Understanding Teachers' Integration of Information and Communication Technology (ICT) in Teaching Grade 7 Natural Sciences

by

Nkosinathi Zungu

Submitted in partial fulfilment of the academic requirements for the degree of Master of Education (Science Education) in the School of Education, College of Humanities, University of KwaZulu-Natal.
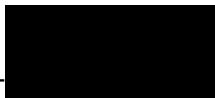
Supervisor: Prof. N. Govender
Co-Supervisor: Mrs M. Good

March 2022

Declaration

I, **Nkosinathi Victor Zungu** declare that:

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2. This dissertation has not been submitted for any degree or examination at any other university.

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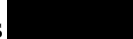
Student Number: 220108390

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Professor Nadaraj Govender

Date: March 2022

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Mrs████ne Good

Date: March 2022

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Abstract

Information and Communication Technologies (ICT) have evolved into the most fundamental component of modern industrial civilization. Many countries have now acknowledged, adopted and are starting to master and understand basic ICT skills and knowledge. The South African Department of Basic Education has also taken the initiative to implement ICT integrated teaching by providing ICT resources to schools. Teachers in South Africa are now confronted with an educational shift that challenge their technical skills as well as their knowledge and pedagogical expertise in the use of ICT in the classroom. Therefore, this study seeks to understand how teachers use Technological Pedagogical Content Knowledge (TPACK) to integrate Information and Communication Technology (ICT) in their teaching of Natural Sciences in Grade 7. The study was carried out at three primary schools in the KwaDukuza region of the iLembe District, KwaZulu-Natal, South Africa. It was focused towards teachers who were already incorporating ICT into their teaching of Grade 7 Natural Sciences. This qualitative study involved three teachers purposefully selected from these schools. Data were gathered from document analysis, questionnaire, lesson observations, and semi-structured interviews. Teachers were observed teaching different topics of the Grade 7 Natural Sciences curriculum, such as Water Cycle, Solar System and Tides. The data collection were based on action research methodology and were done in two cycles. The collected data were analysed using thematic analysis, the categories and emerging themes formed the main findings of the study. The findings revealed that all three teachers had basic ICT skills such as using digital projector connected to their laptop to teach Grade 7 Natural Sciences but were poorly integrating ICT into their lessons. Teachers did encounter some difficulties in their classrooms, such as a lack of internet connection and insufficient resources, but they remain optimistic and eager to incorporate ICT into their teaching. Teachers further stated that they favour technology enhanced teaching over traditional teaching because it allows them to explain complex content more easily in a visual manner. They do have a positive attitude towards ICT but need advanced professional development in integrating ICT pedagogically. The participants feel that ICT can be utilized to improve Grade 7 Natural Sciences teaching and learning since it captures learners' interest and motivates their learning.

Preface

The study presented in this dissertation was done at the University of KwaZulu-Natal, College of Humanities, School of Education, Science and Technology Education Cluster, under the guidance of Professor Nadaraj Govender (Supervisor) and Mrs Mary-Anne Good (co-supervisor).

The Ethics Clearance Approval number is HSSREC/00001513/2020 for this study. Permission was obtained from the Head of Department-KZN Education to conduct research at iLembe District.

Dedication

This dissertation is dedicated to my late parents Mr Mandlenkosi Jacob Zungu and my mother Mirriam Mangalephi Zungu. I will always cherish how you supported me through out my career. Thank you for all your sacrifices you have made for us. To my kids Aphiwe, Lethokuhle and Kwandokuhle, thank you for being my motivation.

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I would like to pass my sincere thanks and appreciation to the following people who helped me during this study:

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Lastly, I wish pass my gratitude to all the participants of this study and God Almighty for making it possible for me to finish.

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Chapter 1
Introduction

1.1 Introduction

Information and Communication Technology (ICT) has dominated many aspects of our lives to the extent that it has transformed our way of living. ICT is defined by Farrell et al. (2007) as the use of computers, software, networks, satellite linkages, and related technologies that enable people to access, analyze, and use data, information, and knowledge in a variety of ways. It doesn't matter how we view its presence and its dominance as there is no denying that it has become necessary in our lives and that ICT is here to stay. Globally, education systems have started to adopt ICT integration in their teaching and learning processes. The international community and society are making efforts to ensure equity and inclusion in education through ICT (Cha, Park & Seo 2020). The South African government, by means of the Department of Basic Education (DBE), has also resorted to new technology to aid improvements in teaching and learning and to address past inequalities in schools and to be on par with the world on ICT integration (Graham, Stols, & Kapp, 2020).

In 2015, more than 300 Gauteng schools received tablets for educational purposes. KwaZulu-Natal's Department of Basic Education followed Gauteng Education's lead by giving ICT infrastructure and resources to public schools for teaching and learning. More than 1500 schools in the province received ICT tools and infrastructure, such as CPU/Projector combinations, laptop computers, interactive whiteboards, desktop computers, netbooks, digital projectors, and tablets.

There are many more ICT tools that teachers can use to support teaching and learning. Still, research indicates that teachers' level of knowledge, skills, and attitude towards the usefulness of ICT resources in learning influences their intention to adopt ICT learning (Kalogiannakis & Papadakis, 2019), even when they have access to these resources. The findings of the study by Manoj and Govender (2005) suggest that teachers have positive attitudes toward using ICT in education but they need to obtain the core proficiency to use them. The findings of the study by Juggernath and Govender (2020) revealed that teachers' beliefs are barriers to successful digital fluency in their classes, but they are willing to adapt with training. The teachers' attitude towards using ICT in the classroom is as important as getting proper ICT development. The Department of Basic Education can train teachers on the use of ICT, but if they don't see the usefulness of

ICT in their teaching, they will not use it. A study in Malaysia by Oye, Iahad and Rabin (2011) listed lack of knowledge as one reason why teachers do not incorporate ICT in their lessons. Professional competency in the educational use of ICT, collaboration for ICT integration, and skills and practices in the educational use of ICT are only a few of the essential characteristics that can be improved through professional development activities (Li et al., 2019).

With the 4th Industrial Revolution currently, and digital learning being promoted by the Department of Basic Education, this study attempted to provide assistance to empower teachers with knowledge and skills to enable them to become frequent ICT users in their Natural Sciences lessons. Therefore, this study seeks to understand how Grade 7 Natural Sciences teachers integrate ICT using Technological Pedagogical Content Knowledge (TPACK) in their classrooms. This study followed an action research approach. According to Cohen, Manion and Morrison (2013), action research is a strong tool for change and improvement at the local level. Action research can be described as applying facts and results to actual problem solving to improve the quality of action. It entails the collaboration and co-operation of researchers, practitioners, and lay people (Bishnu, 2021).

1.2   My Background

As a student at the university, if I did not understand the concept in the lecture hall, I would go to YouTube channels to watch videos on that concept. This was extremely helpful to me. So, as a Natural Sciences teacher, I decided that it would be essential that I use ICT to enhance my teaching. I had a feeling that an ICT integrated lesson would grab learners' attention as it entails different exciting media. Traditional teaching approaches, on the other hand, usually promote memorization without understanding. Essays (2018) states that conventional teaching methods are where teachers mostly give learners instructions to learn through committal to memory andrecital techniques and is not effective in developing learners' critical thinking and decision-making competences.

In my experience as a teacher, I have seen the challenges that most schools face, of insufficient textbooks and other physical text resources. I firmly believe using ICT resources like digital projectors and smartboards can help minimize teacher difficulties associated with this problem. At one of the schools in which I did my teaching practice, one teacher used to scan the textbook as they had limited books, and then project it in class. This practice by the teacher ensured that all learners would be able to see what was in the book while saving the

cost of making copies. I realized that with proper training on the skills of ICT integration, teachers could be able to enhance their teaching by utilising ICT resources that are available to them.

While interacting with primary school teachers in workshops planned by a technology subject advisor on ICT use, I realized that although most teachers had some ICT resources like tablets, projectors, and laptops in their schools, they were not using them as teaching aids. In 2015, the Department of Basic Education issued schools in the iLembe district with Tablets for learners to use for educational purposes. Most of the teachers did mention that they had received these tablets in their schools but they had no clue on how to use them. However, the impression I got from these educators was that they are willing to use ICT in their education provided they get proper training on ICT integration.

The information I got while working with teachers on using ICT in the classroom sparked my interest in doing this study. In this study, I worked with teachers who already have access to ICT resources in their schools.

1.3   Motivation/Rationale

In a concise space of time, ICT has become a cornerstone of modern society. As a result, many countries understand the role that ICT plays in society and the education system. In 2004, the Department of Education (DoE) in South Africa issued White Paper Seven on e-Education, intending to transform learning and teaching through ICT. The DoE went as far as distributing electronic devices in the form of tablets and laptops to schools. This introduction of ICTs in schools created new ways for teachers and learners to engage in information selection, gathering, sorting, and analysis (Department of Education, 2004). Despite all this investment by the Department in schools' ICT infrastructure, ICT acceptance and integration in teaching is still behind the desirable level (Mashile, 2017).

This study looked at factors that might be the root cause of the lack of integration in the education system. It focused more on primary schools that already have ICT resources, but they rarely used ICT in their teaching and learning, even though the teachers accept their utility. This study is in line with Goal number 16 of the Department of Education's action plan, which is about improving teachers' professionalism, teaching skills, and computer literacy throughout their entire careers. One of the priorities of this goal is to increase the educational use of ICT resources by the teachers (Department of Basic Education, 2015).

With the introduction of ICT in our education system, it is essential to look at how it can improve learners' results in Natural Sciences. An improvement in Natural Sciences at the senior phase will positively impact the performance of learners in Life Sciences, Physical Sciences, and other related sciences at the Further Education and Training (FET) phase. The introduction of ICT in education can make the teaching and learning process more effective and exciting for teachers and learners. ICT provides teachers and learners with more opportunities to work together even beyond the classroom. With the Fourth Industrial Revolution and the growing significance of artificial intelligence, all educators will be expected to be digitally proficient in ICT (Govender & Juggernath, 2020). Teachers that are informed about both the technology and its execution via integration into the teaching of their disciplines in order to accomplish educational goals are required in order for ICT to be effective in the classroom (DeCoito & Richardson, 2018).

1.4 Significance of the Study

The significance of this study is linked with four aspects. Firstly, this study aims to shed some light on the teachers' understanding of ICT integration and their experiences with the use of technological tools in the classroom. This was done by understanding the challenges and opportunities that Grade 7 teachers face when they want to integrate ICT in their classrooms. The information gathered was used to inform the second aim of the study, which was to offer targeted, practical guidance to Grade 7 teachers on the use of ICT in the classroom by providing relevant support wherever they needed it. This was done using professional development activities that formed part of this study, which subject advisors may find helpful when planning future workshops for teachers on ICT integration. Thirdly, participants shared ideas with the researcher on using ICT in teaching Natural Sciences in Grade 7 that can be disseminated to other Grade 7 teachers who are not part of the study. Lastly, this study will add to the existing literature available regarding the integration of ICT in teaching Natural Sciences in the senior phase. The literature currently available focuses on integration in sciences and on other grades. This study focused specifically on Grade 7 Natural Sciences in schools with ICT resources.

1.5. Statement of the Problem

The developments in ICT over the past two decades possibly represent the most significant opportunities for, and challenges to, the formal educational process (Juggernath, 2017). There

is a worldwide change happening in the teaching and learning process. Most of these changes include the introduction of ICT tools in the classroom. Teachers are now faced with new social and educational transformations that challenge them in their technical ability and their knowledge and expertise in their pedagogical use of ICT. During the COVID-19 pandemic, most schools with ICT resources adopted online or blended learning to complete their curriculum. Learners could learn from the comfort of their homes with teachers as facilitators of learning using different ICT tools, such as Google Classroom, MS Teams, or WhatsApp groups. Teachers who lacked ICT integration knowledge were left to wait for schools to re-open, together with teachers who had no ICT resources in their schools. This does not necessarily mean they were not integrating any ICT into their regular teaching, rather that they needed support in certain aspects of ICT integration needed during the pandemic. With training and proper guidance, these challenges could have been resolved.

This study sought to determine the understanding and practices of teachers regarding ICT integration and explore how they manage the challenges that could hinder their intention to implement ICT integration successfully. Research shows that even when resources are available, ICTs are often not effectively integrated into teaching (Juggernath & Govender, 2020). Therefore, teachers needed to find the support they need to implement ICT in Grade 7 Natural Sciences so that their practice of ICT integration in the classroom can be further developed.

1.6 Research Questions

To respond to the problem statement and in quest of the objectives, this study looked for answers to the following research main question, which is sub-divided into six sub-questions.

1.6.1 Main Research Question

How do teachers use Technological Pedagogical Content Knowledge (TPACK) to integrate Information and Communication Technology (ICT) in their teaching of Natural Sciences in Grade 7?

1.6.2 Sub-research Questions

RQ1. What ICT tools do teachers' use in Grade 7 Natural Sciences teaching?

RQ2. How do teachers use ICT tools in teaching Grade 7 Natural Sciences?

RQ3. How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before class teaching?

RQ4. What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action research process?

RQ5. How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after being supported in an action research session?

RQ6. Why do Natural Sciences teachers in Grade 7 develop Technological Pedagogical Content Knowledge (TPACK) in the way they do?

1.7 Overview of Chapters of the Study

This dissertation has five chapters. Chapter One introduces the study and lays the background of this study. This chapter highlights the history of ICT integration in South African schools. It also outlines the aims of the research and the research questions that shaped the course of the study, as well as my motivation for undertaking it. The significance of the study was also discussed. The methodology was only briefly referred to in this chapter, and will be fully elaborated in Chapter Three.

The second chapter will review the relevant literature to provide the background to the integration of ICT in education internationally and locally. The history of education in South Africa is discussed shortly here; from the change in South African education system from Outcomes Based Education (OBE) to Curriculum 2005; to the introduction of the White Paper Seven on e-Education in 2004 and the Department of Education in South Africa's intention to transform education through ICT; and the introduction of different programs by the Department of Education to supply various ICT tools to schools. Since this study focuses on teaching Grade 7 Natural Sciences using ICT tools, Natural Sciences as a subject is also discussed in Chapter Two. The chapter also looks at ICT in education and how it benefits teachers when they use it to teach science. It also explores some of the challenges faced by teachers when using ICT in teaching.

Chapter Three is about the research design that was used in the study. The theoretical framework is also discussed in this chapter. This study used the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2008) to understand how Grade 7 Natural Sciences teachers used their content knowledge, pedagogical knowledge, and technical skills to integrate ICT in their lessons for effective teaching. Koehler and Mishra introduced TPACK to understand the knowledge needed by teachers to integrate ICT in their teaching. As this study focused on understanding how teachers integrate ICT in teaching Natural Sciences in Grade 7, the components of the TPACK were reviewed and discussed as to how they link to this study. This study followed an action research design. It followed all four stages of action research: planning, action, observing, and reflecting. Two cycles of action research were done to collect the data from participants. Data collected is qualitative data. Hence the study also used a qualitative approach. The qualitative approach was interested in understanding how teachers interpret their experiences teaching Grade 7 Natural Sciences using ICT and what meaning they attribute to their experiences. It was a helpful way to explore social interactions to better understand the meaning of individuals to their ICT integration problems. The methods used to collect data, and the sampling methods followed are part of the discussion in this chapter.

Chapter Four discusses the findings of the research. It presents the results of the interviews, document analyses, questionnaire data and lesson observations. The results are presented and discussed in this chapter following the sub-research questions.

The last chapter of this dissertation discusses the conclusions based on the findings of the study and recommendations. The results were examined using the Technological Pedagogical Content Knowledge (TPACK) framework. The components of the TPACK used for discussing findings are Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK).

1.8 Summary of Chapters One

In this chapter, the significance of the study and purpose of the study were established. They highlighted what the study hoped to achieve and the impact it will have in the education sector. Research questions were discussed in this chapter, this was followed by outlining how the structure of the study will look like. It is deemed essential to review the most recent research

on ICT use in the educational system and to consider the benefits and challenges of doing so before starting the data collecting. In light of this, a literature review was conducted initially.

Chapter 2
Literature Review

2.1 Introduction

This study explores the integration of ICT tools like tablets, laptops, and digital projectors in the teaching of Grade 7 Natural Sciences within the current education system. The following literature review will provide a background on the education system of South Africa and the use of ICT in this education system. It will discuss how other countries have incorporated ICT in their education systems and the impact of these interventions. It will also give a deeper understanding of the use of ICT in science education. The National Curriculum Statement (NCS) and the Curriculum and Assessment Policy Statements (CAPS) will be quickly examined to discover what the Department of Basic Education has to say about the usage of ICT in South Africa.

2.2 The Education System in South Africa

Post 1994 democratic elections in South Africa, the education system has experienced many modifications. The education system was altered after the apartheid era to empower the formerly disadvantaged majority who were victims of the apartheid school system. The educational system shifted from a content-based to a learner-centred Outcomes-Based Education (OBE) structure. In the former educational system, there was a belief that learners sat passively listening to the educator, writing notes, and not participating actively in the learning process. According to the Department of Education, many students in the education system were not developing problem-solving or critical thinking abilities (Engelbrecht & Harding, 2008). According to Botha (2002), OBE was selected not only to liberate learners and teachers from a content-based education system but to answer to the developments in education internationally. OBE is founded on two knowledge pillars: competency-based education and mastery learning (Schmidt, 2017) and more emphasis was placed on outcomes, which are what learners can do with what they know and have learned (Gandhi, 2002).

The move to Curriculum 2005 was announced in parliament on March 24, 1997. This was seen as a significant public milestone in the process that started two years earlier. This curriculum was scheduled to run until the year 2005 with increasing teacher inputs. This initiative can be perceived as one of the most controversial changes in South African

educational history, yet it was also probably the most essential curriculum change in the country's education history.

Education systems or schools have an obligation to the community to develop learners that are more suited or well prepared to adapt to the world as it changes. So, when the world changes, the education system has to change to accommodate the world's demands. The world is now being dominated by technology, the internet and computers are daily changing our lives and how we do things. Therefore, it is essential to cater to the twenty-first century's needs. Such that, teachers must learn to adapt to change, particularly in light of new ICT-based teaching and learning trends (Barakabitze et al., 2019).

If South Africans were to partake in the knowledge economy, they needed to employ every effort to avoid being excluded in society or the world. The Department of Education released White Paper Seven on e-Education in 2006, with the goal of using ICT to transform learning and teaching. The goal of incorporating ICT into the educational system was to provide new opportunities for learners and teachers to engage in information collection, sorting, and analysis (Department of Education, 2004). This was to be achieved through the movement from the traditional 3 R's (Reading, Writing, and Arithmetic) skills to the new 4 C's (communication, collaboration, critical thinking, and creativity) skills in the education system (Motshekga, 2019). This was done in order to align our educational system with global technological advances.

In 2015, the Department of Basic Education in Gauteng started to implement paperless classroom projects. The Department launched the 'wire-for-life' program in schools in Tembisa and Hamanskraal. The 'wire-for-life' includes different ICT tools: interactive boards, tablets, and laptops with internet connectivity. More than 300 Gauteng schools received tablets for educational purposes. The Department of Basic Education in KwaZulu-Natal followed suit by providing ICT infrastructure and resources to public schools. More than 1500 schools in the province were provided with ICT resources and infrastructure that included CPU/projector combos, laptop computers, interactive whiteboards, desktop computers, netbooks, digital projectors, and tablets for teaching and learning (KwaZulu-Natal Department of Basic Education, 2015).

The Department of Education's initiative was perceived as the end of the era for chalk and chalkboards. The recurring failure to deliver textbooks to schools in time would be a thing of the past as learning materials were to be loaded onto the tablets. Using ICT tools to learn the

official curriculum was a promise for the future (Monyooe, 2015). So, has teaching and learning been transformed at school level? This study looked at how these ICT resources are being utilized in teaching grade seven Natural Sciences in the ILembe District, and how teachers can be supported in order to fulfil this vision.

2.3 ICT in the Education System

The introduction of ICT throughout the world into school systems began with the rationale that learners must develop and master the everyday use of ICT tools. Still, in the 21st century, the focus has shifted to integrating ICT into teaching and learning (Ford & Botha, 2010). ICT has quickly established itself as one of the fundamental building blocks of modern society. According to Kumar (2008), Information and Communication Technologies (ICT) is a broad term that encompasses a wide range of communication devices, such as radios, cell phones, computers, television sets, and satellite systems, as well as the several services and applications that go along with them, such as distance learning and video-conferencing. When these devices are used in educational activities, they can be considered a part of educational technology. In many countries, the use of ICT in teaching and learning has provided new teaching and learning opportunities for both instructors and students (Ngeze, 2017).

According to Dave (2019), ICT has transformed traditional forms of teaching and learning into online and virtual environments. Dave avers that the integration of ICT into the educational system has opened up a world of possibilities. ICT enhances classroom teaching and learning through enabling for digital learning. A study by Nchunge, Sakwa and Mwangi (2012), discovered that that ICT is important and full of benefits for teachers and learners. It motivates learners and hence improves their attitude towards learning; it enhances efficiency in the learning process, and contributes to improvements in the performance of learners. ICT technologies like multimedia computer software that combines text, sound, and colorful animations can help learners understand complex topics that would otherwise be difficult to understand. Many countries are now realizing the value of ICT and the fact that acquiring basic skills and concepts is an essential element of education (Kumar, 2008).

In many developing countries, ICT integration has become a key component of their education reform agenda (Peeraer & Van Petegem, 2011). In Africa, countries like Tanzania have also started investing in integrating ICT into their education system. Tanzania has completed its ICT Policy for Basic Education, which involves integrating ICT in pre-primary,

primary, secondary, and teacher education, along with non-formal and adult education (Hare, 2007b). Private schools in urban areas in Tanzania have been using ICT for teaching. The motivation to use ICT came from learners who wanted to achieve high grades nationally and from parents who also wanted to see improved grades for their children. However, even in these types of schools, ICT was still used to teach basic computer skills, with only a few schools integrating ICT as a resource for teaching. Most of the schools that are using ICT for teaching are high schools, with negligible adoption in primary schools (Hare, 2007b).

The role played by ICT in education has been recognized by other African countries like Burundi, Kenya, and Uganda, to name a few. Burundi updated its national ICT strategy in 2004 by adopting a national ICT development policy in February 2007. Despite having this policy in place, the government lacks a dedicated policy for ICT use in the education sector, despite the fact that ICT is recognized as a tool for improving access to and the quality of education (Hare, 2007a). According to Barakabitze et al. (2019), Kenya currently has a wide range of ICT initiatives and projects centered on e-infrastructure. They go on to say that the Ugandan government has been integrating technology-enhanced learning, with various programs launched in the last decade to boost the country's education system.

As previously stated, in South Africa, the Department of Education issued a White Paper on e-Education in 2004 that was about transforming learning and teaching through ICT. This document on e-Education stipulates the objectives, framework, resources, and strategies for implementing ICT integration in the classroom. According to the Department of Basic Education (2015) Action Plan, for numerous reasons, e-Education is regarded as one of the two most important areas of innovation in the basic education sector. To begin with, e-Education has the potential to alter the way students learn in fundamental ways. Second, modern ICT have the ability to significantly increase and diversify learning, and third, ICT are becoming so widely utilized in society that education without them is quickly becoming an incomplete education.

The Department of Education's Action Plan offers four major methods for improving ICT integration in education. The first technique focuses on establishing a link between classroom ICT use and learning objectives. Second, it is necessary to comprehend the various types of present ICT instruments. Finally, to push e-Education, establish a working connection with all necessary parties, and examine the current state of e-Education efforts and their predicted outcomes (Department of Basic Education, 2015). The Department of Education is clearly calling for greater research to establish the types of technologies that are accessible and whether

these types of technologies have been successfully incorporated, or could be (Padayachee, 2017).

Dehmel, the National Research Council, and Wang, Song, and Kang were all cited in the study by Kavai (2014), as stating that life-long learning has become one of the education policies of numerous countries, allowing students to use what they've learned in science and associated skills in their daily and professional lives. A vital instrument for economic growth and development is the ability to generate scientific and technological information and transfer it into the demands of the world (Mormina, 2019). As the world is now more technical and relies more on science and technology, it has been powerfully recommended that teaching and learning approaches change from being teacher-centred to learner-centred. Current research has indicated that ICT assists in transforming a teaching environment into a learner-centred one (Fu, 2013). Fu claims that ICT gives learners a chance to seek knowledge for themselves, and that it promotes learner independence since learners can learn on their own, anywhere and anytime, rather than viewing the teachers as the source of all knowledge and learning. With the introduction of ICT, the teaching and learning process changes from teacher-centeredness to learner-centeredness (Kuboja, 2019). Learners take charge of their own learning and grow more competent in working independently.

