_M41 was to follow the exemplary standard of teaching set by the previous Physical Science teacher. Through ICT GC_M41 was able to access to previous assessment papers compiled by the past Physical Science teacher. The past papers were seen as important in enabling GC_M41 to achieve the goal of becoming like the Physical Science teacher.

Teachers used video sharing websites such as YouTube to access educational videos to aid the teaching of programming subjects. Through the videos the "*learners were equipped to achieve the goal to develop a fully-fledged application"* (CA_ITB25). ICT helped to achieve this goal by enabling learners to practice after school hours (CA_I_59:31). For SC_IT21 ICT unlocked access to a plethora of knowledge.

In a similar way further research could be carried out on subject contents that were seen as interesting by a learner. By allowing learners to find solutions on their own they were given the opportunity to be part of the educational experience. Students were also given the opportunity to learn from one other through the information gained online (SC_IT21).

ICT provided opportunities for resource sharing

For PL_A12 the ICT aided sharing educational resources and practices with other teachers. With continuous improvement through updates and developments of new applications on iPads, teachers could share new ideas and new ways of using the iPads (PL_A12). For PL_A12, prior to the use of iPads for teaching there was a lack of resource sharing and teachers kept solutions and ideas to themselves.

ICT provided opportunities for storage of educational resources

The ICT offered opportunities for teachers to store educational resources on a shared drive. Educational resources such as past assessment papers could be accessed by learners through a common storage drive (GC_MT36).

ICT provided opportunities for communication

Communication between teachers and learners on assessment tasks took place synchronously and asynchronously "*On Facebook they would send me messages and I would send them like the solutions to questions and things so all of that plays a role"* (GC_MT36). In addition, it enabled learners to communicate with other students around the world (SC_P_41:10).

ICT provided opportunities for immediacy

Through ICT further research was made to gain immediate answers to difficult questions posed to teachers by learners. Email was used to communicate important information and share resources to teachers. GC_M41 indicated that with the use of Email, teachers could gain immediate access to important communication about workshop dates. Without ICT communication of important workshop dates was made via postal mail. With the slow delivery rate of postal mail, teachers often received important information late. Therefore, for GC_M41,

> *"… Emails and all these things you have direct access to all these workshop and everything so that makes it much easier to get out there and learn more about the field that you are in …" (GC_M41).*

Some teachers felt that with game-based applications such as Kahoot, learners were driven to participate in classroom assessments. In addition, they were excited to answer questions (RB_S2). Furthermore, teachers could immediately identify the areas where learners had erred and could offer remediation (RB_S4). ICT enabled independent learning. Interaction with the ICT enabled learners to practice their programming skills. The ability to run programming languages immediately enabled teachers to identify and remedy errors (CA_ITB25).

ICT provided opportunities for diverse educational experiences

ICT offered a wide range of diverse experiences. For example, the main goal for GC_B41 was to enable learners to reach their full potential by discovering their strengths and interests. Therefore, the 16personality.com website was used by GC_B41 to enable learners to carry out personality tests. Through the results of the personality test learners could identify their strengths and their weaknesses needing improvement. The ICT, therefore, enabled the GC_B41 to achieve the goal of preparing learners for life.

APPENDIX 10: INTERVIEW GUIDELINE

Semi structured interviews process	
I	**Pre-interview activities**
• Schedule interviews with a contact person at the institution • Verify venue, date and time for the interview • Read through the interview transcripts • Ensure there is a copy of the consent form • Arrive on time at the venue of the interview	
II	**The interview process**
1. Greet the participants and introduce yourself and state the reason for the interview 2. Request for informed consent (signing the interview consent form) 3. Switch on recording equipment 4. Request for consent to record the interview 5. Allow the participants to ask for clarity of concepts 6. Summarise the points after a question and verify with the participant 7. Switch off the recording equipment and thank the participant for their time	
III	**Post-interview activities**
1. Check the recorded interview and save and store it for transcribing 2. Reflect on the interview and compile brief notes 3. Send thank you emails to participant	