Hinostroza (2018) states that because of the widespread availability and use of ICT in society, teachers and students are increasingly using these tools to supplement their teaching and learning outside of the traditional learning classrooms. In 2020 when the COVID-19 pandemic struck, schooling was disrupted world-wide and schools had to adopt alternative teaching methods to continue their teaching and learning programmes. ICT became one of the solutions implemented by schools, and individual teachers. The COVID-19 pandemic situation has posed unprecedented challenges requiring teachers to adapt to teaching online (König, Jäger-Biela & Glutsch, 2020). However, evidence suggests that many students and teachers lack the digital skills required to make good use of these tools, limiting their potential impact and perhaps increasing educational inequities, particularly in developing nations. As soon as the reality of lockdown struck, ideas about online learning and the use of television and radio for revision began to occupy the corridors of the education sector in South Africa, and schools lost time for teaching and learning (Mhlanga & Moloi, 2020). Only the well-resourced schools with adequate ICT resources, and network connectivity, and those teachers who were ready to adapt, were doing e-learning during the lockdown of 2020; hence the majority of learners who were in poorly resourced schools, or in areas with no or poor internet connectivity, or had ill-

prepared teachers, were losing out on education. This highlights the importance of ICT pedagogy for teachers and learners and to have an understanding of how they practice e-learning in their classrooms.

Serdyukov (2017) says despite several studies showing that e-learning is on a par with learning from traditional teaching, it is going to take more training of teachers and effort to make ICT teaching comparable to more traditional teaching strategies. When we look at education within the ICT perspective, three categories of education can be distinguished, namely e-learning, distance learning, and blended learning (Kumar, 2008). These categories will be explored in the sections that follow.

2.3.1   E-Learning

E-learning is the term used when referring to learning that is enhanced through the use of a computer. It is associated with learning using networks and multimedia technology. Sometimes it is referred to as online learning (Kumar, 2008). In their study of definitions of e-learning, Sangrà, Vlachopoulos and Cabrera (2012) listed a few definitions that other authors have used to define e-learning, including Guri-Rosenblit's (2005) definition of e-learning as the use of electronic media for a variety of learning goals, ranging from add-on functions in traditional classrooms to complete replacement of face-to-face sessions with online options. They also cited Marquès' definition of as e-learning as distance education through remote resources. These definitions portray e-learning as the use of ICT tools for learning using online instructions.

A factor that contributes to the effectiveness of e-learning is the inclusion of application tasks (Noesgaard & Ørngreen, 2015), where learners are given an opportunity to apply the educational material presented via e-learning in a case study or actual work situation. According to Alsalhi, Eltahir, & Al-Qatawneh (2019), e-learning is flexible, allowing learners to learn at their own, at a time and location that suits their needs. They go on to say that numerous studies have indicated the benefits and advantages of using e-learning tools in schools. Some of these benefits include: e-learning is flexible in terms of time and place of learning; it improves the efficacy of knowledge by providing simple access to a large amount of data and it is more cost-effective because learners are not required to attend traditional classrooms. There is a drawback with e-learning because it requires learners to have network connectivity in order to access material. Data can be costly, and given the economic background of many South African learners, this will make it difficult for them to obtain information online. The content in e-

learning is electronic, which allows teachers to quickly and readily examine and change their material as needed, but it may be difficult for learners to obtain that information if they do not have access to a network.

Algahtani (2011) made a list of the characteristics of e-learning. He states that e-learning is not only about teaching the content in the classroom. It also includes the administration work of the teacher. Administrative work for teachers can include, but is not limited to, recording learners' marks, making schedules, and preparing the class register. The teacher can decide how to apply e-learning; he or she can utilize it as a substitute, or supplement for her classroom instruction. Algahtani listed the following characteristics of e-learning in his study. These are:

- *"E-learning is based on the use of ICT and a unified network to provide educational resources and messages amongst participants in the learning and teaching process via interactive electronic devices.*

- *E-learning not only provides content, but it also encompasses all areas of educational administration and planning, from goal-setting through assessment and evaluation.*

- *E-learning can either supplement or replace classroom learning.*

- *E-learning is conducted under some form of supervision.*

- *It does not replace official education delivery with technology, but it does provide alternate teaching and learning methods.*

- *It is designed to produce inputs, processes, outputs, and feedback in a systematic manner.*

- *Learners may engage in e-learning synchronously or asynchronously. With e-learning, learners can either learn alone at home or with their teachers. This is suitable for the COVID-19 era to comply with health regulations of keeping a social distance, as well as enabling learners who are in isolation to continue to participate in learning.*

- *E-learning is the use of a Learning Management System (LMS) and a Learning Content Management System (LCMS) to handle all aspects of learning.*

- *E-learning facilitates self-learning, lifelong learning, and personalization of learning."(p. 41)*

The characteristics of e-learning are summarized in **Figure 1** below.

Figure 1

The Characteristics of E-Learning (Algahtani, 2011, p. 42)
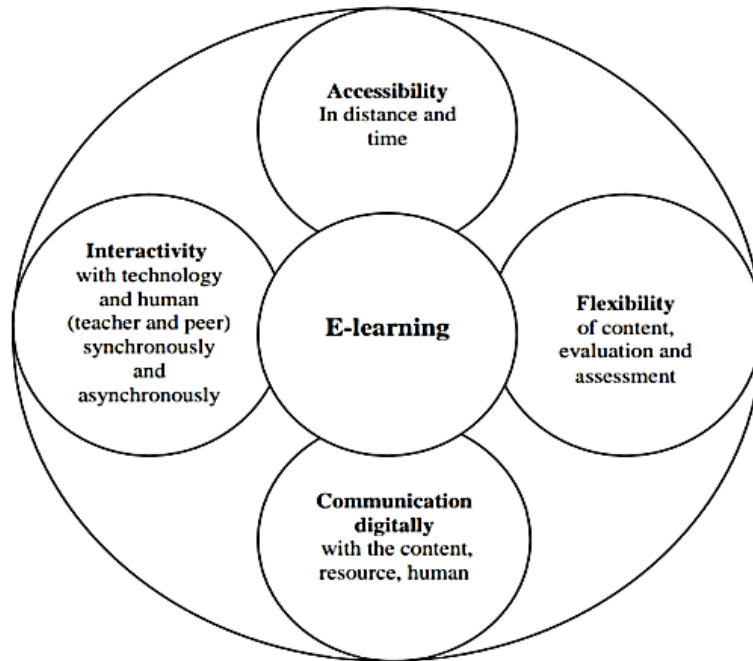
The usage of the internet is an important component of e-learning because it allows learning to take place in or out of the classroom. Due to the lack of ICT infrastructure in the majority of public schools in South Africa, e-learning may be difficult to implement at some of these schools. It is worth noting, though, that switching to e-learning allows for greater flexibility in teaching and learning. This research examined how Grade 7 teachers used their resources to teach Natural Sciences, as well as what ICT tools they have access to, and whether or not they can effectively use them to implement e-learning.

Arkorful and Abaidoo (2015) mentioned that there are three different ways of employing e-learning in education. The three models were discovered by Algahtani (2011) in his study that evaluated the effectiveness of e-learning. These models will be briefly discussed and are illustrated in **Figure 2** below.

Adjunct. Adjunct e-learning is when e-learning is used as a supplement to traditional classroom instruction, allowing learners or students to have more independence.

Blended e-Learning. In blended e-learning, the delivery of course materials and explanations are shared between traditional learning in the classroom setting and e-learning.

Figure 2

Model for Using E-Learning in Education (Alsalhi et al., 2019)
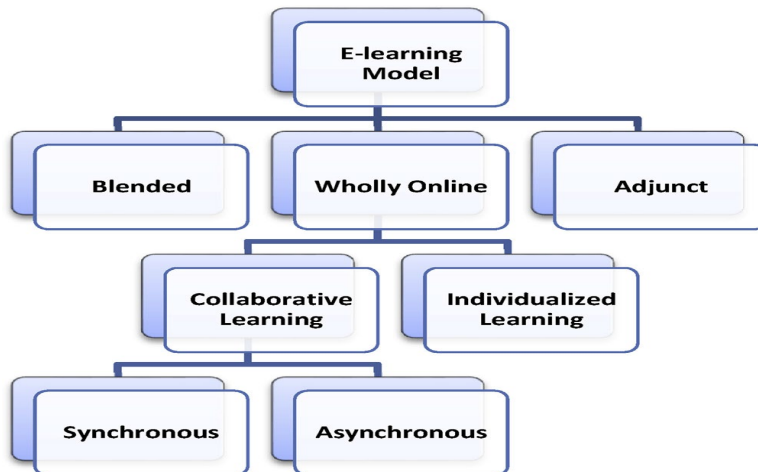
Wholly Online. The third model is totally online, which is without any traditional learning participation or classroom participation. In this form of e-learning the learners are given the greatest independence. The wholly online form is also divided into two categories, collaborative and individual learning. Collaborative learning is further subdivided into synchronous and asynchronous learning.

As already mentioned, the advantage of using e-learning in education is its flexibility, especially when considering issues of time and place (Arkorful & Abaidoo, 2015). The key principle of e-learning is its learner-centeredness and the focus on learning rather than teaching (Dabbagh, 2005). Each class in most schools has different learners with different learning capabilities. There are novice learners and learners who require different kinds of support to perform to their potential. As a result, a layered scaffolding structure is advised, in which rookie learners receive the support and information they require to engage in the learning task while advanced learners, who may not require the same degree or type of support as novice learners, are not slowed down. Providing a forum or chat room where learners may seek advice on how to do certain activities is one way scaffolding can be enacted in e-learning environments employing learning technology (Dabbagh, 2005).

Since most primary school learners still need scaffolding and support in their learning, wholly online learning might not work for the teachers in our district. The socioeconomic background of the community at the iLembe District might put other learners at a disadvantage if wholly online e-learning is employed, even though it would have been perfect for the COVID-19 era. Blended e-learning might suit teachers and learners as it employs both traditional and online learning. In blended e-learning, the learning remains under the supervision of the teachers, so learners are still monitored and supported in the process.

2.3.2 Distance Learning

Distance learning and e-learning are sometimes used interchangeably. They may have similarities, but they are not identical. As cited by Guri-Rosenblit (2005), the phrases 'distance learning,' 'distance education,' and 'distributed learning' are used more or less interchangeably, according to a thorough analysis published by The Pew Learning and Technology Program in the United States. Kumar (2008) defines distance learning as involving learners working on their own and communicating with their educator via an electronic form such as email, chat rooms, or other media. This type of learning is used mostly by higher education institutions like universities and colleges, and is very convenient for part-time learning. Distance learning entails interaction between the learners and the teachers from a distance, allowing for fast responses from the teacher to the students (Tsai & Machado, 2002).

2.3.3 Blended Learning

McGee and Reis (2012) described blended learning as educators and learners working together in mixed delivery approaches to achieve learning objectives that are pedagogically supported and which bridge course environments in a manner meaningful to the learner. Brooke (2015) defines blended learning as an instructional system that uses technology to create a more customized approach to learning, giving students control over when, where, how, and how fast they study. It is defined by The Clayton Christensen Institute (2016) as a formal education program in which students learn in part online and in part at a supervised brick-and-mortar venue away from home. According to Brewer and Harrison (2013), a blended learning approach is a combination of classroom teaching and online educational technology, as illustrated in **Figure 3**, that is tailored to each learner's unique needs.

One common misconception, according to Brooke (2015), is that simply incorporating technology into the school day constitutes a blended learning strategy. However, the sheer existence of technology does not imply a blended learning strategy. Instead, educators can use

technology to customize and streamline the learning process for students, resulting in effective blended learning. When learning takes place partly online and partly through other modalities, the multiple modalities are generally integrated, which is a common element of blended learning to put it another way, what students learn online influences what they learn in person, and vice versa (Staker & Horn, 2012).

Figure 3

Blended Learning
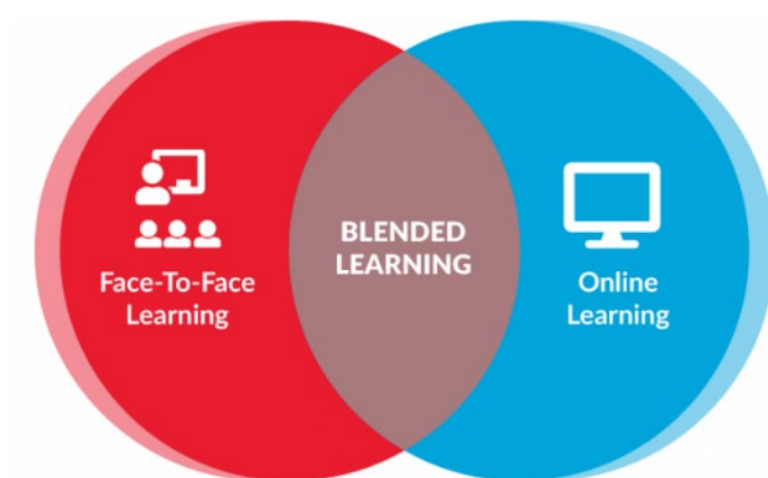
The Clayton Christensen Institute (2016) listed four models of blended learning that are most commonly implemented in schools today. **Figure 4** below, illustrates their taxonomy for blended learning.

Rotation Model. In the rotational model, learners will work in different activities, which may include groups, as individuals on a computer or tablet, pairs with peers, or pencil and paper assignments. Within the rotation model, there are several different implementation settings or or sub-models.

Figure 4

Blended Learning Taxonomy as per Clayton Christensen Institute
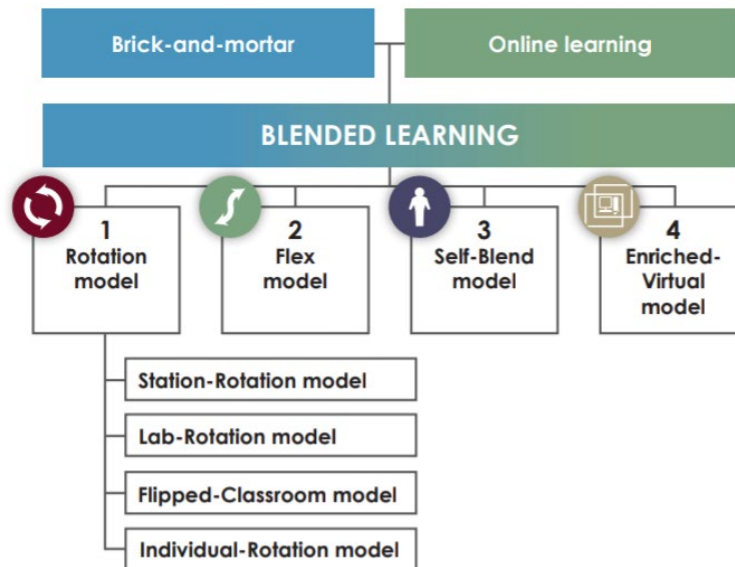
➢ **Station rotation model**: This simulates the classroom setting, where learners work through a track of activities, at least one of which should include the use of ICT as an instructional tool.

➢ **Individual rotation model**: This is the individualized prescribed setting where a learner works through some or all activities set by the teacher with the assistance of an ICT-driven assessment tool.

➢ **Lab rotation model:** In a computer lab, students concentrate on personalized online instruction. The teacher will use the data gathered from individual students' development to inform whole-class instruction.

➢ **Flipped classroom model:** Outside of school hours, all students receive the same education via online learning. The main lesson is provided via the ICT tool and is completed at home. Learners are then supposed to demonstrate skills and understanding of the content of the lesson through projects or assignments with help from the teacher.

Flex Model: Learners are taught on-site in a brick-and-mortar setting, with an online instructional tool serving as the subject's backbone and the teacher offering assistance as needed. Learner instructional methods are tailored, and teacher support varies depending on the school's implementation strategy.

Self-Blend Model. In this model, the learners receive instruction online in a particular subject. The support from the teacher is entirely online via an online instructor who is from a different location to that of the learner.

Enriched Virtual Model. The learners can have face-to-face learning sessions with the teacher, but they will be required to finish the rest of the work remotely on their own. Learners do not meet with their teacher daily, but they do have formal regular scheduled instructional sessions.

When blended learning is implemented properly, it can improve the success, satisfaction, and knowledge retention of the learner. It can also improve student engagement by ensuring that all students participate in class discussions and benefit from collaborative learning (Futch & Chen, na). Twelve case studies were published in different cities of the United States of America on how traditional school districts improved learning outcomes after implementing blended learning (Mackey & Watson, 2017). Brewer and Harrison (2013) also describe further benefits of blended learning, namely, that blended learning creates more time for teachers to focus on individual learners who need additional support and thus increases the learners' academic achievement as well as allowing teachers to get more out of their planning and instructional time. It can also lead to a reduction in the number of teachers that are required, allowing resources to be reallocated to other activities that schools usually cannot afford.

According to Lynch and Brereton's (2020) study, teachers who use blended learning say that planning the session takes a lot of time. A one-hour session, for example, could take four hours to prepare. Teachers need to have technological skills to use blended learning in case something goes wrong with the ICT during the lesson in order to be able to solve it quickly. In respect to approaches to teaching through the blended mode, for many, the flipped approach was a popular choice. They prefer this because they understand learners can be tired of learning through theory, so they prepare videos and stimulating activities for learners to keep them interested in learning (Lynch & Brereton, 2020). According to the findings of a study by Jeffrey, Milne, Suddaby and Higgins (2014) some teachers believe that the online component of blended learning relieves part of their administrative burden. Learners might be directed to online sites for administration and assessment required information and tools. All of the teachers thought that both classroom and online instruction were beneficial to students' learning. However, some teachers also had reservations about using blended learning. They described themselves as old-fashioned and preferred using a traditional classroom to teach their learners. Blended learning

has the potential to improve learners' science process abilities as well as their learning achievement (Harahap, Nasution & Manurung, 2019). This is because if blended learning is used in the science classroom, it can provide images, videos, simulations, and animations. The use of ICT in science will be discussed in detail in the following section.

2.4   Natural Sciences in South Africa

Natural Sciences is a compulsory learning area taught in the senior phase, grades seven to nine, in primary and high schools. Natural Sciences in this phase lays the groundwork for science disciplines in the subsequent phase of Further Education and Training (FET). Life Sciences, Physical Sciences, and Agricultural Sciences are among these subjects (Department of Basic Education, 2011). The Department of Basic Education has developed **Three Learning Outcomes (LO)** for the Natural Sciences Learning Area, which are as follows.

● *"Learning Outcome 1 (Scientific Investigations): The learner will be able to act confidently on curiosity about natural phenomena; and to investigate relationships and solve problems in scientific, technological, and environmental contexts.*

● *Learning Outcome 2 (Constructing Science Knowledge): The learner will know and be able to interpret and apply scientific, technological, and environmental knowledge.*

● *Learning Outcome 3 (Science, Society and the Environment): The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment"* (Department of Basic Education, 2011, pg 10).

These LOs promote teaching and learning that are more learner-centred. Tebabal and Kahssay (2011), in their study, claim that when a learner-centred approach is used, this probably results in a significantly better understanding of scientific conceptions and the elimination of misconceptions. In Natural Sciences, there are many inquiry and investigation activities that need to be done. These methods form part of a hands-on approach as learners are supposed to do investigations themselves. This includes coming up with a hypothesis, then designing and performing an experiment to investigate their hypothesis. A substantial amount of time should be spent on practical projects and investigations that are an important aspect of the science teaching and learning process.

Obe (2018) believes that education should prepare students for a world where science and its applications in technology play a critical role. He goes on to say that in order to understand scientific and technological aspects of both the natural and man-made worlds around them,

students must have a variety of skills and knowledge. This comprises the ability to reason based on facts, as well as a comprehension of science and how scientific knowledge is created. Science is an important field of human mental and practical activity, and the knowledge it produces has a profound impact on our lives and the lives of future generations. It is critical that everyone, not only future scientists, receives a wide awareness of the status and nature of scientific knowledge, as well as how it is formed and how reliable it is. As science and technology play a larger part in our lives, this has become increasingly crucial. ICT in education has demonstrated positive results in terms of supporting learners' collaboration and knowledge development, according to research (Juuti, Lavonen, Aksela & Meisalo, 2009). The results of the study by Fernández-Gutiérrez, Gimenez and Calero (2020) further show that the increase in the use of ICT in science education yields positive results.

2.5   ICT in Science Education

Science teachers are constantly confronted with new opportunities and problems in this information era, which are a result of the quick rate of scientific and technological discoveries on the one hand, and the astonishing growth of information technology on the other. Both concurrently provide new options and provide a source of new ideas that may be utilized effectively in science education teaching and learning processes (Savec, 2017). In the study by Juggernath (2017), Bonk is cited saying learning using ICT is more informal with little reliance on well-structured traditional types of teaching.

According to Al-Rsa'i (2013), the objective of science teaching is to develop in the younger generation a sense and feeling about the way the world moves that will enable them to think independently and critically Innovation and evolution are necessary for an individual, a nation, and humanity to survive and progress. Education-related innovations are particularly important since education is critical to ensuring a long-term future (Serdyukov, 2017).

Akpan and Itighise (2019) state that ICT has a significant impact on all aspects of the science curriculum, including science education. The pervasive influence of ICT on science education has undoubtedly had an impact, particularly on the quality and quantity of teaching and learning. The expansion of ICT in teaching and learning will have a serious effect on the nature and purpose of science education. When ICT is fully integrated in science education, it will provide enhanced possibilities for lifelong education.

South Africa, as a developing country, needs to exploit the use of ICT in science teaching and learning to advance scientific knowledge acquisition (Ramnarain & Moosa, 2017). South African education needs to keep up with learning technologies and how they can be utilized in scaffolding learning. Hilkemeijer (2020) listed ten ICT tools that can be used to enhance primary science. Simulators, MS PowerPoint, and virtual reality are among the tools that can be used as scaffolding tools in primary science. Hilkemeijer continues to state that virtual reality and simulators are on the rise in science classrooms as they bring new learning experiences to the learners. The use of virtual reality and simulations enable learners to explore places and phenomena without ever leaving the classroom.

The critical review of the literature on the effectiveness of simulations in supporting science teaching and learning by Smetana and Bell (2012) revealed that simulations can facilitate conceptual change, thus helping eliminate learners' misconceptions about the content being taught. According to Ramnarain and Moosa (2017), Learners can use simulations to interact virtually with phenomena that would be too dangerous to accomplish in real time, as well as to solve complex problems. The study by Falloon (2019) research adds to the growing body of evidence that simulations are useful in science education. Simulations, they say, give students more chances to explore science phenomena and conduct experiments on their own. The findings of Smetana and Bell (2012) suggest that simulations can be more effective than traditional teaching methods in teaching science. They further found that the effectiveness of simulations depends on how they are used in the classroom. Simulations are most effective when they are used to complement rather than substitute other educational experiences such as interacting with physical materials; when support structures, such as teacher guidance for using the simulation, are provided; or when their engagement results in cognitive dissonance and thus encourages learner reflection.

Teacher ICT integration. In the study by Obaydullah and Rahim (2019), to answer the research question "What can be done to enhance primary science teachers' adoption and integration of ICT into their teaching and learning?" the participants revealed that they need to be equipped with resources, as well as technical and pedagogical skills to effectively integrate ICT in primary science teaching. In other words, they need training on the use of computers and various application software programs, as well as the knowledge of how to use them for teaching and learning. Findings in the study by Akpan and Itighise (2019) revealed that all science educators need to be exposed to the knowledge of different ICT tools that are available and the skills for using them in teaching. This is relevant to my study as it was action research

which aimed to empower teachers by providing them with an opportunity to both share, and develop their knowledge on the use of ICT in teaching Grade 7 Natural Sciences.

According to teachers who have integrated ICT into their instruction, ICT may help existing pedagogical approaches in schools. It can be used to complement classroom teaching and support review in disciplines such as mathematics (Perienen, 2020). The use of instructional videos which can be viewed by learners at any time can help improve learner acquisition of the subject content. Having multiple resources available to teachers might be a positive attribute towards ICT integration, for the fact that teachers can choose whether to implement and use ICT or not. The fact that they do not necessarily have to adapt to this new reality is one of the challenges of ICT integration, even at the level of higher education (Melo, Llopis, Gascó & González, 2020). Some Mongolian primary school teachers have developed long-term relationships with their peers and between schools to assist one another in developing lesson plans to integrate ICT into their teaching, particularly when ICT technologies are regarded new and foreign technique (Li, Yamaguchi, Sukhbaatar & Takada, 2019). In South Africa, even though some teachers show enthusiasm, they also show uncertainty regarding how to proceed with ICT integration in the classroom, hence they are calling for knowledge sharing (Padayachee, 2017). In Kenyan secondary schools, teachers use teacher professional development opportunities to enhance the capacity of schools for effective ICT integration into their curriculum. This was done through the use of peer learning and sharing of ideas and experiences amongst schools (Tondeur et al., 2016). According to Hennessy, Harrison and Wamakote (2010), the ability of teachers to structure their learning environments in non-traditional ways, combining technology with new pedagogies, is critical to the successful integration of ICT into the classroom. This necessitates the development of a unique set of classroom management abilities, as well as new approaches to use technology to promote learning and foster technological literacy, knowledge deepening, and knowledge production. Teacher development, whether it is done through peer training or other professional development, is a crucial component of ICT integration, and was a key component of this action research study. It was interesting to explore how grade seven teachers in the iLembe District responded to the support that was provided, and how they can be supported to further integrate ICT in teaching Natural Sciences in Grade 7. The findings are discussed in Chapter four.

This study also looked at the perceived benefits that using ICT in their science teaching has for the grade seven teachers. The literature suggests a number of benefits that are discussed in the next section.

2.6   Benefits of ICT Usage in Science Teaching

It is an inevitable fact that, in learning environments where ICT is integrated into teaching and learning, both teachers and learners get benefits from using it (Eyyam & Yaratan, 2014). One purpose of integrating ICT in science teaching is to establish the type of education system that will produce citizens who can contribute effectively to live in the society (Akpan & Itighise, 2019).   ICT is a tool that has changed how scientists work (Chaudhari, 2017), and in an education system, it can influence how learners perceive and learn science. Chaudhari (2017) mentions that ICT has the potential to play a significant role in making school sciences more relevant and interesting and in motivating learners to be active in their learning.

Harber (2014) states that ICT offers several opportunities for innovation and development in teaching and learning. He further mentions that ICT has the potential to act as a catalyst to fundamentally change the pedagogic paradigm. Santos, Escudeiro and Carvalho (2014) mention that ICT allows for access to multiple opportunities for interaction, facilitated by flows of information and operational flexibility. This will help to improve the quality of teaching, learning, and management in schools and so help raise standards of educational outcomes.

In their study, Juuti et al. (2009) mentioned that the benefits of using ICT in education are to support learner collaboration and in creating knowledge. The authors also suggest that ICT resources can give learners new resources for learning and amplify opportunities for science education. They further state that science education provides opportunities for interacting with nature using the real-time data logging capabilities of ICT. Some of the other ICT tools that can be used in science activities to enhance the learning of science are multimedia software for presenting content and simulating dynamics processes with animations, simulation software for doing virtual experiments, presentation tools, digital recordings, computer projection technology, graphic tools, and modelling environments. ICT can also enhance both the theoretical and practical parts of science teaching and learning (Osborne & Hennessy, 2003). In the study by Juggernath and Govender (2020), teachers agreed that ICT was good in teaching and learning when used as visuals, but that it should only be utilized to enhance teacher-guided learning when necessary, such as for visual representations.

Four main benefits of integrating ICT in teaching science identified from the literature are as follows.

Improves engagement. Learners who do not enjoy going to school might enjoy school if technology is integrated into their lessons. The inclusion of ICT in a lesson can make learning

more exciting. This can be done by delivering teaching using gaming, virtual field trips, and other exciting programs found online (Jotter, 2016). This will increase learner engagement, which is difficult to achieve and sustain with conventional teaching.

Improves knowledge retention. Learners will retain more information if they are more involved in the learning process (Duffy, 2018). Learners will actively participate in learning if ICT is used to foster a learner-centered approach to learning, which is critical for knowledge retention. The use of ICT tools like PowerPoint presentations with animated images will also help learners to understand difficult phenomena thus improve knowledge retention.

Benefits for teachers. ICT can be used by teachers to get access to a countless number of educational resources. These resources can bring more diverse teaching approaches to the classroom. ICT can improve the educational process by enhancing collaboration and communication with learners, providing flexibility, and assisting learners in better understanding the teacher (Coman et al., 2020). ICT can save teachers time for doing lesson planning since there are virtual lesson plans online that can be adapted or adopted. In the study by Juggernath (2017), teachers stated that ICT helped them reduce the amount of time they spent on tedious manual labor such as data processing and sorting. This valuable time can be put to better use by assisting struggling learners, in order to increase their achievement in science.

Interaction with intangible phenomena. There are instances where direct interaction with a science phenomenon is not possible because of its complexity, location, or dangers involved; that is when simulation software is often used. Juggernath (2017) states that when using simulation software, learners can set and manipulate variables and observe results. Simulations have the potential to foster conceptual transformation and comprehension of scientific processes in general, but their success is determined by the quality of the simulation and how it is used, as previously noted.

While ICT integration can be beneficial, it must again be noted that having ICT resources in the school is not sufficient if the teachers have not developed the skills for using them. The challenges that might hinder the integration of ICT in the classroom will be discussed in the following section.

2.7 Challenges of Using ICT in Teaching Sciences

Both developing and developed countries have invested in ICT resources for their education systems (Pedrelli, 2001). Investment is made as an attempt to increase the quality of education. This is particularly significant in developing countries where existing educational environments do not afford opportunities to integrate ICT into education due to limited infrastructure (Cha et al., 2020). When making such investments, the typical expectation is that once gear and software are installed in schools, ICT integration would happen on its own (Tezci, 2010). However, once schools have been provided with the right ICT resources, the use of these resources will depend on teachers' perception of the tools and teachers' beliefs and level of knowledge of how to integrate such into a lesson.

Salehi and Salehi (2012) mention these additional challenges that emanated from their study. Firstly, if teachers do not have the abilities to filter information for relevance or construct a cohesive organizing principle, the nearly endless chances for access to information in an educational context might represent a serious danger of information overload. Secondly, teachers often lack confidence, have a shortage of time to invest in mastering new technologies and teaching methodologies, and are resistant to change. Thirdly, teachers lack effective training in solving technical problems that might arise, and finally, a lack of access to ICT resources.

In their study on the impact of ICT, Balanskat, Blamire and Kefala (2006), classified challenges into two categories; teacher-level barriers and school-level barriers. The teacher-level barriers are similar to those identified by Salehi and Salehi (2012), namely, a lack of ICT skills, a lack of motivation and confidence in using ICT, and inappropriate teacher training. Even when teachers can overcome these teacher-level barriers, they still find themselves faced with school-level barriers. The school-level barriers are as follows: The absence, or poor quality of, ICT infrastructure, limited teacher access to the ICT equipment that is available, and the absence of ICT mainstreaming into schools' developmental strategies.

Fu (2013) suggested schools should provide technology-related professional development activities to keep their teaching' skills and knowledge up to date, as well as technical assistance when needed. This will assist in addressing the issues associated with the use of ICT in education. Schools can also provide workshops that allow teachers to reflect on effective ways for integrating technology into teaching and to uncover issues that are critical to understanding

the process of integrating technology into teaching and learning (Almekhlafi & Almeqdadi, 2010).

The study by Juggernath and Govender (2020) confirms that teachers' beliefs are barriers to effective digital literacies in the classroom but that proper training can help to change that. They further state that teachers' beliefs affect their perceptions and judgments, which affect their classroom behaviour. If a teacher believes an ICT tool is not effective or simple to use, he or she will have a negative attitude toward it and will not use it in the classroom. So, simply providing technology in the school is not enough to transform education (Padayachee, 2017).

Teachers should learn not just how to utilize technology to enhance traditional teaching or increase productivity, but also how to integrate ICT into classroom activities in order to encourage learning from a learner-centered perspective. If teachers are well trained on the use of ICT, it will allow them to expand access to education, and it will also allow both learners and teachers to interact simultaneously (Fu, 2013). With learners more involved in their learning, ICT can provide them with the opportunity to make decisions, plan their own teaching pace and become independent learners (Lu, Hou & Huang, 2010).

2.8 Conclusions from Literature

The introduction of ICT in the school system began with the rationale that learners are required to learn how to use ICT tools; but, with the new developments in the education system, the focus has shifted into integrating ICT into teaching and learning. ICT has provided novel teaching and learning experiences for both teachers and students, according to the literature. It has opened up a world of possibilities. Teaching and learning have improved for those who have successfully integrated ICT into their educational system. ICT provides access to a variety of opportunities for engagement and operational flexibility that aids in improving the quality of teaching and learning and thus raises educational standards (Santos et al., 2014).

Many countries have recognized the important of ICT integration and have started to invest in the development to improve ICT infrastructure in their education system. South Africa has also invested in the development to improve ICT in education. This was mentioned in the Department of Education Action Plan (Department of Basic Education, 2015). The Action Plan considered that e-Education can involve changing the way schooling occurs and that ICT has the potential to improve and diversify learning.

ICT was brought into the South African educational system as a development tool to improve the quality of education and to provide all learners and teachers with equitable educational opportunities. In particular, the goal was to include schools that were previously disadvantaged so that they could participate fully in the education system (Mkhize, 2019). This was a sign that the South African education system was attempting to keep on par with what was happening globally. But I believe there is still a long way to go before schools in South Africa will reach the level of developed countries with regards to ICT integration. A lack of infrastructure in some part of the country may be only the first stumbling block to ICT integration. Due to low infrastructure and limited service delivery, it is challenging to train qualified teachers in rural areas (Department of Basic Education, 2017).

Although countries have invested in ICT resources for their education systems, the use of these resources will depend on the teachers' perception of the tools and the teachers' belief and level of knowledge of how to integrate such into a lesson. Literature reveals that many ICT interventions fail because the receivers are unable to maintain the ICT tool they have been given. Lack of fit between ICTs and user needs has been cited as one of the reasons for such failures. Teachers' ICT competencies and attitudes must be assessed prior to the introduction of new ICT tools to limit these issues. This assessment should be based on the ICTs they have personally adopted (Mwapwele, Marais, Dlamini & Van Biljon, 2019).

Like any other innovations, the use of ICT in teaching, learning, and administering educational institutions necessitates the creation of a new set of skills, attitudes, and pedagogical approaches, which necessitates ongoing training programs to build appropriate capacity among teachers. According to the literature, the South African Department of Education has launched an initiative to provide schools with ICT resources. Teachers must be familiar with how to use them in order to apply an integrated strategy to ICT use and new techniques.

The literature mentioned some benefits of using ICT in the education system. When it is used in science education, it can provide new possibilities for learners, such as learning at different rates and in different ways. Computer programs can also be used to scaffold learners to understand science, and improve how learners perceive science. It can enable learners to explore the world independently through the use of programs like simulators and virtual reality. While there are undoubtedly challenges in ICT integration, the benefits far outweigh the challenges.

2.9 Summary of Chapters Two

In this chapter, the literature gave an indepth understanding of how South African education has changed post 1994 democratic elections. All these changes were meant to bridge the gab in education amongst all races that was created by the apartheid government. Literature also looked at ICT as an educational tool, the benefits and challenges of using ICT in the Science education. ICT integration in education encompasses various notions for various people at various times, which has an impact on how technology is used in the classroom and the particular methodology that teachers engage their students with. Several common factors seem to surface regardless of the method chosen. This is then depend on teacher's attitude and belief on ICT integration and the developmental support to overcome those factors and use ICT effectively in the classroom. The literature has reveal that department of education has taken an initiative to provide support on ICT integration by supplying ICT resources to some schools but developmental workshops are still not adequate.

The research methodology and design are the main topics of the next chapter. It goes into detail with information about the methods utilized to collect the required data for this study.

Chapter 3
Methodology

3.1 Introduction

This chapter outlines the methodology of the action research study designed to explore the teachers' understanding of ICT integration and their experiences using technology tools in their Natural Science classrooms. This was done by understanding the challenges and opportunities that Grade 7 teachers face when they want to integrate ICT in their classrooms. The data collection methods were guided by the six sub-research questions.

RQ1.   What ICT tools do teachers use in Grade 7 Natural Sciences teaching?

RQ2.   How do the teachers use ICT tools in teaching Grade 7 Natural Sciences?

RQ3.   How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before class teaching?

RQ4.   What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action-research process?

RQ5.   How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after being supported in an action-research session?

RQ6.   Why do Natural Sciences teachers in Grade 7 develop Technological Pedagogical Content Knowledge (TPACK) in the way they do?

The data were collected using questionnaires, lesson observation, document analysis, and semi-structured interviews. Some of the data were collected during the support session with the teachers. Details of the data collection will be discussed later in this chapter. The sampling procedure and data analysis are also discussed in this chapter. This is followed by the discussion of the trustworthiness of the data generation process and ethical considerations. The theoretical framework used in the study will be discussed first.

3.2 Paradigmatic Perspectives

3.2.1 *Introduction to the Theoretical Framework*

Addressing the integration of ICT in teaching and learning is not limited to the provision of technology only but also involves the pedagogical approach, content, and its context (Juggernath, 2017). Therefore, the theoretical framework needed to take all of these into account. There are a few theories that could have been used in this study, like the Technology

Acceptance Model (TAM). TAM is an information technology framework for analyzing how people accept and use new technologies, notably in the workplace (Portz et al., 2019). TAM suggests that the person's intention to use technology depends on the person's perception of the usefulness of the tool and ease of use. While relevant to this study, TAM deals primarily with the acceptance of technology, rather than how it is actually utilised. In this study, I focus more on the actual integration of ICT by teachers, in other words, their actual practice in integrating ICT, rather than just their beliefs and intentions towards it. Thus, TAM is not the most suitable framework for the study.

Instead, I have used the Technological Pedagogical Content Knowledge (TPACK) framework for this study. Since this study is about teaching and the integration of ICT in the classroom, TPACK will be most suitable for this study as it includes content, pedagogical and technological knowledge as elements of the framework. This study did not just look at whether or not Grade 7 teachers use ICT in the classroom (adoption), but also how they integrate it into their teaching (technology, content and pedagogy). The content aspect can be partly seen in the planning process for a lesson; during the planning phase the teacher selects the learning outcomes that they will focus on during the lesson. These learning outcomes include the content that teachers will teach as well as the skills that need to be developed. Teachers will next decide on the activities that will assist in the delivery of content and how learners will learn, which are aspects of pedagogical knowledge. This research also examined how teachers select an ICT tool to complement the teaching and learning activities, and this requires technological and pedagogical knowledge. Finally, using the technology successfully in the lesson delivery requires technological knowledge. This study went on to look at how all of these aspects are combined by teachers in order to teach Grade 7 Natural Sciences effectively.

TPACK is viewed as a significant tool in promoting the pedagogical improvement of education (Rahman & Harun, 2018), and it has been suggested that it be formally included in teacher education programmes in order to foster effective ICT integration in education. The TPACK framework is discussed in more detail below.

3.2.2 *Technological Pedagogical Content Knowledge (TPACK)*

The TPACK framework is widely recognized as a useful tool for determining how well teachers integrate technology into their courses (Baran, Canbazoglu Bilici, Albayrak Sari & Tondeur, 2019). TPACK was created as a means of thinking about the knowledge that teachers need to effectively incorporate technology into their classrooms in order to accomplish

discipline-specific outcome (Koehler & Mishra, 2008). According to Andyani, Setyosari, Wiyono and Djatmika (2020), TPACK is the understanding of how to use pedagogical and technical approaches to help learners learn specific content. It is viewed as a viable framework for teachers to use in order to solve difficulties linked to integrating ICT into classroom teaching and learning activities.

Three knowledge elements form the basis of the TPACK framework; these are Content, Pedagogy, and Technology, as illustrated in Figure 5 below.

Figure 5

Technological Pedagogical Content Knowledge (Koehler & Mishra, 2008)
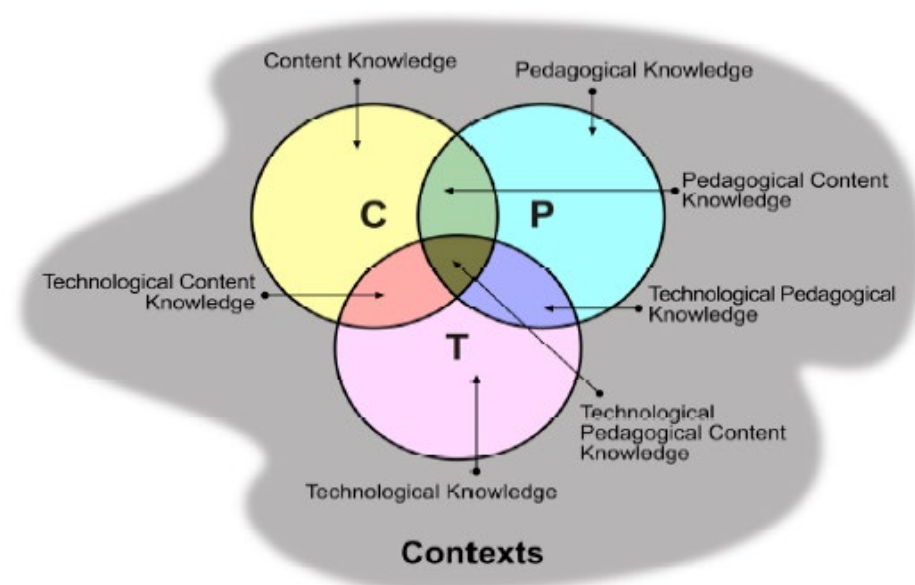
Rather than being considered three distinct bodies of knowledge, content, pedagogy, and technology intersect in this framework, forming complex relationships (Bibi & Khan, 2017). According to Koehler and Mishra (2008), TPACK is a type of knowledge distinct from that of a technology expert and from that of a teacher's general pedagogical knowledge. Rather, it is information that enables teachers to comprehend how to effectively teach a specific topic utilizing a specific sort of technology. This study will focus on the three elements of this framework, and these are Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK).

Technological Pedagogical Knowledge (TPK) is an addition to pedagogical knowledge. It focuses on the knowledge of different technologies and the way they are used in teaching and

learning (Koehler & Mishra, 2008). TPK can include knowledge of how teachers engage with learners in cooperative learning or how they motivate learners using technology (Cox & Graham, 2009). Thus, the focus is not on the content they teach, but rather on how they use technology to engage learners in the learning process.

In the framework of TPACK, Technological Content Knowledge (TCK) refers to an understanding of how "technology and content influence and constrain one another (Koehler & Mishra, 2008). Thus, teachers must understand which particular technology is most appropriate for teaching their specific content, and how the technology can change the way content is represented and learned. That is, technology may affect or change content knowledge and vice versa (Shu & Radio, 2016). Teachers with this type of knowledge are aware of the impact that technology has on general pedagogical practices.

Pedagogical Content Knowledge (PCK) is the knowledge that teachers develop through experience about how to teach particular content in particular ways to lead to enhanced learner understanding (Loughran, Berry & Mulhal, 2012). In simple terms, PCK is how teachers transform subject matter for teaching (Juggernath, 2017), and includes the choice and sequencing of content, as well as the way in which content is represented in the classroom.

According to Shu and Radio (2016) Technological Pedagogical Content Knowledge (TPACK), which builds on Shulman's construct of Pedagogical Content Knowledge (PCK), not only emphasizes that teacher knowledge has the characteristics of complexity, versatility and contextually, it is also regarded as a theoretical framework for understanding teacher knowledge required for effective technology integration.. Rather than perceiving content knowledge (CK), pedagogical knowledge (PK), and technical knowledge (TK) as separate entities, the TPACK paradigm emphasizes the intricate interplay and dynamic balance between all three (Koehler & Mishra, 2008). Teachers used to focus solely on adjusting content knowledge to adapt to new technology; but, with the advent of new technologies, we now need to evaluate the relationship between content knowledge and pedagogical knowledge. So, how can we present content knowledge effectively utilizing technology in order to achieve learning outcomes, and how can we use technology to enable learners to connect their existing knowledge to new content knowledge? In other words, how can we integrate ICT into teaching for more effective learning of the subject content?

According to Otrel-Cass, Khoo and Cowi (2012), TPACK defines the social and technological aspects of teaching that must be considered when teachers attempt to use

technology as a support for teaching; This requires teachers to learn how to plan their lessons with the affordances of the supporting technology already in mind. Due to the development of new teaching technologies that are readily becoming available, teachers are now encountering new ICT for teaching and learning. It is essential that they learn how to use these tools and have an understanding of their potential (Juggernath, 2017).

The TPACK framework was also used to inform the development of the lesson observation tool in this study as the purpose of the lesson observation was to understand how teachers use ICT to support content and pedagogy in teaching Natural Sciences. The observation tool that will be used will be designed to collect information on how teachers apply Technological, Pedagogical, and Content Knowledge (TPACK) in the classroom. TPACK was then utilized to inform the analysis and to interpret the study's data, concentrating on the three aspects in particular, Technological Knowledge (TK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) that were used to determine and present the findings in Chapter 4.

3.3 Methodology

This study followed an action research design. This methodology was chosen because I was interested in researching how teachers teach using ICT and sought to find practical solutions to their difficulties, which will then potentially improve their teaching. According to Creswell et al. (2015), action research aims at developing solutions to practical problems, which then inform practice. Action research has these characteristics, that is, it is practical, it focuses on change, it is a cyclical process, it involves participation, and it is an interactive form of knowledge development (Creswell et al., 2015). According to Bertram and Christiansen (2014), action research is often seen as an important way for teachers to engage in professional learning. This can be done by observing the practice, the process, and the results to constitute action research. In this study, action research is used to help teachers to plan, implement, observe, and reflect on their teaching practices to improve how they teach using ICT in Grade 7 Natural Sciences.

Many definitions are used to describe what action research is. According to Frost (2002), action research is a systematic process of thought, investigation, and action carried out by individuals concerning their professional practice. Bishnu (2021) defined action research as the application of facts and results to practical problem solving in order to improve the quality of action within it, and it entails the collaboration and cooperation of researchers, practitioners,

and laymen. Action research is concerned equally with changing individuals, on the one hand, and on the other, the groups or institutions and societies to which they belong (Cohen et al., 2013). According to Bertram and Christiansen (2014), action research is about improving educational practice in education.

Finally, according to Burns (2015), action research involves a self-reflective, systematic, and critical approach to an investigation. It involves participants who are also part of the research community, and its purpose is to bring about critically informed changes in practices that participants themselves identify as problematic.

Based on all these definitions and descriptions of action research, it is clear that action research is a reflective process. The participants have to reflect on their practice, and collaboratively seek solutions to their everyday problems. For teachers, this can involve looking for ways to improve their teaching practice and learner achievements. This methodological approach was chosen to enable me, as the researcher, to explore limitations and possibilities that had risen for the Grade 7 teachers when ICT was introduced in their schools. Action research used in this study involved gathering and interpreting data to better understand an aspect of teaching and learning using ICT and applying the outcomes to improve teaching practice (Costello, 2003). The idea that teachers will begin a cycle of raising questions, gathering data, reflecting, and deciding on a course of action is implicit in the phrase action research (Ferrance, 2000). As stated by Waddell (2018), the cyclical process of action research starts by identifying the problem, then designing the strategy on how to deal with the problem, then taking action on trying to solve the problem. After the action has been taken, reflection on what has happened is done. This process is then repeated multiple times until there is an improvement.

This study had two cyclical processes to collect data. First, it investigated the barriers that impede Grade 7 Natural Sciences teachers from integrating ICT into their classrooms. This was done using observation and questionnaire distributed to all participants. This was later followed by planning and implementing support strategies to address the issues identified during the observation. After the support session, participants were interviewed to collect data on integrating ICT and how the support has helped them. Figure 6 below represents the action research collection cycles.

Figure 6

Action Research Data Collection Cycles
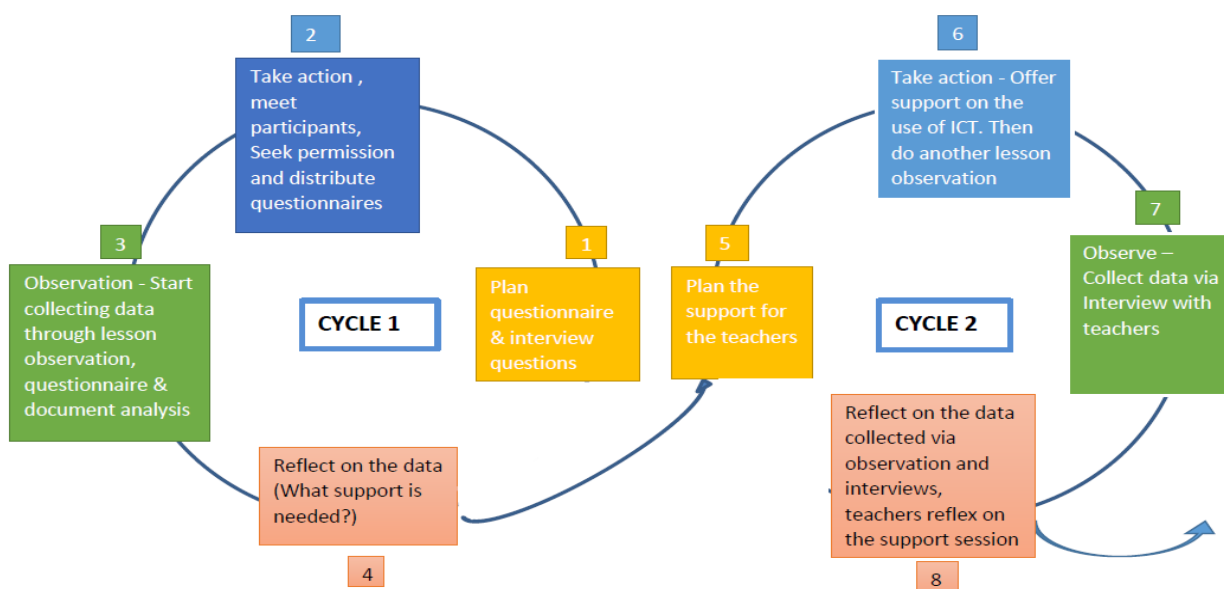
Participants were visited a maximum of three times at their schools in order to carry out this research. The first visit was for observation purposes and to give them the questionnaire to complete. Participants were later visited for the developmental activity, which took 45 minutes to one hour per teacher depending on the individual needs of each teacher. The interviews were conducted on the third visit where possible, else completed over the phone. COVID-19 protocols were complied with during all school visits and interactions with participants.

The cycles are described in detail in the following sections.

3.3.1 *The First Cycle of the Action Research*

The Planning. In the planning of the first cycle, I decided on the relevant documents for document analysis, and prepared the lesson plan observation schedules and questionnaires for the teachers. This was a very important stage of this research as it was meant to collect the initial data that had the potential to shape the structure of the study. The first cycle was meant to find out what ICT resources were being used by teachers, their experience in using ICT, and to collect background information on the teachers. When all the documents were ready, it was time to take action.

The Action. This stage involved visiting the participants in their respective schools for me to introduce myself and explain what the study was about. Seeking permission from Principals to conduct the study in their schools was done during this stage. I started by explaining the whole process to the participants. I discussed how the study was going to be done and their roles and rights as participants. Participants had to sign an informed consent form at this point. They were then handed the questionnaire to complete.

The participants were given time to decide which lesson they wanted me to observe, and meetings were then scheduled around these lesson times.

The Observation. During this stage of the action research, I collected all the completed questionnaires from teachers, as well as the teachers' lesson plans and development portfolios (Annexures A and B). Three teachers participated in the study and the first participant I met with was Miss Mbambo (pseudonym) from school A, followed by Miss Khumalo (pseudonym) from school B then Miss Shandu (pseudonym) from school C. The lesson observation was conducted by using a laptop to video record the participants' lessons.

The Reflection. In this stage of the action research, I had to look at the data available to identify what teachers needed to improve their ICT integration. The documents were analysed using the Document Analysis Tool that is attached at the end of this study (Appendix 9), and the recorded lessons analysed using the Lesson Observation Schedule (Appendix 8). The questionnaire data were also analysed to inform the second phase of the action research process. I then reflected on the data in order to plan for the support sessions based on each teacher's individual needs.

3.3.2 *The Second Cycle of the Action Research*

The Planning. During the first stage of the second cycle, I used the data and findings from the first cycle to plan the support sessions for the teachers. The resources that were required from the internet such as PhET simulations were identified and downloaded in preparation for the support sessions, and I ensured that I would have sufficient data and internet connectivity. When this preparation was completed, I scheduled a time with each participant to discuss how they could be supported on ICT integration.

The Action. The participants discussed the challenges they encountered when they integrated ICT in their teaching of Grade 7 Natural Sciences. I discussed the initial findings from the lesson observation with each teacher individually. The support sessions were done individually with the teachers as they had different needs and wanted different support. It is important to note that the support sessions were not one-way, with me simply telling the

teachers what they could do. Instead, teachers also shared their ideas in these sessions on how ICT integration should be done.

The Observation. The discussions during the individual support sessions were recorded and then analysed to provide further data regarding the teachers' integration of ICT.

The Reflection. After the sessions, all three teachers were requested to take the new information from the support session and plan for a new lesson. They were given a chance to go back to their classes to apply the new knowledge gained through the support. They then reflected on how their teaching had improved. I then scheduled the semi-structured interviews with the teachers. The semi-structured interviews were conducted to get more data on their teaching experience and to have an understanding of how their TPACK developed in their teaching of Grade 7 Natural Sciences. The interview made teachers reflect on their teaching before and after the session. This is where they shared their inner thoughts about what they think about ICT integration and why they do ICT integration the way they do it.

3.4   Sampling and Context

In this study, purposive sampling was used to select three teachers and three schools that participated in the research. These teachers were purposively selected because they were already using ICT in their teaching and they came from a poor resourced schools. According to Creswell et al. (2015) purposive sampling or criterion-based sampling is when the researcher selects participants and locations for research because they can help in understanding the research problem and the study's main phenomenon. Purposive sampling was used in this study because the researcher has a specific purpose in mind (Creswell et al., 2015), and participants were selected because they possess a specific characteristic needed for this study (Cohen et al., 2013). Since this study focused on teachers who are using ICT to teach Natural Sciences in Grade 7, it made sense to use this kind of sampling.

Teachers from three schools (Schools A, B, and C) were selected to take part in this study, one from each school, giving three participants for the study. All schools from which participants were selected are situated in the KwaDukuza area, in Groutville, under the iLembe district and Umhlali circuit. They are all public schools in a highly-populated area and share a common problem of congested classrooms with an average of 52 learners per class in Grade 7.

The facilities available at each school, as well as its infrastructure, were considered for the selection. Therefore, these schools were selected because the teachers in these schools were

already using ICT in teaching Natural Sciences in Grade 7, but not were not frequent users, and they had limited ICT resources available to them. All teachers in these schools were using digital projectors and laptops for teaching. All teachers that participated in the study were female. Pseudonyms were allocated to teachers following ethical guidelines.

Mrs. Mbambo has been teaching Natural Sciences for the past four years in grades 4 and 5 and three years in Grade 7. Miss Khumalo has nine years of teaching experience and has been teaching Natural Sciences in Grade 7 for seven years. Finally, Miss Shandu is in her fifth year of teaching and has taught Natural Sciences in Grade 7 for the five years.

3.5 Methods of Data Generation

Five methods of data generation were used to collect data for this study. They were questionnaires, lesson observation, semi-structured interviews, document analysis, and the interactions with participants during the support sessions. A pilot study was first done with a colleague who was not part of the study, because a pilot study is important for the improvement of the quality and efficiency of the main study (In, 2017). Piloting the study helped to assess the feasibility of the study and to establish if data generated from the research instruments can be interpreted in terms of the information that is required for the study, as suggested by (Van Teijlingen & Hundley, 2002).

3.5.1 *The Questionnaire*

Data were collected using a questionnaire (Appendix 7). It was distributed to all three teachers on the day of the first meeting with each participant. The questionnaire was used as a tool to collect the background information on the participants. Questionnaires are frequently used and useful instruments for collecting data, according to Cohen et al. (2013). The questionnaire that was used in this study had three sections with short questions. The first section focused on the biological information of the participants. It was about the age of the participants, the number of years in teaching in general, and the number of years teaching Natural Sciences in Grade 7 in particular. The second section focused on understanding the experience a teacher has on teaching Natural Sciences using ICT tools. It also looked at the development activities a teacher has attended on the use of ICT in teaching. The last section of the questionnaire focused on the resources a teacher has at his/her disposal in the school. It also seeks to find if a teacher is aware of all ICT resources available in the surrounding environment. The data collected using a questionnaire helped to complement the data collected during interviews that were digitally held using a cellphone and one done face-to-face.

3.5.2 *Lesson Observations*

There were also lesson observations that were done. Teachers were given a chance to conduct a Natural Sciences lesson using ICT in their classroom. Due to COVID-19 regulations, two of the lesson observations (Miss Khumalo and Miss Shandu) were recorded using a laptop that was either set up by me or the teacher before the lesson started as due to the lockdown levels restriction, I could not get permission to go to into the class to observe. However, the lesson observation for Miss Mbambo was done in-person because at that stage South Africa was on level one of lockdown, and I was now allowed to enter the class to collect data. I used these recordings to observe how ICT was utilized in the lesson. According to Bertram and Christiansen (2014), observation is when the researcher goes to the site of the study, which may be a classroom, and observes what is happening. This way, the researcher obtains first-hand data on teacher practices. This allows a researcher to report on things he witnessed and recorded himself, as opposed to relying on claims made by other people.

The lesson observations were used as a background check on the teachers' use of ICT in preparation for the action research development activity with teachers. It was used to help me to have talking points when I meet with the teachers. It must be noted that this lesson observation was not meant to find fault in the teachers practice, but rather to better understand how ICT was being utilized in the lesson. Lesson observation focused on TPACK, more specifically on the Technological Knowledge, Technological Content Knowledge, and Technological Pedagogical Knowledge of the teacher that could be identified through their practice using an observation schedule (Appendix 7).

Observations of technological pedagogical knowledge in the lesson focused on the teacher's knowledge of technologies and the way the teacher used them in teaching and learning (Koehler & Mishra, 2008). It also looked for evidence of how teachers engage with learners in cooperative learning and how they motivate learners using the ICT tool (Cox & Graham, 2009). The observations of Technological Content Knowledge focused on how the teacher used technology to create a new representation of the content being taught. Technological Content Knowledge was also determined by how the teacher used ICT to change the way learners viewed the content knowledge (Shu & Radio, 2016).

3.5.3 *The Semi-structured Interviews*

Qualitative data were collected using audio recording during individual face to face semi-structured interviews with teachers. These qualitative semi-structured interviews played a vital

role in assisting the researcher in seeing the world through the eyes of the participants, and they provided a valuable source of data (Creswell et al., 2015). The semi-structured interview questions (Appendix 10) were sent to the participants before the scheduled interview time, and the procedure for the interview, the structure and organization of the interview, was explained (Cohen et al., 2013). This was done to put the participants at ease and to provide an opportunity for the participants to seek clarity where it was needed.

The semi-structured interviews conducted were about 30 minutes to give each participant enough time to express their opinions. Due to COVID-19 regulations, two interviews were done using a telephone, and when the restrictions were lifted, I sat down with one respondent and asked questions face-to-face. I digitally recorded the interviews using a cell phone instead of writing down answers, because writing down answers is time-consuming and may be distracting (Creswell et al., 2015). Permission to record the interviewee was gained before each interview commenced. Recorded data from interviews were transcribed fully to facilitate their analysis.

3.5.4 *Document Analysis*

Documents analysis was used to collect data. Teachers' learning portfolios and lesson plans for each lesson were examined to collect data to further understand teachers' integration of ICT.

3.5.5 *Interactions During Support Sessions*

Data were collected during the support session with the teachers on the use of ICT. Audio recordings for the session were transcribed to get more data on teachers' integration of ICT in Grade 7 Natural Sciences.

The researcher's use of methodological triangulation, which Cohen et al. (2013) define as using multiple methods in the study, hoped to produce consistent and dependable results. Table 1 below summarizes the data collection methods.

Table 1

Research Questions and Data Generation Methods

Research question	Data collection method and instruments	Data sources
RQ1: What ICT tools do teachers' use in Grade 7 Natural Sciences teaching?	Questionnaire	Teachers
RQ2: How do the teachers use ICT tools in teaching Grade 7 Natural Sciences?	Lesson observation and interview	Teachers
RQ3: How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before classroom teaching?	Interview and document analysis (Teachers' learning portfolio & lesson plans)	Teachers
RQ4: What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action-research process?	Interview and document analysis (Teachers' learning portfolio & lesson plans)	Teachers
RQ5: How do teachers develop TPACK after they have been supported?	Interview and lesson observation and document analysis (Teachers' learning portfolio & lesson plans) Observations during the support sessions	Teachers
RQ6: Why do Natural Sciences teachers in Grade 7 develop TPACK the way they do in integrating ICT?	Interview Observations during the support sessions	Teachers

3.6   Data Analysis

This study followed a qualitative approach to collecting data, and this means the analysis of the data should be done qualitatively. Recorded data from interviews were first transcribed fully. After the data had been transcribed, audio recordings were listened to again to make sure they corresponded with the transcribed data. The transcribing used in this study is the one Matheson (2007) describes as "listen and repeat." All the data were personally transcribed by me personally because transcribing one's qualitative data allowed me to grow closer and more familiar with the data (Matheson, 2007).

This also ensured that I listened to the data several times before starting the actual analysis. This data were then analyzed by the use of content analysis. Content analysis is an approach that analyses qualitative data to identify and summarize message content (Creswell et al., 2015). Creswell et al. (2015) defines content analysis as a process of viewing the qualitative data from

a different perspective to identify keys in the text or data to help the researcher understand data and then interpret it.

Before starting the coding of the data, I went back to notes, and records that were taken during interviews and observation to verify data. In some instances, going back to the participants to verify or to collect additional data were required to confirm the meaning of the data.

After all the data gathered from the interview were transcribed, it was then coded to make it easy to understand and interpret. Creswell et al. (2015) defines coding as the process of reading carefully through the transcribed data, line by line, and dividing it into meaningful analytical units. I went through each interview notes to identify each code. The codes used were derived from the data responsively rather than being created before coding (Cohen et al., 2013). When few codes were identified, I went back again to see if I have missed any crucial information and other codes from the data. The generated codes were checked for similar ideas, phrases, practices, recurring problems, similar wording, or ways of thinking. They were then grouped into clusters to identify patterns. Then I examined all the clusters of meaning to determine if there is one or more central theme (Cohen et al., 2013). The data from all participants was then interpreted in order to answer each sub-research question.

3.7 Trustworthiness of Data Generation Process

Ensuring and verifying the quality of the data and data analysis are essential features of the research project (Athanasou et al., 2012). The validity of qualitative research can be improved by increasing the sources of validation, and this is referred to as triangulation (Athanasou et al., 2012). Creswell et al. (2015) mentions that triangulation involves the use of different sources of information, methods, theories, researchers, or types of data.

In this study, various data sources were employed to assure the trustworthiness and credibility of the data acquired. The data were collected using interviews, lesson observations, a questionnaire, document analysis as well as observations made during the support sessions. After the completion of each interview transcription, the notes and transcripts of the interview were submitted to the participants to correct errors and verify if the interpretation of what they shared was correct. External verification in the form of a critical friend was also utilized to boost the credibility of the findings. The raw data and coded data were both submitted to my critical friend to assess the way analysis was carried out.

The data collected from interviews and the questionnaire were compared to enhance trustworthiness. The notes taken during lesson observation were verified with the participants as well to enhance the credibility of the data. After the data were coded and interpreted, copies of the draft results were given to the participants for written or oral feedback on the interpretation. The different aspects of trustworthiness for findings of this study, are further discussed below in relation this research.

3.7.1 *Credibility*

In this study, I started collecting data without a predetermined outcome assumption. More importantly, I was committed to providing an accurate presentation of the research findings in order to fully comprehend the phenomenon under consideration. To enhance credibility of the findings, interviews were recorded using a voice recorder. This means transcripts were more accurate than if I were to simply jot down notes during interviews (Bertram & Christiansen, 2014). Lesson observations were recorded using a laptop video camera, which ensured that data collected using lesson observations can be reviewed by replaying of the video recording. This eliminated some of the blind spots the researcher might have missed during the first replay of the recording, or missed completely had the lesson not been recorded.

3.7.2 *Dependability*

Dependability entails participants reviewing the study's findings, interpretations, and recommendations to ensure that they are all supported by the data collected from the study's informants (Anney, 2014). The participants were given access to the study's findings in order to confirm that my interpretations were correct. This assured that the study's findings are reliable and can be trusted.

3.7.3 *Confirmability*

Confirmability ensures that the findings were the result of the teachers' experiences and opinions, rather than the researcher's prejudices. This was done by using different methods of collecting data. To increase the reliability of the results, the data acquired through the questionnaire and lesson observation were compared to the findings from the semi-structured interview.

3.8 Ethical Considerations

I made sure to respect the autonomy of all the participants in the research. The research did not commence until the approval letter from the University of KwaZulu-Natal for ethical

clearance was received and the ethical certificate was issued (Appendix 2). The application letter to conduct research in schools that fall under the administration of the KwaZulu-Natal Department of Education was sent to the Head of Department for approval. The approval letter was then sent to the District Director of ILembe District and Umhlali Circuit Management Centre (CMC) (Appendix 1). A letter, informing principals about the project and inviting them to participate, was then sent to the principals at the identified schools in order to obtain permission before I approached teachers (Appendix 3).

All teachers were informed of what would be expected of them if they took part in the study and that their involvement was entirely optional and that they may withdraw at any time if they changed their minds. The aim and benefits of the study were clearly explained to all participants. All participants were made aware that all the information they shared would remain confidential, and no real names would be used in this study. In reporting the results of the study, participants and schools are referred to using pseudonyms to ensure their anonymity. Informed consent letters were signed by everyone who agreed to participate in the research (Appendix 6). According to Bertram and Christiansen (2014), consent means that the participants agree to take part in the study.

During the visit to the participating schools, all efforts were made to ensure that the daily functioning of the school was not interrupted. In respect of the COVID-19 regulations, all protocols were adhered to: social distancing was observed while working with the teachers, masks were worn at all time and hands were sanitized as required.

3.9 Summary of Chapters Three.

The method used to gather the data for this study was described in this chapter. The research design and methodology were thoroughly examined, and the choice to utilize a purposive sample was supported by the evidence. In order to help the reader understand how the data in this study were created and analyzed, the procedures followed at each stage of the research was described. This chapter also covered the steps taken to guarantee the validity and dependability of the data and the study's findings.

The following chapter will discuss in detail the findings of the study.

Chapter 4
Findings and Discussions

4.1   Introduction

This chapter presents and discusses the data generated in this study. The findings and discussions are consolidated according to the sub-research questions that were used for analysing data following the stages of the action research cycles. These findings emerged from the data that came from lesson observations, documents analyses, questionnaires, interactions during the support sessions, and semi-structured interviews that were conducted with the participants.

The purpose of the study was to understand how Grade 7 teachers use ICT when they teach Natural Sciences in Grade 7. The main research question for this study was: How do teachers use Technological Pedagogical Content Knowledge (TPACK) to integrate Information and Communication Technology (ICT) in their teaching of Natural Sciences in Grade 7? This was then divided into six sub-research questions as follows:

RQ1.   What ICT tools do teachers' use in Grade 7 Natural Sciences teaching?

RQ2.   How do the teachers use ICT tools in teaching Grade 7 Natural Sciences?

RQ3.   How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before classroom teaching?

RQ4.   What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action research process?

RQ5.   How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after they have been supported in an action research session?

RQ6.   Why do Natural Sciences teachers in Grade 7 develop TPACK in the way they do in integrating ICT?

The main research question was sub-divided in different sub-questions which were further sub-divided to assist with the analysis of the data obtained. The data were analysed using a framework called Technological Pedagogical Content Knowledge (TPACK).

Following the two cycles of the action research, this chapter discusses the data and the findings of the action research I carried out intending to explore teacher understanding and practice in the use of ICT in teaching Grade 7 Natural Sciences. It followed all the cyclical steps of action research, planning, acting, observing, and reflecting as illustrated in Figure 7 below.

Figure 7

Stages of the Action Research Cycle
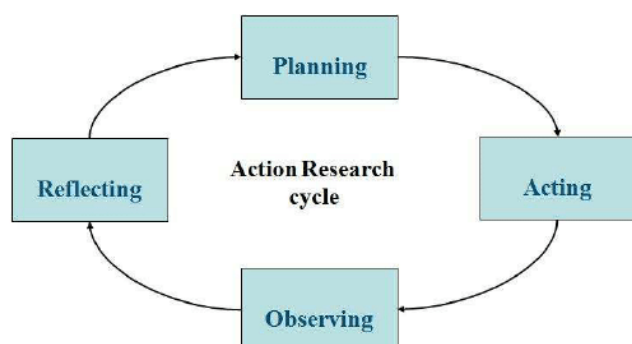
4.2   ICT Tools Teachers' use in Grade 7 Natural Sciences Teaching

The questionnaire (Appendix 7) was given to teachers in the first cycle of this action research and was used to collect data for RQ1. What ICT tools do teachers' use in Grade 7 Natural Sciences teaching? This question also hoped to get an understanding of the experience of the teachers on the educational use of ICT in the classroom and outside the classroom. The findings of the questionnaire are discussed first in the following section.

4.2.1 *Findings from the Questionnaire*

Teachers' Experiences with the use of ICT for Teaching. Miss Khumalo and Miss Mbambo have been using ICT in their teaching for the past three years while Miss Shandu has been teaching using ICT for more than four years. All teachers mentioned in the questionnaire that they were not exposed to any ICT development training. Out of all three teachers, Miss Khumalo is the most frequent user of the internet in her classroom, using the internet at least four times in every five lessons. Miss Mbambo indicated that in five lessons, she will use the internet twice. Miss Shandu had never used the internet in her classroom before. The summary of their experiences is tabled in Table 2.

The questionnaire also showed that all the participants mostly use a laptop connected to the digital projector for PowerPoint presentations. It was observed from the questionnaire that all teachers were frequent users of the digital projector, with Miss Khumalo using the digital projector every day. Out of the three teachers, Miss Khumalo was the only teacher who frequently used YouTube videos in her lessons. The sources of information accessed by the

participants varies as well, with Miss Khumalo and Miss Shandu often using the internet and a learning platform like nect.org to collect information when they prepare their lesson, while Miss Mbambo relied more on the textbook, and rarely used the internet for resources.

Table 2

Teachers' Experience in Teaching Natural Science and in Integrating ICT

Teacher	Experience teaching Grade 7 Natural Sciences (years)	Experience of teaching using ICT in the classroom (years)	Using the internet in the classroom (Out of five lessons)
Mbambo	1-5	3	2
Khumalo	6 - 10	3	4
Shandu	6 - 10	4	0

Due to the socio-economic background of the community in which all three schools are situated, none of the teachers had ever communicated with their learners online. A lack of access to ICT resources, particularly home internet access, is another difficult barrier to ICT integration, according to several research findings (Bingimlas, 2009). The limited access to ICT resources calls for the government and education sectors to address contextual and environmental difficulties faced by needy and rural school learners who are excluded from the e-learning platforms through factors beyond their control (Adarkwah, 2021). The findings from Msiza, Malatji and Mphahlele (2020) support that Internet access can be one of the impediments to ICT integration implementation. Learners and teachers may find it easier to get information for assignments, projects, and resources if internet connectivity is available.

Teachers' Confidence on the use of ICT in Teaching. One of the questions on the questionnaire sought to understand the confidence teachers had in completing different tasks involving ICT. Miss Khumalo and Miss Shandu indicated that when it comes to using a spreadsheet (Excel) and downloading and install programs on a computer, they were not very confident. While Miss Mbambo felt extremely confident in the use of a spreadsheet, she also had little confidence in downloading and installing programs on a computer.

Miss Mbambo and Miss Khumalo expressed that they were very confident in creating a presentation with animation functions although they might need help when it comes to a developing a presentation including videos and audio clips. Animations have long been perceived as an effective tool in teaching and learning (Chan, 2015), and the use of animations in classroom activities can significantly improve learners' competencies and achievement in primary school (Nurdyansyah, Mandarani & Rais, 2020). The use of videos in the science classroom can help to illustrate potentially dangerous, costly, or hard-to-access phenomena. It can help connect school science with the world by bringing real-life examples into the classroom (Otrel-Cass et al., 2012). According to the study by Richtberg and Girwidz (2019) on the use of videos in a science classroom, teachers rarely recommend and very rarely use videos in their classrooms. This could be caused by the lack of knowledge by teachers of different sources of videos and how to integrate them into their lessons. The summary of the findings are presented in Table 3 below.

Table 3

Teachers' Confidence in Using ICT

To what extent are you confident in the following?	None	A Little	Somewhat	A lot
Use of spreadsheet (Excel)	Shandu Khumalo			Mbambo
Create a presentation with simple animation functions	Shandu		Khumalo Mbambo	
Create presentation with video or audio clips		Shandu Khumalo Mbambo		
Download and install software program in a computer	Shandu	Khumalo	Mbambo	
Assist someone in the use of ICT	Shandu	Mbambo		Khumalo

Attitude Towards the use of ICT in Teaching and Learning. All three teachers agreed as reflected in the questionnaire that ICT integration improves their teaching and they are very comfortable in using ICT in teaching Grade 7 Natural Sciences. This is in agreement with Bindu (2016) who states that ICT in education serves to improve the quality of education by transforming teaching and learning into a fun, dynamic process that is relevant to real life.

All teachers indicated in the questionnaire that accessing information on the internet can improve content knowledge of Natural Sciences. They believed the use of ICT allows them to take greater control of their Natural Sciences teaching and improved their content delivery. This is consistent with the view that ICT is capable of providing a dynamic and proactive teaching and learning environment (Ghavifekr et al., 2014). There is also considerable evidence in research that learners are more highly motivated, more engaged in activities, and show an increase in interest in the lesson when their learning is supported by ICT; thus improving their attention span and enabling them to retain more knowledge (Denby & Holman, 2002). The results of a study by Nikolopoulou (2020) seem to agree that ICT can increase learners' interest and learner participation in learning due to improved content delivery.

Table 4 below presents all the findings about the teachers' attitudes on the use of ICT in education.

Table 4

Teachers' Attitudes Towards the use of ICT in Education

Statement	Strongly disagree, Disagree or Neutral	Agree	Strongly Agree
I am comfortable using ICT in teaching Grade 7 Natural Sciences.		Mbambo Shandu	Khumalo
I think ICT integration improves my teaching.		Shandu	Mbambo Khumalo
I think getting information on internet can improve my content knowledge of Natural Sciences.		Khumalo Shandu	Mbambo
I believe the use of ICT allows me to take great control of my science teaching.		Khumalo Shandu	Mbambo
I would like to use ICT more in my teaching of Grade 7 Natural Sciences.		Shandu	Mbambo Khumalo
It is important to find different ways to integrate ICT in teaching of Natural Sciences in Grade 7		Shandu	Mbambo Khumalo
Learning how to integrate ICT is a teacher's professional goal to accomplish.		Khumalo Shandu	Mbambo

All three teachers agree that they would like to use ICT more in their teaching of Grade 7 Natural Sciences and it is very important to find different ways to integrate ICT in teaching Natural Sciences in Grade 7. They indicated in the questionnaire that learning how to integrate ICT should be a teacher development goal. Jung (2005) also states that ICT can make teacher professional development more flexible and effective, increase pre- and in-service teacher training, and connect instructors to the global teacher community. It is insufficient that schools have the most up-to-date ICT resources if teachers lack the pedagogical understanding necessary to successfully integrate them. According to recent studies, many teachers lack the technology skills needed to build novel teaching methods (Graham et al., 2020). The findings of the study by Mwapwele et al. (2019) suggest that Teachers must have the appropriate personal ICT skills to utilize ICT for learning and generate artifacts such as presentations and digital tales, and this can only be handled in South African schools through professional teacher development.

ICT resources. ICT resources come in many forms and can be used differently in the classroom. There are computer programs, YouTube channels, educational television programs, computer simulations, and internet websites to name a few. None of the teachers had used simulations to enhance their teaching of Grade 7 Natural Sciences, but they had used internet search engines like Google for resources. None of the teachers had used educational television programs to enhance their lessons.

The last part of the questionnaire was intended to find out about the resources that teachers have used in their teaching. Based on the answers from Miss Khumalo, she had not used many resources. Although she was aware of resources like smartboards and LCD or LED screens, she had never used them before. She frequently uses ICT tools like a digital projector and laptop, but she had never used radio broadcasts or a tablet or smartphone as resources in her lessons. When asked about educational programs or software, she indicated that she had never used PhET simulations but had used YouTube videos in her lessons for Grade 7 Natural Sciences. PhET simulations are freely available computer simulations developed at the University of Colorado at Boulder, some of which can be used to teach and explore concepts in Grade 7 Natural Sciences and Mathematics. The simulations can either be used online or downloaded to use offline, and many have even been translated into other languages, such as Afrikaans and Tswana, to make them more accessible to learners across the world. McFarlane and Sakellaria were cited in the study by Chaudhari (2017) mentioning that the computer-based simulations can provide better support for the development of theoretical concepts than

practical skills as they remove the need for competence in the handling of apparatus, allowing learners to focus on concepts rather than procedures. They can also offer simultaneous representations of the real and theoretical behaviour of the system under the investigation. Simulations in general have the potential in promoting conceptual change and understanding of scientific processes but as previously stated, the quality of the simulation and the way it is used will determine its effectiveness (Juggernath, 2017).

According to the indication on the questionnaire, Miss Mbambo's school and Miss Shandu's school do not allow learners to bring cell phones to school and they also do not have a computer lab or tablets for learners. Miss Mbambo indicated that she had no knowledge of PhET Simulations and Mind-set e-Learning but she had heard of Vodacom e-school and Nect.org.za, although she had never used them in her teaching of Grade 7 Natural Sciences. Mindset e-learn is the website that can be used to enhance learning through the educational videos found there. It can also help in teacher development as it has a program to help empower teachers. YouTube channels were familiar to all the teachers even though not all of them had accessed them. Miss Shandu seems to know about PhET Simulations, Vodacom e-school, and all other programs and software mentioned in the questionnaire, although she had never used them. The teachers' responses regarding their knowledge of educational resources are summarised in Table 5 below.

Table 5

Teachers' Knowledge of Available ICT Education Resources

ICT resource	Know about it but never used	Have used in the classroom	Doesn't know about
YouTube	Mbambo	Shandu & Khumalo	
Vodacom e-school	Shandu & Khumalo		Mbambo
Nect.org.za	Shandu		Khumalo & Mbambo
Mindset e-learn	Shandu		Mbambo & Khumalo
PhET Simulations	Shandu & Khumalo		Mbambo

4.3 How do the Teachers use ICT Tools in Teaching Grade 7 Natural Sciences?

Lesson observations were used to obtain data for the second sub-question. The focus of the lesson observations were. The focus of the lesson observation was to observe how teachers use ICT to support their teaching of Natural Sciences in Grade 7.

4.3.1 *Findings from the Lesson Observations*

Athanasou et al. (2012) defined observation as a systematic process of collecting data that relies on a researcher's ability to gather data through his or her senses without communicating with participants. The advantage of observation as a data gathering strategy is that it allows a researcher to collect data in real time from organically occurring social settings. Instead than relying on second-hand information, the researcher can witness what is happening in a situation (Cohen et al., 2013).

The purpose of the lesson observations were to understand how teachers use ICT to support learning when teaching Grade 7 Natural Sciences. The observation tool that was used assessed how teachers apply Technological, Pedagogical, and Content Knowledge (TPACK) in their classroom practice. There are six components in TPACK, these are Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) as illustrated in Figure 8 below.

Figure 8

Technological Pedagogical Knowledge (Koehler & Mishra, 2008)
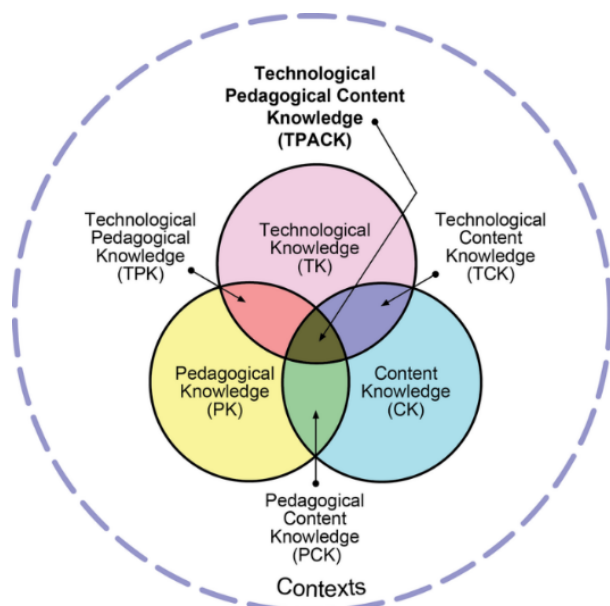
The lesson observation focused on three components of TPACK which are Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK).

Technological Knowledge (TK). The first part of the lesson observation tool was to assess teachers' Technological Knowledge (TK). Koehler and Mishra (2008) define Technological Knowledge as knowledge about technologies and it also involves the skills required to operate particular technologies. From the video observations, it was evident that Miss Khumalo was using ICT activities that were stimulating and motivating in her lesson. (Refer to Annexure A for all lesson plans.) She had used animations to explain the water cycle and later used a video to summarize the lesson. Miss Shandu had also planned a very stimulating lesson on earth's revolution and rotation by incorporating interesting pictures in her slides. This captured the interest of the learners during the lesson which was observable by the response from the learners when she was asking questions. On the other hand, Miss Mbambo used images from the textbook that were not properly cropped and skew and thus not very stimulating or motivating for learners. All teachers had used PowerPoint to present traditional lessons. The use of PowerPoint presentations did not allow for any learner-centred activities or allow learners to manipulate the ICT tools. Consequently, some learners were not active participants in the lessons. In the study by Juggernath and Govender (2020), some teachers believed the use of ICT in the classroom can make learners passive and they can lose their ability to think critically. The use of visualization can capture the learners' interest but it is not the same as when learners manipulate things themselves. This could be caused partly by the limited ICT resources in the participants' schools, suggesting that teachers require assistance in order to get the most out of using ICT in the classroom, particularly in areas where resources are limited (Hennessy et al., 2010).

Miss Khumalo had the essential technology tools for the lesson even though it was evident that she experienced a few problems when using the digital projector. It took her some time to connect the projector as it is not permanently mounted on the wall in her school. The same could be not be said of Miss Shandu, given the speed with which she able to connect the digital projector and set up for the lesson. Like Miss Shandu, Miss Mbambo was knowledgeable with the ICT tools she used and she did not have any difficulties connecting a digital projector.

All three teachers were using PowerPoint presentations but not in slide show mode. When they stayed on one slide for too long, the laptop would go to hibernation mode thus interrupting the lesson and distracting the learner concentration. The teachers were forced to stand near the laptop to shift between slides, blocking learners' view of the screen. Despite these practical considerations with using their PowerPoint presentations, it was obvious that Miss Khumalo

and Miss Mbambo were still very capable and confident when they used a digital projector. This supports what teachers indicated in their questionnaire responses.

Technological Content Knowledge (TCK). The second part of the lesson observation focused on the Technological Content Knowledge (TCK) of the teachers. TCK is an understanding of how technology and content influence and constrain one another (Koehler & Mishra, 2008). In Miss Khumalo's lesson, technology was used to explain the complex content of science appropriately. As she was teaching about the water cycle, the use of video from the internet helped to enhance lessons in the classroom. The use of pictures in her lesson allowed learners to observe different processes on the water cycle that would otherwise be difficult to observe. Some learners would find it hard to understand the whole process of the water cycle, but the graphics used, such as that presented in Figure 9, made it easy for learners to visualize it. The PowerPoint presentation she used made the lesson attractive and supported the content by including colourful digital graphics.

Figure 9

Water Cycle Image used by Miss Khumalo
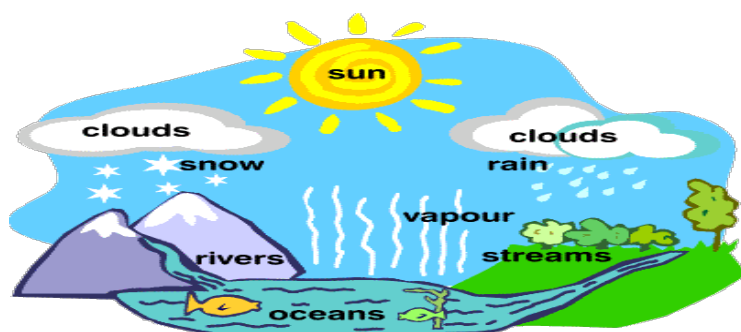
During the lesson observation for Miss Mbambo, ICT technology was not used to explain the complex content of science. Miss Mbambo was teaching about the formation of the tides and the digital projector was mainly used for projecting notes for learners to copy, and explaining simple content. The static pictures used, such as that presented in Figure 10 were taken directly from the textbook, and did not aid the learners in understanding the formation of tides in the way that an animation might have. The same could not be said about Miss Shandu's lesson. It was well prepared with colourful pictures used to explain science content. The PowerPoint presentation was very attractive and Miss Shandu used animated pictures to

demonstrate and explain how the Earth moves around the Sun. Learners could see the image of the Earth revolving around the Sun and it made it easier for them to understand the rotation and revolution of the Earth. A static version of the animated picture can be seen in Figure 11.

Figure 10

Formation of the Tide Taken from the Book by Miss Mbambo
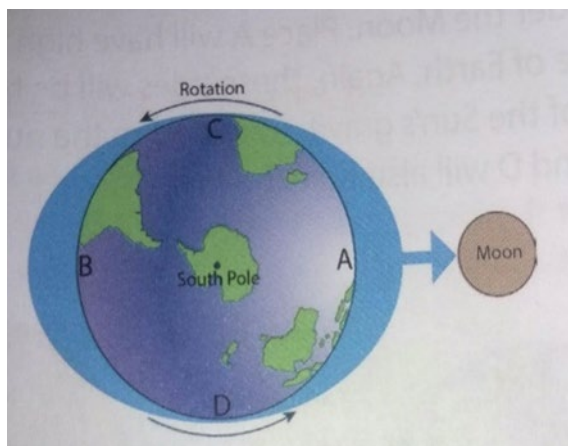
Figure 11

Image on Revolution used by Miss Shandu
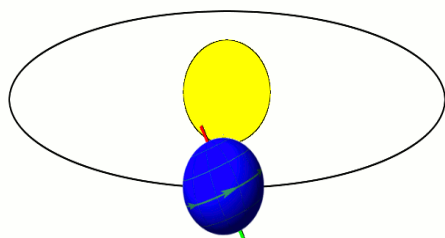
Technological Pedagogical Knowledge (TPK). The third aspect of lesson observations examined the Technological Pedagogical Knowledge (TPK) of the teacher. TPK is knowledge of various technologies and how they are used in teaching and learning (Koehler & Mishra, 2008). All lessons that were observed combined appropriate technology, subject content, and teaching methods. All lessons showed that they were well prepared and well thought of although there were aspects of the presentations that could be improved.

Miss Khumalo and Miss Shandu were able to manipulate ICT technology somewhat successfully to present relevant subject content while Miss Mbambo had a little struggle when

it came to manipulating technology. All teachers that took part in this study were using a teacher-centred pedagogical approach in their lesson using a digital projector as a supporting teaching aid to present content. Teacher-centred approach is the method where students simply obtain information from the teacher without building their engagement level with the subject being taught (Ganyaupfu, 2013). Kurniawan (2018) defines a teacher-centred approach as an instructional approach which puts the teacher at the centre of learning process including leading the learning process, preparing for activities, being the source of knowledge and determining all classroom activities. All teachers were leading in the lesson with minimal learner-based activities. The main activity of learners was to answer questions that were asked by the teachers.

There were opportunities for development that were observed from all teachers' use of ICT in their teaching of Grade 7 Natural sciences. These areas of development included how to link animated images to a PowerPoint presentation in order to represent scientific processes dynamically. Miss Mbambo, who used only images from the textbook, needed to be taught how to download images on the internet, or if she wanted to use the textbook, to find the appropriate tool to both scan and then edit the scanned images.

4.3.2 Findings from the Document Analysis

The document analysis was used to get further data to understand teachers' use of ICT tools. The documents that were analysed were lesson plans (Annexure A) and the teacher's learning portfolios (Annexure B). It was noticeable that in her lesson plan, Miss Khumalo did not refer to any ICT tools, even though she did use them in the actual lesson. The limited ICT tools available in her school did not allow learners opportunities to manipulate technology as they only used a single laptop connected to a digital projector. Learner activities were mentioned in the lesson plan and they did involve ICT-related activities in that her lesson plan indicated that learners would be watching videos as part of learner activities.

Miss Khumalo has a projected personal growth plan that included growth in teaching using ICT. It was also observed that even though she indicated her interest in this area, there were no records to show the school management had discussed this with her Development Support Group. The Development Support Group (DSG) is a school-based team with the responsibility of assisting educators in the development and refinement of their Personal Growth Plans (PGP). The DSG consists of three members, the Departmental Head, one peer educator, and an educator who desires or has been identified as needing development. The educator's peer must be selected by the educator based on expertise that is related to the prioritized needs of the

educator. The DSG is also responsible for the baseline evaluation of the educator (Department of Education, 2003).

During the document analysis for Miss Shandu, it was notable that her lesson plan was well prepared and it mentioned the ICT resources to be used in her lesson. Amongst the learner activities that were mentioned, were for the learners to watch videos. The content to be taught was in line with the prescribed annual teaching plan. The teacher's learning portfolio was also analysed; it was observed that Miss Shandu participates in the activities that foster her professional growth in teaching. In her projected personal growth plan, she mentioned that she would like to be developed on the use of a digital projector. Just like Miss Khumalo, Miss Shandu has never discussed her desire to be developed in using a digital projector with her Development Support Group (DSG). This was observed from the minutes of the DSG who are supposed to help in her development needs.

On all the three teachers' learning portfolios, it was noticeable that although all teachers do participate in activities that foster professional growth, unfortunately, none have been for ICT integration in teaching. Just like Miss Khumalo, Miss Mbambo's document analyses revealed that she did not refer to the ICT resources to be used in her lesson in her plan, even though she did use them in presenting the lesson. The learner activities she had planned did not include the use of ICT by learners. In her learning portfolio, she had not indicated what she has achieved in the use of ICT in her teaching but she had indicated that she needs development on the use of a digital projector. The minutes of the meeting with her Development Support Group indicate they did meet to discuss her development needs but they did not discuss ICT development. This raises a concern that teachers despite indicating areas for development in their Personal Growth Plans, they do not seem to follow it up by discussing it with their Development Support Group. This is a gap that needs to be closed to achieve every teacher's development needs.

4.4 Supporting Teachers to Integrate ICT in Teaching Natural Sciences in Grade 7 Before Class Teaching

The questionnaire and lesson observations were used not only to collect data on the teachers' practices, but also to design a support program as part of an action research intervention to support teachers' integration of ICT in teaching Natural Sciences in Grade 7. In exploring the RQ3: *How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade*

7 before class teaching? a few areas for development were identified during the teachers' lessons.

During the lesson observation, I noticed that teachers were having a hard time connecting a digital projector. This was the first issue that was discussed in the support session. Time for connecting the digital projector is not allocated in the teaching contact time. Saving this time is very important for teaching and learning. During the lesson, Miss Khumalo and Miss Mbambo had to switch between PowerPoint and videos/images and this distracted the learners' concentration. This could have been avoided if videos were hyperlinked to the PowerPoint presentation. These issues were discussed during the support session with teachers

To avoid using videos directly from the YouTube channel, teachers were shown how to download YouTube videos and to use offline. This will make them readily available for classroom use and will prevent problems caused by unstable or poor network such as a delay in the buffering of the video. The term buffering was also not known to all teachers. Downloading pictures and animated images was also discussed with all teachers to help enhance their presentations. After downloading images, we shared knowledge of how to format images once they were pasted into a presentation or other application software.

Miss Mbambo, who likes to use images from the textbook, was shown an appropriate scanning App for her cell phone that she can use to scan these images. Miss Khumalo also showed interest in knowing how to take pictures from the textbook and digitally paste them in the assessment on Ms Word.

> "*I always have to copy a picture from the book then cut and paste it in the assessment. When we duplicate the copies for the learners, a picture will not be clear or too dark.*"

I have encountered a few teachers, other than the participants, who have a similar problem to Miss Khumalo with images used in tests. They often have to explain to learners during the test what is in a picture that has been incorporated this way, as it is unclear to learners. When a picture has been photocopied from a book, it cannot be formatted but if the picture is in MS Word, the brightness, size, and other properties can be adjusted appropriately.

None of the participants displayed their PowerPoint presentations using the slide show mode. This was discussed with teachers and they were shown the difference it makes, especially with links and animated images. Animated images do not move when the presentation is not on slide show mode. Another advantage that was explained is that using the slide show mode when

presenting will also prevent the laptop from going into hibernation when a teacher stays on one slide for too long.

I also introduced all the teachers to PhET simulations and how to hyperlink them to their presentations to save time, and discussed ways for the teachers to make their presentations more interesting for learners.

4.5 Teachers' Experiences of ICT Integration in Teaching Grade 7 Natural Sciences in the Action Research Process

The interviews, that were conducted after the support session, provided data to answer RQ4, *what are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action research process?*

Due to a busy schedule of the participants, some interviews were conducted telephonically. Interview questions were given to the participants a day before the interview. This was done so the participants could read and seek clarity where necessary. Teachers' experiences were explored by asking five specific questions, the results of which are discussed below.

4.5.1 *Why did you Decide to Start Using ICT in Your Teaching?*

Miss Khumalo mentioned that the main factor that influence her decision to start using ICT was that ICT makes it easier for her to do her schoolwork at home. Downloading software for schoolwork is another priority for her. She further felt that the use of ICT in her teaching makes it easy for her to work effectively.

When asked why she decided to use ICT in her teaching, Miss Shandu mentioned that:

> *"ICT is a good platform of replacing the chalkboard with a good gadget that will make learners more enhanced and eager to learn. It also makes it easy to use classroom time more efficiently and more interactive exercises during teaching and learning. The use of ICT in teaching Grade 7 Natural Sciences saves a lot of time as compared with using normal chalkboard for teaching and learning and instead of using textbook use a computer".*

Saving time seems to be the common factor between Miss Mbambo and Miss Shandu as both mentioned it as one of the reasons they started using ICT in teaching Grade 7 Natural Sciences.

"ICT helps me not to spend more time writing on the chalkboard," said Miss Mbambo. She continued to add:

> *"I started to use digital projector because it made my work easier. I have too much workload and using a digital projector during my teaching relieves pressure and at the same time my learners' focus is drawn towards a lesson"*

This response from the teachers seems to agree with Henderson (2020). In his study about the use of ICT in education, he mentioned that using Teachers can save a lot of time by using ICT. This time could be better spent working with struggling students. I agree that ICT can save time when it is effectively integrated into teaching. Juggernath (2017) also mentioned time-saving as one of the benefits of ICT, he states that ICT can save a lot of time for the teachers on doing lesson planning as there are virtual lesson plans online. For the Grade 7 Natural Sciences teachers, they can access these lesson plans on websites like Nect.org.za.

4.5.2 Can ICT be used to Enhance the Teaching and Learning of Natural Sciences?

According to Miss Khumalo, ICT helps promote better understanding for her learners. She added that with the use of the internet, even a teacher can learn something she does not understand. She continued to say this will help make it easy to explain to the learners and the use of visual components in the classroom helps her to explain content better.

All teachers agreed that ICT can be used to enhance the teaching and learning of Grade 7 Natural Sciences. Miss Mbambo mentioned that ICT enhances learning and teaching as learners can get access to more information via ICT. This is in line with what Chaudhari (2017) said in his study, namely that ICT gives access to knowledge as learners can draw on a global pool of knowledge. Miss Mbambo continued to say that the use of videos can help learners understand concepts they didn't understand in the classroom.

> *"Technology enhances the learning as well as teaching because learners get to access more information via technology even if they didn't understand me as a teacher in class, by watching video clips which draws their attention and focus. Another advantage is that learners can have access to these videos and watch them over and over at their time. That means learning has continued even outside the classroom setting."*

Miss Mbambo also believes that the use of ICT in teaching Grade 7 Natural Sciences can have an impact on changing how learners think as they can get alternative explanations of

concepts by viewing multiple video clips which have different people explaining the same concept.

"ICT can change the way of thinking as we know they get a different version of information explained to them by different people which will instil an understanding of a particular topic."

Miss Shandu believes that the use of ICT in teaching and learning can provide different opportunities to make learning more fun and enjoyable in terms of teaching using pictures and audio.

"Yes! Technology can be used to enhance teaching and learning as it provides different opportunities to make learning more fun and enjoyable using pictures and audio, teaching the same thing in a new way."

She also believes ICT can improve learners' perception of the subject by changing the learners' least favourite subject to become more interesting.

"Using Technology can make a learner's least favourite subject more interesting to them by using virtual lesson videos to capture learners' attention."

In a study by Cox, Cox and Preston (2000), the vast majority of teachers agreed with the statement that using ICT in my teaching makes my lessons more interesting for me. Bindu (2016) mentioned that using ICT in education can help learners grasp the concept better and also retain it for a longer period. He continued to say ICT can help to develop a positive attitude towards learning. This is in line with what Miss Shandu believes; Miss Shandu mentioned that the use of animated pictures in the lesson can make learning more interesting for the learners and make it easier for a teacher to explain a topic like photosynthesis. This will then develop the love of the subject.

"For example, explaining photosynthesis using animated pictures is simple for learners to understand."

The interest of the learners when learning using ICT might be caused by the fact that young people are fascinated by technology. ICT triggers their interest and helps them concentrate in the lesson. This then helps the teacher with lesson delivery, as learners are paying more attention. The use of animated images can increase learner engagement and thus improve learning. These findings are in line with what Harber has said. Harber (2014) mentioned that using ICT in education can help learners grasp the concept better and also retain it for a longer

period. However, teachers need to be able to choose the appropriate animated image as it can sometimes be distracting to learners. Some animated images and videos may be enjoyable and fun for learners, but have inaccurate content, or be presented in a way that learners may lose focus on the context of the image or lesson objective. This is where the Technology Content Knowledge of the teacher is vital. Teachers need to have a good content knowledge in order to choose appropriate animated images to use for teaching and learning.

4.5.3 *What Role does Technology Play in the Teaching of Natural Sciences in Terms of Content Delivery?*

Miss Shandu believes that ICT plays a vital role in terms of content delivery, which she elaborated as follows.

> *"Delivering information using technology makes it easy for teachers to deliver content as compared to using textbook. It also makes a lesson to be more democratic than teacher-centred. Both teachers and learners are engaged more in the lesson. Therefore, teaching and learning will be more fun and enjoyable for both parties thus making learners more active in the lesson."*

Her view concurs with that of Kuboja (2019) who stated that ICT causes a paradigm change in the teaching and learning process from the perspective of the teacher -centeredness to learner-centeredness, in which the teacher conveys information to students more efficiently and in a more understandable manner.

Miss Mbambo also believes ICT has an important role in teaching Natural Science. She believes technology can simplify topics thus using less time to teach that topic.

> *"Technology simplifies topics to learners with less time. For example, if I were to explain about the earth's revolution around the sun when learners see a video or animated pictures showing the movement of the earth, that will help learners not to forget the information. I also believe ICT can help especially in the topics that have many misconceptions or topics that have abstract information like term 1 work on fertilization and pollination."*

4.5.4 *How was your Experience of Implementing ICT Learning in your Classroom After the Support?*

Miss Khumalo's response on her experience of implementing ICT after the support session was as follows. The session did help her learn how to transfer videos and photos from her cell

phone and the internet to her laptop. This newly found knowledge has enabled her to use her phone to download videos or images from the internet and then transfer them to her laptop to use in her lesson. This has helped to improve her content delivery, thus improving learner's understanding.

The support session for Miss Mbambo helped her to be able to use different teaching strategies. During the support session, we discussed different ways of integrating ICT in her teaching of Grade 7 Natural Sciences. She could use videos to explain complex concepts during the lesson. Some videos can be used to introduce a topic, they can be used to stimulate interest and to engage learners in an educational debate about the topic before a teacher explains the concepts, especially those topics that have a misconception. When teaching electrical conductivity, there are simulations that she can use to do experiments with different materials to test their electrical conductivity. This will be very helpful if there are not enough electrical components in her school as she can use a virtual circuit construction simulator instead. We also discussed how she could use videos to revise the topic as some videos can summarize the whole concept. Thus, these videos are used after teaching has been completed. She also learned how to include different types of pictures in her slides.

> *"Wow you know to tell you the truth, I was a bit sceptical about participating in your study. The session was very helpful to me and thank you for that. Right now, I can use different strategies for teaching and be able to introduce or teach topics in different ways. My notes are more detailed and straight to the point. The most interesting part that always frustrated me was to format a picture after pasting it on MS Word. I look forward to setting my assessment. Oh! Another thing, now I can download videos on YouTube, now I will teach my learners easy with these videos. Remind me again, what is that program you told me about? The one that made things move (Pause for me to answer) Yes! PhET Simulations. I know how to use it as well. Very happy about that."*

Miss Shandu did find the support session very helpful in her teaching using ICT in Grade 7.

> *"The implementation of ICT learning after the support has been of great success. It gave me a platform to learn and to be more confident in terms of content delivery and also in teaching as a whole."*

She also mentioned that the support session has given her confidence to use a digital projector in the classroom. She strongly believes it will make her learners more active in their learning.

"I'm confident in my teaching using a digital projector. My learners are also learning more and participate eagerly and more actively."

4.5.5 *In your own experience, do you believe the use of ICTs proves to be a better method of teaching as compared to the traditional method?*

Comparing traditional teaching and technology-enhanced learning, Miss Khumalo said that in her personal experience, she prefers a teaching method that includes ICT. This is because technology enhances teaching by not only teaching theory, but also illustrating to learners what happens in real life.

> *"Yes! Because technology does not only teach theory, it also gives ideas to learners as to what is happening in real life."*

She also felt that it takes learners to a higher level of thinking. ICT offers more opportunities to advance critical thinking skills for the learners (Das, 2019).

According to Miss Shandu, technology-enhanced teaching is far better than the traditional method as it provides more platforms for learning. As stated by Kawade and Kulkarni (2012), learners can access extra resources using ICT in primary schools, such as online encyclopaedias, dictionaries, government-sponsored instructional sites, learning games, and online tutoring. Miss Shandu also felt that the traditional method can be too theoretical, while technology-enhanced lessons can be virtual.

> *"Technology-enhanced lesson is better than the traditional method. Technology provides more platforms for learners to observe and learn about things they see using virtual images."*

> *"When using a textbook, it is more theoretical than technology that makes it more virtual and easier for learners to understand concepts."*

All teachers seem to agree on the point that technology makes it easier for learners to understand complex concepts. Teachers can use video, images or simulations to break down a difficult topic for learners. Miss Mbambo mentioned that she once used a video to explain energy transfer in the classroom, and found that most of the learners showed a great understanding of the concept. Learners were actively participating in the lesson.

> *"From my observation and experience, technology-enhanced learning is much better because I have seen learners who are not that bright in the classroom catch up more when they see pictures and video clips."*

This is supported by the literature. In the learning process, ICT technologies like multimedia computer software that combines text, sound, and colorful moving images can be utilized to provide clarity on difficult content (Hu & McGrath, 2012).

Miss Mbambo and Miss Shandu also shared the same sentiment on the traditional method of teaching.

> *"Attention or focus on the learners is drawn and they get eager for more information when learning with technology as compared to the traditional method where there is a lot of theory."*

She continued to say technology-enhanced lessons could also be fun for learners as they can explore important information. She further stated that technology helps learners to learn by seeing objects move while it is being explained by the teacher. This will help to retain the knowledge gain in the lesson. Even learners who are struggling in the classroom grasp information more easily as compared to being taught in a traditional way.

> *"In the traditional method, learners are less focused as more time is spent on writing on the board than explaining important information. This means the traditional method is more time-consuming and less fun for the learners. Learners really enjoy watching colourful animated images and videos; it makes them look forward to learning and makes them not to forget information."*

The sentiments of the participants are in line with findings from the literature. In the study by Cox et al. (2000), The authors identified elements that were determined to be the most significant to teachers in their use of ICT in their teaching, such as making lessons more engaging, easier, and entertaining for them and their learners, as well as more diverse, motivating, and pleasurable for the learners. This is further supported by Henderson (2020) who stated that technology encourages more active participation in the learning process which can be hard to achieve through a traditional teaching method.

4.6 Teachers' Development of Technological Pedagogical Content Knowledge (TPACK) After they have been Supported

The support session with teachers covered topics ranging from administration, assessment, lesson planning, and actual ICT integration in the classroom setting. The topics varied depending on the needs of each teacher based on the lesson observation or a specific request from the teacher. Data obtained from these sessions, as well as the interviews conducted after these sessions, were analysed to answer the following research question.

RQ5: How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after they have been supported?

4.6.1 *How and Why are the Technologies used in this Lesson most Suitable for the Content Objectives?*

The ICT tool that Miss Khumalo had been using most frequently to teach was a laptop, connected to a digital projector, Miss Khumalo believes a digital projector saves time for her. Previously she had to write notes on the board which consumed a lot of class time. By using a digital projector, she no longer has to write notes on the board for learners. When there is no electricity, she could teach then print notes for the learners later.

When Miss Mbambo was asked about other ICT tools she has used, at first, she denied ever using any other technology. However, after asking about her using a cell phone in her class, she acknowledged having used it to teach certain concepts. She shared the same sentiment as Miss Khumalo regarding the digital projector being the best ICT tool she used.

> *Miss Mbambo: "I have never used any other technology tool in my lesson before."*
>
> *Interviewer: "You mean you have never even used a cell phone to show learners something educational?"*
>
> *Miss Mbambo: "Oooh! I have done that. Compared to using a projector, the data projector is way better as it helps to explain concepts better. In the presentation, I can include notes for everyone to see. When you have many classes as I do, it reduces the workload of keep rewriting the same thing in every class I will teach. And for the fact that once I prepare these presentations, I will have them for a very long time makes this the best resource to use. Now armed with the new knowledge gained in the session we had. My slides will be more interesting and support all learners' level of understanding as they will have animated pictures and simulations."*

Miss Shandu has been using different technology gadgets before in her teaching of Natural Sciences in Grade 7. She has used a tablet and a smartphone as supporting teaching resources but she still finds a digital projector most suitable as it draws learners' attention and makes them eager to learn. Furthermore, with the data projector, the learners can all see at the same time and the pictures are big enough to be easily seen, enabling the learners to understand easily.

4.6.2 *How does Using ICT Improve the Teaching Strategy?*

In looking at how the use of ICT has improved their teaching, Miss Shandu mentioned that digital projector has made it easier for her to deliver content at a minimum time.

> *"Using a digital projector has improved my teaching. It is now easier for the learners to understand the content and it is also easier for me to explain complex topics. It saves teaching time by summarizing and explaining using slides and with the help of virtual images."*

The use of ICT in teaching has improved Miss Khumalo's ability to capture her learners' attention. Her learners are more interested and pay more attention when she is teaching. The media used in the lesson capture their concentration. It makes them pay more attention during the lesson, thus making content delivery easier. Increasing interest in the learners during the lesson is one of the motivational uses of ICT in education that has been identified in the literature (Badia, Meneses & Sigalés, 2013).

> *"When I use a digital projector, my learners are intrigued and they pay more attention than by simply listening."*

Miss Mbambo believes that the use of ICT in teaching Grade 7 Natural Sciences has improved her teaching. She now enjoys her teaching and learners enjoy being in the classroom. It has saved her lots of time as it reduces the time needed to explain complex content. She can even see the improvement in the results of her learners in Natural Sciences. This could be the cause of learners' eagerly participating in the lessons.

> *"Teaching using digital projector makes my teaching easy and enjoyable for me and my learners. My teaching has improved in a way that because Technology reduces time to explain complex topics, even during these times of COVID-19 with fewer contact times, I manage to finish my curriculum. Even if I don't finish, but I can rest easy knowing what my learners have learned will be retained in their minds. Results have also improved as that is an indication of improved teaching strategy. Learners' participation has increased*

a lot as learners are more engaged therefore, they have a better understanding and participate better."

4.6.3 *Can you Explain how you Integrated ICT with your Teaching Methods and Learning Objectives?*

Planning the lesson should ensure that resources, learning objectives, and teaching methods are kept in mind by the teacher. When teachers were asked how they fit all these in the lesson, Miss Shandu said when she is planning her lessons; her goal is for learners to have a better understanding of every concept, to be able to grasp faster than learning using a textbook.

"My objectives of the lesson are what guide me on the ICT resource to use. If it is a topic that will need a video, I will go online to look for a suitable video to use. When I use a video, my teaching method will be that of facilitating instead of lecture method. If I were to explain some concepts and look at the projector and listen to what is being explained, that will be a teacher-centred approach."

Miss Mbambo had this to say on the topic.

"Lesson planning is one of the critical parts of the teaching and learning. So, to fit all these together need proper planning. Example. If I will be teaching phases of the moon, the objective in this lesson will be to ensure they can name all phases and understand their shapes. Obviously, I will need spherical shapes as resources and an appropriate video showing how they change. That means now the teaching approach will be a leading method but if I will be teaching electrical conductivity, I will use simulations you showed me and my teaching method will be the demonstration method. So, it depends on the topic you see."

Based on the answers of Miss Mbambo and Miss Shandu, it's clear both teachers used ICT resources depending on the topic and the method will change depending on the topic they need to teach. By comparison, Miss Khumalo simply mentioned that she always checks and download relevant pictures and videos and did not elaborate on how this relates to her lesson objectives or teaching strategy.

Teachers have theories about how their learners learn, which informs their approach to teaching (Afshari et al., 2009). According to Kawade and Kulkarni (2012), teachers can use a variety of teaching approaches to the whole class using a large electronic screen facility, which all the teachers in the study were doing to some extent. However, the authors further state that

teachers can design ICT-based materials to meet the needs of individual learners effectively which offer diagnostic, learning support, consolidation, and extension tasks within a subject area. This practice was not evident in the teachers' responses in this study.

4.7   Why do Natural Sciences Teachers in Grade 7 Develop TPACK in the way they do?

In answering the last RQ6: *Why do Natural Sciences teachers in Grade 7 develop TPACK in the way they do?* the participants were asked four questions in the interviews that are discussed below.

4.7.1 *How has ICT Changed your Perspective on Teaching and Learning?*

All participants agreed that ICT has changed how they previously viewed teaching and learning for the better. This perception of the teachers on ICT integration is related to the fact that teachers find ICT integration very useful. When teachers find ICT useful, that will result in them deciding to use it more often in their teaching. The use of ICT in education can enhance teaching and learning by increasing learner engagement in the lesson. When it is used appropriately, it can shift teaching from a teacher-centred approach to a learner-centred approach. Some teachers believe ICT can reduce the stress that comes with repeatedly explaining things to learners. Miss Khumalo believes using ICT has made teaching more interesting for learners and for her as a teacher. She continued to say that using resources from internet has made it easier for her to explain difficult concepts. Her sentiments on the use of ICT in education is supported by Hennessy et al. (2010) who state that most teachers perceived ICT in education as very useful and making their teaching and learning easier.

> *"Technology has made me more interested in teaching and it made my teaching easy."*

Some teachers find it more fun to teach using ICT just like Miss Shandu. She mentioned that teaching is now more fun and enjoyable for all parties.

> *"It has changed my perspective a lot. I used to see teaching as stressful sometimes, now it is more fun and enjoyable. It is now easier for both parties in teaching and learning."*

Miss Mbambo was praising the use of ICT in her teaching of Grade 7 Natural Sciences for reducing the stress of deciding on the methods to use in the classroom and the examples to use in her teaching. Miss Mbambo enjoys her teaching so much that she now looks forward to her lessons.

"Technology has relieved stress level of running short of methods of example to include in my lesson. Technology is full of fun, more educational, and informative. Going to class was very stressful at times, now I look forward to it. I enjoy my teaching of Grade 7 Natural Sciences."

Based on the finding on this sub-question, it is quite clear that ICT has changed how teachers perceive teaching and learning. This positive attitude to teaching using ICT is very important in the quest to improve ICT integration in schools in South Africa, as teachers' attitudes and beliefs can be a barrier to ICT integration. According to Bingimlas (2009), teachers' attitude is important because teachers' beliefs influence what they do in the classroom. He continues to state that teachers' attitude towards the use of ICT in the classroom depends on their understanding of how ICT benefit their teaching.

4.7.2 *Can you Reflect on your Initial Experience in the use of ICT and how it has Affected the way you use ICT in the Followed Lessons?*

When looking at the teachers' initial experiences when using ICT and how the support session has affected the way they used ICT in the subsequent lesson, Miss Khumalo mentioned that she can now make her teachings more interesting. That is because now she can use resources that learners can see clearly. Her teaching skills have improved a lot compared to before. She feels as though she is now the best teacher.

"I can make teaching more interesting because I can use the things learner can see."

Miss Mbambo mentioned that she is full of confidence now but she was very nervous thinking the digital projector will not work as she had planned when she is in front of learners.

"When I started using a digital projector in my teaching, I was very nervous in my first lessons. I was thinking what if things don't go as I planned in front of the learners. I got used to it but after the session we had, I am full of confidence. I look forward to going to class. I can tell that my learners enjoy my latest lessons now."

Miss Shandu said there have been a lot of changes in her lesson ever since she started using a digital projector in her teaching of Grade 7 Natural Sciences. She had gained a lot of information she did not have before.

"Before I did not get enough information on how to use technology to make my teaching more efficient and more understandable to learners. Right now, I can be able to

develop my slides. Now I can be able to add pictures, virtual images, and notes to every lesson."

The literature shows that teachers consider ICT to improve the presentation of material; to make lessons more fun for the pupils and more interesting for the teacher (Cox et al., 2000), which is consistent with the feelings of the teachers in this study.

4.7.3 *When planning to use ICT in your Teaching, what were your Personal Objectives?*

Teachers were asked what they wanted to achieve when they started to use ICT in their teaching. Miss Mbambo decided to use ICT to minimize the time spent writing on the board. which is consistent with the findings of Badia et al. (2013). that one of the factors that motivate teachers to use ICT is that it saves time. Miss Mbambo later saw an opportunity to improve her teaching strategy that would yield positive results in her subjects.

> *" At first, I wanted to use a projector to write corrections for my IsiZulu subject. I used to write lots of corrections on the board, then go to another class and write the same thing. It was time-consuming and exhausting for me. Then I started to write these corrections on my laptop to project to my learners. When I saw how much time I had saved up, that is when I thought I should do the same with my Natural Sciences lessons. So, I can say I wanted to minimize the time used to write on the chalkboard. After successful using it in the classroom my objective now is to ensure I give my learners an equal chance to learn Natural Sciences using little time."*

In comparison, Miss Shandu wanted to improve her learners' performance in her Grade 7 Natural Sciences subject which agrees with the findings of Kawade and Kulkarni (2012) that teachers can use ICT for improving the quality of the teaching and learning process. This was to be achieved by utilizing different methods and ICT resources to cater to all learning abilities of the learners.

> *"My objective in using ICT was to improve Grade 7 Natural Sciences results. I have an understanding that not all learners learn the same. Some learn through observation while others learn through listening. With the use of a digital projector, I was hoping to reach out to all the learners in my classroom. I also wanted to grab learners' attention through the use of videos and these moving pictures."*

4.7.4 *What Opportunities, if any, has the use of Technology in your Classroom Presented to you?*

All participants had different opportunities that ICT use in their classroom presented to them. These opportunities range from administration work to finding suitable teaching aids or resources to use in the classroom. Miss Mbambo can now use ICT to do her assessments with pasted pictures for properly assessing learners. The administration part is the capturing of her learners' marks on the Department of Education's South African School and Administration Management System (SA-SAMS).

> *"Oh Yes! I am now able to use a computer to type my assessment. I can include pictures on my assessments. I used my computer to punch marks on SA-SAMS and do a print-out analysis of my subjects. Eyi! There is a lot I can think of. My class administration work is like a class list and typing class timetable. More importantly, I get to store my work on the computer. Technology has presented many opportunities for me."*

Miss Shandu said ICT use in her teaching Grade 7 Natural Sciences presented her with an opportunity to save paperwork as most of her work is safely stored in the system. Typing of assessment were also mentioned by her as one of the opportunities presented to her by the use of ICT in the classroom.

> *"The use of ICT has minimized the use of paperwork at school. The information is now stored safely in the system. I can type my assessments and they are more presentable."*

4.8 Summary of the Findings and Discussions

4.8.1 *Teachers' Attitude Towards ICT Integration*

The findings suggest that teachers of Grade 7 Natural Sciences have a good attitude towards using ICT in their lessons. They believe that ICT has positively influenced their instructional methods. Even the tone of their voice when discussing ICT-enhanced teaching revealed this. They are all eager to learn more about using ICT to teach Natural Sciences in Grade 7. This calls for more developmental workshops that are ICT integration based to be done in our district.

4.8.2 *The Support Session*

The support session we had as part of the second cycle of the action research proved to be very fruitful for all teachers. This was observable by the replies of the teachers during the semi-

structured interviews. All teachers mentioned that they gained a lot of new information and skills during the support session that they find very useful. This suggest that a lack of ICT training for teachers could be a significant barrier to ICT integration in schools. Teachers need to be exposed to ICT training to increase their Technological Knowledge, and thus increase their confidence in using ICT in their teaching. These findings conform to the findings of Dube, Nhamo and Magonde (2018) who found that a lack of ICT pedagogical training is one of the barriers to effective ICT integration in the classroom.

4.8.3 *Impact of ICT Integration on Learners*

Teachers seemed to enjoy the use of ICT in their classrooms. They mentioned that learners enjoy ICT enhanced learning as compared to the traditional teaching method. This was noticeable during the lesson observation as most of the learners paid more attention in the lesson, especially when animated images were displayed on the screen. It made me realize that using animated pictures can provide stimulation and enjoyment for learners while learning.

4.8.4 *Resources*

The school's resources contributed to ICT integration by the teachers. The schools that took part in this investigation lacked adequate resources. Teachers were unable to access some ICT resources online to utilize in their teaching of Grade 7 Natural Sciences because of their schools' limited resources. All teachers that participated in this study had access to a digital projector attached to their personal laptops, and they find it very interesting for their learners when they are using a digital projector in their lesson. These findings are in line with the findings of the study by Khalo (2020) that teachers seem to prefer using digital projectors because it makes it easy to display information and show colourful pictures and videos for better content delivery and learner concentration enhancement.

4.8.5 *Time*

Time-saving was the priority for all teachers when they were starting to use ICT in their teaching. They then discovered other benefits of using ICT in their teaching of Natural Sciences. Learner participation and learner concentration were amongst the benefits of ICT integration that were mentioned by teachers. It was evident that teachers not only use ICT in the classroom for teaching, but they do also use them for the administration part of their work. ICT is used in the recording of the learners' marks and other class management activities. Teachers do need

additional development on the use of Microsoft Office applications like Excel and PowerPoint but they seemed to be well equipped with skills to use Word.

4.9 Summary of Chapters Four

In order to understand the tools that teachers used in their classrooms and their motivations for using them, this chapter addressed the first research question and gave an analysis of the data. This data were gathered by reviewing the questionnaire. Analyzing the information gathered from lesson observation came next. The second research question, which focused on how teachers can be supported to effectively integrate ICT, was addressed using the lesson observation. The findings from the support session and the semi-structured teacher interview findings were then discussed. A more detailed summary of results and recommendations will be discussed in the following chapter.

Chapter 5
Conclusions and Recommendations

5.1 Introduction

ICT in education has been a regular phenomenon that has been widely discussed and investigated. While wealthy countries have made significant advances in the use of ICT in the teaching and learning process, schools in underdeveloped countries still need to improve their ICT integration (Ismail, Jogezai & Baloch, 2020). There are many factors that determine the effective implementation of ICT integration, as discussed in Chapter 2, not least of which is teachers' attitudes towards, and knowledge of ICT.

This study was guided by three aspects. Firstly, this study aimed to shed some light on the teachers' understanding of ICT integration and their experiences in the use of ICT in the classroom. This was done by collecting information on Grade 7 teachers' use of ICT when they integrate it in their classrooms. The information gathered was also used to inform the second aim of the study which was aimed at offering targeted, effective guidance to Grade 7 teachers on the use of ICT in the classroom, by providing relevant support wherever they needed it. This was done using professional development activities that formed part of this study, which subject advisors may find useful when planning future workshops for teachers on ICT integration. Thirdly, participants shared ideas with the researcher on the use of ICT in teaching Natural Sciences in Grade 7 that can be disseminated to other Grade 7 teachers who are not part of the study. It is hoped that this study will add to the existing literature available regarding the integration of ICT in teaching Natural Sciences in the senior phase.

The main research question for this study was, how do teachers integrate ICT in their teaching of Natural Sciences in Grade 7? The following sub-research questions helped to shape this study. What ICT tools do teachers use in Grade 7 Natural Sciences teaching? How do the teachers use ICT tools in teaching Grade 7 Natural Sciences? How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before classroom teaching? What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action research process? How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after they have been supported? Why do Natural Sciences teachers in Grade 7 develop TPACK in the way they do in integrating ICT? The summary of the research process will be discussed in details below.

5.2   Summary of the Research Process

This study followed a qualitative action research design with two cyclical processes to collect data. Each cycle followed all four stages of action research; planning, action, observation, and reflection.

Purposive sampling was used to select three participants for this study. They were selected because they were teaching Natural Sciences in Grade 7 and they were already using ICT in their teaching and learning. Data were collected from teachers by using semi-structured interviews, lesson observation, document analyses, recordings of the support sessions, and questionnaires. Multiple methods were used in the study in order to produce consistent and dependable results (Cohen et al., 2013). The documents that were analyzed were the teachers' lesson plans and their learning portfolios. The data collected from teachers were then coded and analyzed in themes under each sub-research question, as has been presented in Chapter 4.

5.3   Discussions of Findings

Sub-research question 1: What ICT tools do teachers' use in Grade 7 Natural Sciences teaching?

The most common ICT item used by teachers is a digital projector connected to a laptop. Teachers are very comfortable in using this kind of a tool to enhance their teaching. Not all teachers utilize YouTube to enhance their classroom teaching. Teachers utilize YouTube directly online when they use it; a lack of awareness of how to download videos from YouTube leads to a relatively low utilization of YouTube videos. According to Ghavifekr, Kunjappan, Ramasamy and Anthony (2016), when new tools and approaches to teaching are introduced, teacher training is essential.

Teachers' personal smartphones and tablets are among the numerous ICT tools they use to enhance their teaching of Grade 7 Natural Sciences. This is due to the fact that all teachers have these tools at their disposal. Teachers are already aware of how to use these tools, so incorporating them into the class and using them to obtain information is simple. Most teachers utilize the internet as a source of information, however limited access to the internet prevents some teachers from using the internet frequently. Due to a lack of internet access in schools, some teachers have been required to scan their textbooks in order to use an ICT tool like a digital projector to project images in class.

Sub-research question 2: How do the teachers use ICT tools in teaching Grade 7 Natural Sciences?

Teachers use interesting and motivating ICT tools in their lessons. Using moving images captures the interest of the learners and makes it easy for the teachers to explain content. The visuals used by teachers are highly engaging, especially the animated images. All teachers had some knowledge on how to select and use the technological tools at their disposal. Some teachers scan images from the textbook to use them on the digital projector. This is very useful where there is a limited number of textbooks in the school.

Teachers used the digital projectors with their laptops to explain complex content. This was done by incorporating animated images and using videos to engage the interest of the learners. It also helps learners to observe the different processes being taught. PowerPoint is used by teachers to support the content by including digital graphics, and for learners to takes notes during the lesson. This shows that teachers have some Technological Content Knowledge (TCK) as they manage to select suitable ICT tools for the content they teach.

Teachers can manipulate the ICT tools that they are currently using, but more technological development is required for efficient and effective ICT integration. The teachers all teach using a teacher-centred approach using a digital projector and their laptops as supporting ICT tools. Topics are explained through relevant graphics, and some lessons are summarized using videos.

Sub-research question 3: How can teachers be supported to integrate ICT in teaching Natural Sciences in Grade 7 before class teaching?

When teaching with ICT technologies, teachers need guidance on how to apply various teaching strategies. During the support session, these were the areas that were discussed in depth. Teachers should also be trained on how to use YouTube videos offline, which would help them avoid the challenges that come with slow internet connections.

The following specific areas for development were observed from teachers and addressed in the support sessions.

- How to download images and link them into PowerPoint presentation?
- Workshop on the new educational programs like PhET simulations and how to use them.
- How to use PowerPoint features for effective and engaging presentations? How to format images in MSOffice programs like Word and PowerPoint.

Sub-research question 4: What are teachers' experiences of ICT integration in teaching Grade 7 Natural Sciences in the action research process?

Teaching with a digital projector and laptop is easy and effective, according to teachers. This is because they believe that incorporating ICT will help their students comprehend more effectively. When compared to a teacher who only talks, ICT is capable of grabbing students' interest and attention by its visual attractiveness and diverse approach, keeping the senses stimulated for a longer period of time. If teachers have access to the internet, they will all be able to learn something new. Teachers who have used ICT equipment such as a digital projector report that it makes teaching and learning more fun for them and their students, particularly when animated graphics and audio are included. ICT provides educators with the potential to discover new ways and methods for making learning more effective, as well as the opportunity to gain new skills and further their careers (Kler, 2014).

Most teachers feel that ICT can be utilized to improve Grade 7 Natural Science teaching and learning since it captures learners' interest. The learners' interest in using ICT to learn could be due to the fact that young people are fascinated by technology. ICT entices their interest and encourages learners to pay attention in class. As a result, a teacher's lesson delivery will be improved because learners will be paying more attention. That is one of the reasons why most teachers indicated they preferred technology-enhanced teaching compared to teaching using a chalkboard and the textbook.

Teachers believe that ICT has improved their perceptions of teaching and learning. Teachers' attitudes on ICT integration are likely influenced by the fact that teachers perceive ICT integration to be extremely beneficial. Teachers will decide to use it more frequently in their teaching if they find it useful.

Sub-research question 5: How do teachers develop Technological Pedagogical Content Knowledge (TPACK) after being supported in an Action-Research session?

The findings of this research indicate that teachers feel that the knowledge and skills gained during their support sessions has made their teaching of Grade 7 Natural Sciences more interesting and their learners are always eager to learn now. Teachers can now explore the internet for appropriate videos or images to utilize in their lessons as part of their planning. This also allows teachers to gain access to additional information as they watch various videos online before deciding which one to utilize, increasing their content knowledge in Natural Science.

Teachers have gained knowledge on how to use different ICT tools in their teaching. This newly found knowledge has enabled them to use their phones to download videos or images from the internet and then transfer them to their laptop to use in the classroom. Even though teachers prefer using a digital projector connected to laptop, they have used other ICT tools to teach their learners. All teachers that participated in the study believe that the use of ICT in teaching Grade 7 Natural Sciences has really improved their teaching. Learner concentration has also increased, thus making content delivery easier. This is consistent with the literature, that increased interest in the learners during the lesson is one of the motivational uses of ICT in education (Badia et al., 2013). Teachers use internet to source for information; this makes them enjoy going to the classroom as they are well prepared on the topic and it will make learners participate actively.

Teachers have theories about how their learners learn, which together with the lesson objectives, should inform their approach to teaching (Afshari et al., 2009) and guide them on the appropriate ICT resource to use. The support session has helped teachers to be able to use different teaching strategies that incorporate ICT. Teachers are using different ways to integrate ICT in their teaching of Grade 7 Natural Sciences. They can use a video to explain complex topics or use them to summarize the lesson. Using different teaching strategies makes learners to enjoy being in the classroom thus improving their concentration.

Sub-research question 6: Why do Natural Sciences teachers in Grade 7 develop TPACK in the way they do in integrating ICT?

Teachers agreed that ICT has shifted their perspectives on teaching and learning in a positive way. Teachers' attitudes on ICT integration are likely influenced by the fact that teachers perceive ICT integration to be extremely beneficial. Successful technology integration in education requires teacher support and a positive mind-set. If teachers do not believe that ICT integration in teaching and learning is addressing their and their learners' needs, they will be hesitant to use technology in the classroom (Kler, 2014).

Teachers are using ICT to improve their learners' marks in Natural Sciences in Grade 7. This was accomplished by developing their technological pedagogical content knowledge on how to use various ICT resources to accommodate learners of all learning abilities. Teachers can use ICT for improving the quality of teaching and learning process (Kawade & Kulkarni, 2012). According to teachers, ICT has provided them with a variety of opportunities. These possibilities include everything from administrative duties to locating appropriate instructional

aids or materials for use in the classroom. As teachers search for appropriate teaching aids, it also helps improve their knowledge on the topic because they go through a lot of information before selecting the most relevant.

Teachers have realised that ICT has can improve learner participation, by improving learner participation in the classroom, ICT integration can improve teaching and learning. They have realized that ICT integration has the potential to shift teaching from a teacher-centred to a learner-centred approach when implemented properly. However, this is an area where teachers need further development. Teachers believe that individual learners' needs are fulfilled by ICT, and assists them in their learning by motivating them to learn. As a result, learners learn better and more effectively. Thus, teachers state that having knowledge on how to incorporate ICT into their teaching helps to reduce the stress of having to explain concepts to learners multiple times. This cuts down on the time spent teaching a concept, and the time saved can be put to better use elsewhere in the lesson.

5.4   Conclusions stemming from the study

Main research question: How do teachers use Technological Pedagogical Content Knowledge (TPACK) to integrate Information and Communication Technology (ICT) in their teaching of Natural Sciences in Grade 7?

The findings of the main research question are discussed below. Three aspects of the Technological Pedagogical Content Knowledge (TPACK) framework are used to present the findings of the study.

5.4.1 Technological Knowledge

According to Koehler and Mishra (2008), Technological Knowledge is knowledge about technologies and it also involves the skills required to operate particular technologies. Polly et al. (2010) were cited in a study by Agyei and Keengwe (2014) stating that, Knowledge of standard technologies, such as books and chalkboards, as well as more sophisticated technologies, such as the internet and digital video, and the various modalities they enable for representing information, is referred to as Technology Knowledge (TK). Teachers in this study were using a few of the ICT tools that were highlighted by Hilkemeijer (2020) as ICT tools that can be used to enhance primary science, namely MS PowerPoint and virtual images.

The findings indicate that many teachers lack the knowledge about ICT resources that are available for teachers to use in their teaching. Useful tools like PhET simulations and websites like Mindset E-Learning and NECT where teachers can get resources from, were unfamiliar to the teachers. On a positive note, all three teachers who participated in the study indicated that they are familiar with YouTube, although not all teachers had used YouTube to search for videos that can be used to enhance their teaching of Grade 7 Natural Sciences. A lack of knowledge on how to download, or use the videos offline, could have been the main reason why some teachers did not use YouTube as source of resources. This was evident during the support session with the teachers when we discussed how to download YouTube videos. Teachers were very excited to learn how to download videos from YouTube, or the internet.

During the lesson observation that was conducted in the first cycle of the action research, it was observed that teachers were very comfortable in the use of the digital projector even though some teachers had a little challenge in connecting the digital projector in the beginning of the lesson. These challenges were discussed during the support session. Also discussed, were the challenges that were observed during the lesson observation such as the teachers not using PowerPoint Presentation on slide show mode and not utilizing other features of PowerPoint like animation and linking videos to their presentations. Teachers indicated in the semi-structured interviews, that were conducted after the support session, that they are now able to utilize more features of the MS Office applications PowerPoint and Word.

Technology Knowledge for all teachers improved considerably after the action research support session. This is a sign that teachers need, and will benefit from, ICT development workshops. If they were offered more developmental opportunities, then there will be an improvement in ICT integration in South African schools. This is supported by the teachers, who complimented their support sessions as they claimed it had enhanced their knowledge of the digital projector, and how to download videos and images from the internet.

During the support session which was part of the action research to empower teachers, they mentioned their desire to be developed in the use of ICT. This information seems to support what teachers mentioned in their Personal Growth Plans; that they need to be developed on how to use the digital projector for their teaching of Grade 7 Natural Sciences. These teachers expressed that even though they had attended developmental workshops that were done by the Department of Education, none of these workshops were about the use of ICT in the classroom. This highlights the need for the Department of Education to start planning these kinds of ICT development workshops if they are to accomplish some of the goals set out in the Department

of Basic Education White Paper 7 on e-Education of intending to transform learning and teaching through ICT.

5.4.2 Technological Pedagogical Knowledge (TPK)

Technological Pedagogical Knowledge is the knowledge of various technologies and how they are used in teaching and learning (Koehler & Mishra, 2008). Shu and Radio (2016) state that Technological Pedagogical Knowledge (TPK) is also about understanding that using technology may change the way teachers teach. The technology that most teachers used in this study was a digital projector connected to a laptop. They used this to display PowerPoint presentations and YouTube videos in class. Teachers believe the use of the digital projector has improved their teaching of Grade 7 Natural Sciences. As technology has become an important part of our lives and our education system, it is essential that teachers have a positive attitude toward teaching using ICT. The teachers in this study are positive about ICT because they can use the digital projector to explain complex content by including videos and pictures in their teaching presentations. It must be noted however, that initially some of the teachers were not including digital graphics in their presentations to explain the content of Grade 7 Natural Sciences.

The teaching method that most of the teachers used in their observed lesson was a teacher-lead pedagogical approach using a PowerPoint presentation as a supporting teaching aid. The design of their presentations did not allow teachers to use a learner-centered approach as their focus was on the teacher explaining concepts to learners. The teachers were not aware of alternative software that would allow for a more learner-centred teaching method. The support session was used to help teachers with the knowledge required to implement a more learner-centered approach using appropriate software. This was very essential as all teachers indicated the importance of finding a different method of teaching using the digital projector.

Teachers mentioned different reasons for deciding to use a digital projector for teaching. Saving time to explain science content was a common reason for two teachers. Not only were they no longer spending most of the lesson writing notes on the board, so that they had more time to teach, but teachers also believed using the digital projector helps them simplify the content using less time. This valuable saved time can now be used to help struggling learners in the classroom. This will thus improve the performance of the learners in Grade 7 Natural Sciences.

All participants regarded the digital projector as an important educational tool that can bring about substantial improvements to teaching and learning. Even though there was a lack of necessary ICT skills, all participants had a positive attitude towards using ICT to improve teaching practices. Technological Pedagogical Knowledge also looked at how teachers incorporate the technology tool they have in their teaching strategy. In this study, two teachers were very good at selecting appropriate videos and images to use in their teaching of specific content of Natural Sciences, while one teacher needed guidance in selecting and using these technological tools in her teaching.

5.4.3 *Technological Content Knowledge (TCK)*

Technological Content Knowledge (TCK) refers to knowledge about how technology may be used to provide new ways of teaching content (Agyei & Keengwe, 2014). Teachers need to understand which technology are best suited to teach specific subject-matter (Koehler & Mishra, 2008). Technological Content Knowledge includes knowing how to use a certain technology to teach a certain topic. This includes the selection of the right images, simulation, videos or educational program. Two out of three teachers that participated had chosen images that were stimulating for learners. The pictures were very colorful and enhanced the learning thus improving the learners' understanding of the concepts being taught. It requires a great knowledge of the subject teacher to be able to select the appropriate technology tool to use to facilitate learning of a specific topic. During the support session, teachers were introduced to using Graphic Interchanged Format (GIF) images in their PowerPoint presentations. These are very good resources to use when explaining scientific processes as these are moving pictures on a loop; they work like a video on repeat. They can help improve understanding of the content being taught as they keep repeating the process over and over.

Their lack of knowledge about educational programs like the PhET simulations denied teachers an opportunity to help improve learners' knowledge and understanding through more learner-centred approaches. All teachers agree that the use of the internet and other educational programs does not only improves learner knowledge, it also improves their own knowledge on the content they teach. Using planning programs like NECT can provide needed content knowledge for teachers as it also guides teachers on the appropriate resources to use for a specific lesson or topic.

Unfortunately, some schools do not allow learners to use their cellphones in the school. A cellphone can be a very useful tool for learners to learn but it can also be distracting to teaching

and learning if not properly managed. When cellphones are properly incorporated into teaching and learning, they can help learners to master content knowledge by using educational Apps. Teachers can also use cellphones to share digital resources with learners. Allowing learners to use these gadgets in the class can help to improve learner participation in the lesson, and encourage a more learner-centred approach. It is quite clear that the advantages of having a cellphone in the classroom can outweigh the disadvantages when properly managed.

Teachers acknowledge that the use of internet resources and educational programs have improved their content knowledge. However, a lack of resources like internet access and tablets in these schools has a negative impact on how teachers can use technology to enhance teaching and learning. Internet access in schools provides teachers and learners with a platform to research topics and relearn or extend the content they are taught in the classroom. While individual teachers may be able to do that using their personal cellphones, and data, access to school computers and computer rooms with network access would make integrating ICT easier.

In conclusion, to answer the research question, *how do teachers use Technological Pedagogical Content Knowledge (TPACK) to integrate Information and Communication Technology (ICT) in their teaching of Natural Sciences in Grade 7?* Teachers in grade 7 Natural Science classes used a digital projector connected to a laptop to enhance teaching and learning by integrating interesting visuals, but they had insufficient knowledge of how to use these ICT tools in their classes. Teachers were unable to fully utilize ICT tool due to a lack of knowledge. However, it should be highlighted that the action research support sessions did assist teachers in improving their Technological Knowledge, Technological Pedagogical Knowledge, and Technological Content Knowledge. This demonstrates the need for ICT development workshops in order to improve ICT integration. Teachers' positive attitudes toward ICT integration, which they believe has helped them enhance their teaching strategies and topic understanding, are also critical to a successful ICT deployment in the school system.

5.5   Recommendations

Despite the rapid development of ICT and significant developments in science and technology over the preceding decade, science teachers face numerous obstacles and possibilities in their classroom practice with relation to science teaching (Savec, 2017), and with effective ICT integration. As demonstrated in the findings, while teachers are integrating ICT to a limited extent, there are many areas for further development. The following section will present the recommendations based on the findings and conclusions of this study.

5.5.1 Recommendation One – Technology Knowledge

There is a worldwide change happening in the teaching and learning process. Most of these changes include the introduction of ICT tools in the classroom, and for online or remote learning, which accelerated in 2020 due to the ongoing COVID-19 pandemic. Since teachers play a central role in the integration of ICT tools and the transformation of education, there should be regular workshops designed specifically for developing teachers' knowledge and skills in ICT integration. These workshops should equip teachers with knowledge of ICT resources, both hardware and software, that are suitable for the grades and subjects that they teach, as well as providing opportunities for teachers to learn how to use these resources. Schools should allow teachers to attend these kinds of professional development workshops. Teachers need to be exposed to educational programs that can help enhance their knowledge of the subject content. This can be achieved by increasing technological tools like computers and allowing supervised cellphone usage in the schools. The policy on learners' use of cellphones in the school needs to be revised to help address the lack of technological resources as these gadgets can be useful in teaching and learning.

Lack of accessibility to ICT resources like internet and mobile gadget for teachers and learners is still a barrier to effective integration in some of the schools. The Department of Basic Education should work together with the school leaders and School Governing Bodies to ensure that school's budget for school internet services and that it is available to both teachers and learners for educational purposes. The Department of Basic Education should offer assistance to those schools that cannot afford to pay for internet services because of inadequate Norms and Standard Allocation, and low fee income.

5.5.2 Recommendation Two – Technological Pedagogical Knowledge

The findings indicate that teachers lacked knowledge of many educational programs that are freely available on the internet. The Department of Education should make these programs familiar to teachers and actively encourage their use. This can be done by distributing information about them to schools as part of the Learning and Teaching Support Material that the Department already provides. Teachers have demonstrated that they are willing to learn and integrate these resources into their teaching; they simply need support and guidance in terms of appropriate pedagogy. So, as well as sharing technical knowledge, workshops should also develop teachers on how to use these resources in their teaching in order to teach more effectively.

5.5.3 Recommendation Three – Technological Content Knowledge

Teachers also need focused workshops to learn how different ICT resources can be used to address learning outcomes in specific topics within Natural Sciences. This entails learning to use new learner-centered pedagogies, such as learning to use a PhET simulation and an inquiry approach to teach about concepts on electricity in Grade 7 Natural Sciences. This will extend the teachers' ICT integration practices beyond a teacher-centred approach, involving only PowerPoint Presentations and YouTube videos.

5.5.4 Recommendation Four – For Future Studies

This study was based on the integration of ICT in Grade 7 Natural Sciences focusing on schools with teachers who are already using ICT in their teaching, but to a limited extent. Further studies could be done in schools that have ICT resources but where teachers are not using them to further understand the barriers and support that is needed. Researching teacher practices in well-resourced schools where ICT has been integrated into the teaching of Natural Sciences could also reveal best practices that could then be shared with other teachers.

Promoting the effective integration of ICT in all schools will help to fulfill the goal set by Department of Basic Education of transformation from the traditional 3 R's (Reading, Writing, and Arithmetic) skills to the new 4 C's (communication, collaboration, critical thinking, and creativity) skills in the education system (Motshekga, 2019).

5.6 Limitations of the Study

Due to both the action research design of the study, and fact that the research was conducted during the COVID-19 pandemic and lockdown in South Africa, this study was conducted with only three participants. Therefore, the findings cannot be generalized to all Grade 7 Natural Science teachers, although they are consistent with findings from the literature. However, the findings do still provide some insight into how teachers are currently integrating ICT in their teaching of Grade 7 Natural Sciences, and what could be done to further develop their expertise in this area.

References

Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?": ICT in Ghana post Covid-19. *Education and Information Technologies, 26*(2), 1665-1685. https://doi.org/10.1007/s10639-020-10331-z

Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction, 2*(1), 77-104. https://eric.ed.gov/?id=ed524156

Agyei, D. D., & Keengwe, J. (2014). Using technology pedagogical content knowledge development to enhance learning outcomes. *Education and Information Technologies, 19*(1), 155-171. https://doi.org/10.1007/s10639-012-9204-1

Akpan, I. F., & Itighise, A. E. (2019). Students' Perception of Lecturers' Utilization of Information and Communication Technology (ICT) Tools for Instructional Delivery in Science Education Programme. *Journal of Education and Development, 3*(2), 35. https://doi.org/10.20849/jed.v3i2.606

Al-Rsa'i, M. S. (2013). Promoting Scientific Literacy by Using ICT in Science Teaching. *International Education Studies, 6*(9), 175-186. https://doi.org/10.5539/ies.v6n9p175

Algahtani, A. (2011). Evaluating the Effectiveness of the E-learning Experience in Some Universities in Saudi Arabia from Male Students' Perception [Doctoral Dissertation, Durham University]. Durham e-Theses. http://etheses.dur.ac.uk/3215/

Almekhlafi, A. G., & Almeqdadi, F. A. (2010). Teachers' perceptions of technology integration in the United Arab Emirates school classrooms. *Journal of Educational Technology & Society, 13*(1), 165-175. https://www.jstor.org/stable/jeductechsoci.13.1.165

Alsalhi, N. R., Eltahir, M. E., & Al-Qatawneh, S. S. (2019). The effect of blended learning on the achievement of ninth grade students in science and their attitudes towards its use. *Heliyon, 5*(9), e02424. https://doi.org/10.1016/j.heliyon.2019.e02424

Andyani, H., Setyosari, P., Wiyono, B., & Djatmika, E. (2020). Does Technological Pedagogical Content Knowledge Impact on the Use of ICT In Pedagogy? *International Journal of Emerging Technologies in Learning (iJET), 15*(3), 126-139. https://www.learntechlib.org/p/217025/.

Anney, V. N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies*, *5*(2), 272-281. http://repository.costech.or.tz/handle/123456789/9978

Arkorful, V., & Abaidoo, N. (2015). The role of e-learning, advantages and disadvantages of its adoption in higher education. *International Journal of Instructional Technology and Distance Learning, 12*(1), 29-42. https://www.itdl.org/Journal/Jan_15/Jan15.pdf#page=33

Athanasou, J. A., Di Fabio, A., Elias, M., Ferreira, R., Gitchel, W., Jansen, J., & Mpofu, E. (2012). *Complete your thesis or dissertation successfully: Practical guidelines*. Juta.

Badia, A., Meneses, J., & Sigalés, C. (2013). Teachers' perceptions of factors affecting the educational use of ICT in technology-rich classrooms. *Electronic Journal of Research in Educational Psychology*, *11*(3), 787-808. http://repositorio.ual.es/bitstream/handle/10835/3011/Art_31_845.pdf?sequence=1

Balanskat, A., Blamire, R., & Kefala, S. (2006). The ICT impact report. *European Schoolnet, 1*, 1-71. https://doi.org/http://colccti.colfinder.org/sites/default/files/ict_impact_report_0.pdf

Barakabitze, A. A., William-Andey Lazaro, A., Ainea, N., Mkwizu, M. H., Maziku, H., Matofali, A. X., Iddi, A., & Sanga, C. (2019). Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities. *Education Research International, 2019*, 1-29. https://doi.org/10.1155/2019/6946809

Baran, E., Canbazoglu Bilici, S., Albayrak Sari, A., & Tondeur, J. (2019). Investigating the impact of teacher education strategies on preservice teachers' TPACK. *British Journal of Educational Technology, 50*(1), 357-370. https://doi.org/10.1111/bjet.12565

Bertram, C., & Christiansen, I. (2014). Understanding research. *An Introduction to Reading Research. Van Schaik Publishers*.

Bibi, S., & Khan, S. H. (2017). TPACK in action: A study of a teacher educator's thoughts when planning to use ICT. *Australasian Journal of Educational Technology, 33*(4). https://doi.org/10.14742/ajet.3071

Bindu, C. (2016). Impact of ICT on teaching and learning: A literature review. *International Journal of Management and Commerce Innovations, 4*(1), 24-31. https://www.researchpublish.com/papers/impact-of-ict-on-teaching-and-learning:-a-literature-review-2016

Bingimlas, K. (2009). Barriers to the Successful Integration of ICT in Teaching and Learning Environments: A Review of the Literature. *Eurasia Journal of Mathematics Science & Technology Education, 5*(3), 235-245. https://doi.org/10.12973/ejmste/75275

Bishnu, K. (2021). Action research: The reflection on professionalism. *Journal of Education Sciences,* 1*(1)*, 31-39. https://www.researchgate.net/publication/349009533_Article_on_Action_Research

Botha, R. (2002, March 6-9). The Introduction of a System of OBE in South Africa: *Transforming and Empowering a Marginalized and Disenfranchised Society* [Paper presentation]. 46th Annual Meeting of the Comparative and International Education Society, Florida. https://eric.ed.gov/?id=ED477153

Brewer, S., & Harrison, R. (2013). Blended Learning in South Africa. *Focus: Education: Overcoming & Innovation*, *68*(1), 62-67. https://hsf.org.za/publications/focus/focus-68/%2812%29%20S.%20Brewer%20and%20R.%20Harrison.pdf

Brooke, E. (2015). Four keys to success using blended learning implementation models. *Lexia Learning, 22*, 1-5. https://www.lexialearning.com/sites/default/files/Blended%20Learing%20Whitepaper%202021.pdf

Burns, A. (2015). Research Methods in Applied Linguisti**cs:** *Action Research.*187-204. Routledge. https://www.researchgate.net/publication/282199978_Action_research

Cha, H., Park, T., & Seo, J. (2020). What should be considered when developing ICT-integrated classroom models for a developing country? *Sustainability, 12*(7), 2967. https://doi.org/10.3390/su12072967

Chan, C. K. (2015). Use of animation in engaging teachers and students in assessment in Hong Kong higher education. *Innovations in Education and Teaching International, 52*(5), 474-484. https://doi.org/10.1080/14703297.2013.847795

Chaudhari, M. (2017). Role of ICT in Science Education. *Abhinav-National Monthly Refereed Journal Of Research In Arts & Education, 6*, 1-5. https://www.semanticscholar.org/paper/role-of-ict-in-science-education-chaudhari/cd82c5408b2e855ea4972cb0608a666f45af18b9

Cohen, L., Manion, L., & Morrison, K. (2013). *Research Methods in Education*. Routledge.

Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: students' perspective. *Sustainability, 12*(24). https://doi.org/10.3390/su122410367

Costello, P. J. (2003). *Action research*. Bloomsbury Publishing. https://mthoyibi.files.wordpress.com/2011/04/action-research_patrick-j-m-costello-20031.pdf

Cox, M., Cox, K., & Preston, C. (2000). *Teachers as Innovators in Learning: What motivates teachers to use ICT. (1st ed.)* Mirandanet.

Cox, S., & Graham, C. R. (2009). Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends, 53*(5), 60-69. https://doi.org/10.1007/s11528-009-0327-1

Creswell, J. W. E., L; Eloff, I; Ferreira, R; Ivankova, N.V; Jansen, J.D; Nieuwenhuis, I; Pietersen, J; Plano Clark, V.I; van ser Westhuizen, C. (2015). *First Steps in Research*. Van Schaik Publishers.

Dabbagh, N. (2005). Pedagogical models for E-Learning: A theory-based design framework. *International Journal of Technology in Teaching and Learning, 1*(1), 25-44. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.475.4593&rep=rep1&type=pdf

Das, K. (2019). Role of ICT for Better Mathematics Teaching. *Shanlax International Journal of Education, 7*(4), 19-28. https://eric.ed.gov/?id=EJ1245150

Dave, D. (2019). An analytical study of the role of ICT in higher education. *Journal of Global Economy, 15*(1), 56-61. https://doi.org/10.1956/jge.v15i1

DeCoito, I., & Richardson, T. (2018). Teachers and technology: Present practice and future directions. *Contemporary Issues in Technology Teacher Education, 18*(2), 362-378. https://www.learntechlib.org/p/180395/

Denby, D., & Holman, J. (2002). *ICT in Support of Science Education: A Practical Users Guide*. University of York Science Education Group. https://www.york.ac.uk/org/seg/about_us/about_us_images/ICTinSupport.pdf

Department of Basic Education, R. (2011). *Curriculum and Assessment Policy Statement, Natural Sciences Senior Phase*. Government Printing Works. https://www.education.gov.za/portals/0/cd/national%20curriculum%20statements%20and%20vocational/caps%20sp%20%20natural%20sciences%20gr%207-9%20%20web.pdf?ver=2015-01-27-160159-297

Department of Basic Education, R. (2015). *Action Plan to 2019 Towards the Realisation of Schooling 2030, Taking forward South Africa's National Development Plan 2030*. Government Printing Works. https://www.education.gov.za/portals/0/documents/publications/action%20plan%202019.pdf?ver=2015-11-11-162424-417

Department of Basic Education, R. (2017). *Rural Education Draft Policy*. Government Printing Works. https://www.education.gov.za/Portals/0/Documents/Policies/Draft%20Policy%20on%20Rural%20Education%200218.pdf?ver=2018-02-09-105713-287

Department of Education, R. (2003). *IQMS Training Manual*. Government Printing Works. https://www.dhet.gov.za/Education%20Labour%20Relations%20and%20Condit/Integrated%20Quality%20Management%20System%20For%20Public%20FET%20College%20Based%20Educators.doc

Department of Education, R. (2004). *White Paper on e-Education, Transforming Learning and Teaching through Information and Communication Technologies (ICTs), NOTICE 1922 OF 2004, CORRECTION NOTICE, Notice 1869 of 2004, published on page 3 of Government Gazette No. 26734 of 26 August 2004,* . Government Printers. https://www.education.gov.za/Portals/0/Documents/Legislation/White%20paper/DoE%20White%20Paper%207.pdf?ver=2008-03-05-111708-000

Dube, B., Nhamo, E., & Magonde, S. (2018). Factors affecting ICT integration in the teaching and learning of physical education in South Africa: A case of Johannesburg East cluster primary schools in the Gauteng Province. *International Journal of Sport, Exercise and Health Research, 2*(1), 88-92. http://www.sportscienceresearch.com/IJSEHR_201821_03.pdf

Duffy, L. (2018). *Reasons Why AR and VR Should Be Integrated In eLearning*. The Quill Consultancy, Flexible Training. https://quill.com.au/reasons-ar-vr-integrated-elearning/

Engelbrecht, J., & Harding, A. (2008). The impact of the transition to outcomes-based teaching on university preparedness in mathematics in South Africa. *Mathematics Education Research Journal, 20*(2), 57-70. https://doi.org/10.1007/BF03217477

Essays, U. (2018). Traditional versus modern methods of effective teaching. https://www.ukessays.com/essays/education/traditional-versus-modernmethods-of-effective-teaching-education-essay.php

Eyyam, R., & Yaratan, H. S. (2014). Impact of use of technology in mathematics lessons on student achievement and attitudes. *Social Behavior and Personality: An International Journal, 42*(1), 31S-42S. https://doi.org/10.2224/sbp.2014.42.0.S31

Falloon, G. (2019). Using simulations to teach young students science concepts: An Experiential Learning theoretical analysis. *Computers & Education, 135*, 138-159. https://doi.org/10.1016/j.compedu.2019.03.001

Farrell, G., Isaacs, S., Hamdy, A., Hare, H., Tchinda, J. T., Mangesi, K., Agyenman-Duah, O. T., & Fall, B. (2007). Survey of ICT in Education in Africa, *53 Country Report*, *2*. http://oasis.col.org/handle/11599/248

Fernández-Gutiérrez, M., Gimenez, G., & Calero, J. (2020). Is the use of ICT in education leading to higher student outcomes? Analysis from the Spanish Autonomous Communities. *Computers & Education, 157*, 103969. https://doi.org/10.1016/j.compedu.2020.103969

Ferrance, E. (2000). *Action research*. Providence, RI: Northeast and Islands Regional Educational Laboratory, Brown University. http://www.lab.brown.edu/pubs/themes_ed/act_research.pdf

Ford, M., & Botha, A. (2010). *A pragmatic framework for integrating ICT into education in South Africa* [Paper presentation]. 2010 IST-Africa, Durban, South Africa. https://ieeexplore.ieee.org/abstract/document/5752994

Frost, P. (2002). Principles of the action research cycle. In R. In, A. Ritcie, & P. Pollard (Eds.), *Action research: A guide for teachers. Burning issues in primary education* (pp. 24-32). National Primary Trust.

Fu, J. (2013). Complexity of ICT in education: A critical literature review and its implications. *International Journal of education and Development using ICT, 9*(1), 112-125. https://www.learntechlib.org/p/111900/.

Futch, L., & Chen, B. (na). *BlendKit Course: BlendKit Reader: Chapter1*. https://blended.online.ucf.edu/blendkit-course-blendkit-reader-chapter-1/

Gandhi, P. O. (2002). *Outcomes Based Focused Education overview* [Doctoral thesis, University of London]. University of London. https://www.researchgate.net/publication/317209834_Outcomes_Based_Education

Ganyaupfu, E. M. (2013). Teaching methods and students' academic performance. *International Journal of Humanities and Social Science Invention, 2*(9), 29-35. http://tinyurl.com/2p87sh8n

Ghavifekr, S., Kunjappan, T., Ramasamy, L., & Anthony, A. (2016). Teaching and Learning with ICT Tools: Issues and Challenges from Teachers' Perceptions. *Malaysian Online Journal of Educational Technology, 4*(2), 38-57. https://files.eric.ed.gov/fulltext/EJ1096028.pdf

Ghavifekr, S., Razak, A. Z. A., Ghani, M. F. A., Ran, N. Y., Meixi, Y., & Tengyue, Z. (2014). ICT integration in education: Incorporation for teaching & learning improvement. *Malaysian Online Journal of Educational Technology, 2*(2), 24-45. https://eric.ed.gov/?id=EJ1086419

Govender, N., & Juggernath, A. (2020). Science teachers' critical reflections of ICT use in a well-resourced school, In P. Vale, L. Westaway, Z. Nhase, & I. Schudel (Eds.), *Proceedings of the 28th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education* (pp. 367-377). Eastern Cape, South Africa. https://saarmste.org/images/Conference_Proceedings/SAARMSTE2020-Rhodes_University/FINAL%20SAARMSTE%20PROCEEDINGS_compressed.pdf

Graham, M. A., Stols, G., & Kapp, R. (2020). Teacher Practice and Integration of ICT: Why Are or Aren't South African Teachers Using ICTs in Their Classrooms. *International Journal of Instruction, 13*(2), 749-766. https://eric.ed.gov/?id=EJ1249105

Guri-Rosenblit, S. (2005). 'Distance education' and 'e-learning': Not the same thing. *Higher Education, 49*, 467-493. https://doi.org/10.1007/s10734-004-0040-0

Harahap, F., Nasution, N. E. A., & Manurung, B. (2019). The Effect of Blended Learning on Student's Learning Achievement and Science Process Skills in Plant Tissue Culture Course. *International Journal of Instruction, 12*(1), 521-538. https://eric.ed.gov/?id=EJ1201370

Harber, I. M. (2014). *Learning and doing: Exploring the role of information and communication technology (ICT) in fostering learning and education amongst youth in rural KwaZulu-Natal* [Doctoral dissertation, University of KwaZulu-natal]. University of KwaZulu-Natal Research Space. http://hdl.handle.net/10413/13399

Hare, H. (2007a). ICT in Education in Burundi. In: Farrell, G (eds). *Survey of ICT and Education in Africa*. 1. https://openknowledge.worldbank.org/handle/10986/10648?locale-attribute=en

Hare, H. (2007b). ICT in education in Tanzania. *Survey of ICT and education in Africa, 53*. https://www.infodev.org/infodev-files/resource/InfodevDocuments_389.pdf

Henderson, D. (2020). Benefits of ICT in Education. *IDOSR Journal of Arts and Management, 5*. https://www.idosr.org/wp-content/uploads/2020/02/IDOSR-JAM-51-51-57-2020.-1.pdf

Hennessy, S., Harrison, D., & Wamakote, L. (2010). TTeacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale Online Journal of African Studies*, *2*(1), 39-54. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.461.916&rep=rep1&type=pdf

Hilkemeijer, M. (2020). 10 Powerful ICT tools for primary science. *ICTE Solutions Australia*. https://www.ictesolutions.com.au/blog/10-powerful-ict-tools-for-primary-science/

Hinostroza, J. E. (2018). New challenges for ICT in education policies in developing countries: The need to account for the widespread use of ICT for teaching and learning outside the school. In I. A. Lubin (Ed.), *ICT-Supported Innovations in Small Countries and Developing Regions: Perspectives and Recommendations for International Education* (pp. 99-119). Springer International Publishing. https://doi.org/10.1007/978-3-319-67657-9_5

Hu, Z., & McGrath, I. (2012). Integrating ICT into College English: An implementation study of a national reform. *Education and Information Technologies, 17*(2), 147-165. https://link.springer.com/article/10.1007/s10639-011-9153-0

In, J. (2017). Introduction of a pilot study. *Korean Journal of Anesthesiology, 70*, 601. https://doi.org/10.4097/kjae.2017.70.6.601

Ismail, S. A. M. M., Jogezai, N. A., & Baloch, F. A. (2020). Hindering and enabling factors towards ICT integration in schools: A developing country perspective. *Elementary Education Online, 19*(3), 1537-1547. https://doi.org/10.17051/ilkonline.2020.733176

Jeffrey, L. M., Milne, J., Suddaby, G., & Higgins, A. (2014). Blended learning: How teachers balance the blend of online and classroom components. *Journal of Information Technology Education, 13*. http://www.jite.org/documents/Vol13/JITEv13ResearchP121-140Jeffrey0460.pdf

Jotter, S. (2016). *Top 6 benefits of using technology in the classroom*. https://www.schooljotter.com/blog/2016/02/top-6-benefits-technology-classroom/

Juggernath, A. (2017). *Exploring grade 8 natural science teachers' use of information, communication technology (ict) in teaching natural sciences: A case study in a public school in KwaZulu-Natal* [Unpublished Master's thesis]. University of KwaZulu-Natal

Juggernath, A., & Govender, N. (2020). Natural Sciences Teachers' Beliefs as Barriers for Integrating ICTs in a Technology-rich Context. *African Journal of Research in Mathematics, Science and Technology Education*, 1-11. https://doi.org/10.1080/18117295.2020.1736854

Jung, I. (2005). ICT-pedagogy integration in teacher training: Application cases worldwide. *Journal of Educational Technology & Society, 8*(2), 94-101. https://www.jstor.org/stable/jeductechsoci.8.2.94?seq=1#metadata_info_tab_contents

Juuti, K., Lavonen, J., Aksela, M., & Meisalo, V. (2009). Adoption of ICT in science education: A case study of communication channels in a teachers' professional

development project. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(2), 103-118. https://www.learntechlib.org/p/69825/

Kalogiannakis, M., & Papadakis, S. (2019). Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences. *International Journal of Mobile Learning and Organisation, 13*(1), 113-127. https://www.inderscienceonline.com/doi/abs/10.1504/IJMLO.2019.096479

Kavai, P. (2014). *The use of animal organ dissection in problem-solving as a teaching strategy* [Doctoral thesis, University of Pretoria]. University of Pretoria: Research Output. http://hdl.handle.net/2263/40228

Kawade, D. R., & Kulkarni, S. N. (2012). Use of ICT in primary school. *Pioneer Journal*. https://www.researchgate.net/publication/318339329_Use_of_ICT_in_Primary_School_final

Khalo, X. (2020). *Exploring Information and Communication Technology integration in life sciences teaching in rural schools in South Africa*.[Paper presentation] Proceedings of EDULEARN20 Conference, 6(1). https://library.iated.org/view/KHALO2020EXP

Kler, S. (2014). ICT integration in teaching and learning: Empowerment of education with technology. *Issues and Ideas in Education, 2*(2), 255-271. https://doi.org/10.15415/iie.2014.22019

Koehler, M. J., & Mishra, P. (2008). Introducing tpck. *Handbook of technological pedagogical content knowledge (TPCK) for educators, 1*(1), 3-29. http://www.matt-koehler.com/publications/Mishra_Koehler_AERA_2008.pdf

König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education, 43*(4), 608-622. https://doi.org/10.1080/02619768.2020.1809650

Kuboja, J. M. (2019). Revamping students' academic performance through the use of information and communication technology in teaching and learning activities: Correlating variables. *International Journal of Educational Policy Research and Review*, *6*(3), 46-53. https://journalissues.org/ijeprr/wp-content/uploads/sites/7/2019/05/Kuboja.pdf

Kumar, R. (2008). Convergence of ICT and Education. *World Academy of Science, Engineering and Technology, 40*(2008), 556-559. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.193.2558&rep=rep1&type=pdf

Kurniawan, M. (2018). *The use of mobile phone in English language lesson: A shift from teacher-centred to student-centred through mobile learning*. [Paper presentation]Web of Conferences. *1*, 1-76. 10.1051/20184200076

KwaZulu-Natal Department of Basic Education. (2015). *Information and Communication Technology (ICT) in KwaZulu-Natal Schools*. South African Government.

https://www.gov.za/speeches/ict-kwazulu-natal-schools-24-jul-2015-0000?gclid=cj0kcqjwhip6brcmarisalu9lfn9cjnirdu60qezwnjlfyqec64ztb2wdjuicybcx7my_r1akxuqdkmaaixzealw_wcb

Li, S., Yamaguchi, S., Sukhbaatar, J., & Takada, J.-I. (2019). The Influence of Teachers' Professional Development Activities on the Factors Promoting ICT Integration in Primary Schools in Mongolia. *Education Sciences, 9*(2), 78. https://www.mdpi.com/2227-7102/9/2/78

Loughran, J., Berry, A., & Mulhall, P. (2012). *Understanding and Developing ScienceTeachers' Pedagogical Content Knowledge* (Vol. 12). Springer Science & Business Media. http://link.springer.com/book/10.1007/978-94-6091-821-6

Lu, Z., Hou, L., & Huang, X. (2010). A research on a student-centred teaching model in an ICT-based English audio-video speaking class. *International Journal of education and Development using ICT, 6*(3), 101-123. https://www.learntechlib.org/p/42381/

Lynch, R., & Brereton, B. (2020). *What it means to be a 21st century teacher: Experiences from the blended learning perspective.* https://www.researchgate.net/publication/342354935_what_it_means_to_be_a_21st_century_teacher_experiences_from_the_blended_learning_perspective.

Mackey, K., & Watson, J. (2017, *June, 28*). Proof Points: *Blended Learning Success in School Districts*. https://www.christenseninstitute.org/wp-content/uploads/2015/05/dcps.pdf

Manoj, S., & Govender, D. W. (2005). The attitudes of educators to information technology adoption in school settings. *Alternation, 12*(2), 79-91. https://hdl.handle.net/10520/aja10231757_390

Mashile, T. (2017). *Technology integration and the digital divide: Understanding factors that impact on educators' ability to integrate technology in South African classrooms* [Master's thesis, University of Pretoria]. University of Pretoria: Research Output. https://repository.up.ac.za/handle/2263/59868

Matheson, J. L. (2007). The Voice Transcription Technique: Use of Voice Recognition Software to Transcribe Digital Interview Data in Qualitative Research. *Qualitative Report, 12*(4), 547-560. https://doi.org/10.46743/2160-3715/2007.1611

McGee, P., & Reis, A. (2012). Blended course design: A synthesis of best practices. *Journal of Asynchronous Learning Networks, 16*(4), 7-22. https://eric.ed.gov/?id=EJ982678

Melo, E., Llopis, J., Gascó, J., & González, R. (2020). Integration of ICT into the higher education process: The case of Colombia. *Journal of Small Business Strategy, 30*(1), 58-67. https://libjournals.mtsu.edu/index.php/jsbs/article/view/1665

Mhlanga, D., & Moloi, T. (2020). COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa? *Education Sciences, 10*(7), 180. https://doi.org/10.3390/educsci10070180

Mkhize, S. N. (2019). *An implementation analysis of e-learning: a case study of Kwapata Secondary School, Dambuza township* [Master's thesis, University of KwaZulu-Natal]. University of KwaZulu-Natal Research Space. https://researchspace.ukzn.ac.za/xmlui/handle/10413/16316

Monyooe, L. (2015). 'Paperless classrooms': What are the Issues? *Unpublished*. https://doi.org/https://www.researchgate.net/publication/271647477_%27Paperless_classrooms%27_What_are_the_Issues

Mormina, M. (2019). Science, technology and innovation as social goods for development: rethinking research capacity building from sen's capabilities approach. *Science and Engineering Ethics, 25*(3), 671-692. https://doi.org/10.1007/s11948-018-0037-1

Motshekga, A. (2019). *Speech by the Minister of Basic Education, Mrs Angie Motshekga, MP, delivered at the 9th SADTU National Congress*. https://www.sadtu.org.za/content/speech-minister-basic-education-mrs-angie-motshekga-mp-delivered-9th-sadtu-national-0

Msiza, G. M., Malatji, K. S., & Mphahlele, L. K. (2020). Implementation of an e-Learning Project in Tshwane South District: Towards a Paperless Classroom in South African Secondary Schools. *Electronic Journal of E-learning, 18*(4), 299-309. https://doi.org/10.34190/EJEL.20.18.4.003

Mwapwele, S. D., Marais, M., Dlamini, S., & Van Biljon, J. (2019). Teachers' ICT Adoption in South African Rural Schools: A Study of Technology Readiness and Implications for the South Africa Connect Broadband Policy. *The African Journal of Information and Communication, 24*, 1-21. http://dx.doi.org/10.23962/10539/28658

Nchunge, D. M., Sakwa, M., & Mwangi, W. (2012). User's perception on ICT adoption for education support in schools: a survey of secondary school teacher's in Thika district Kenya. *International Journal of Humanities and Social Science, 2*(10), 17-29. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1060.1929&rep=rep1&type=pdf

Ngeze, L. V. (2017). ICT integration in teaching and learning in secondary schools in Tanzania: Readiness and Way Forward. *International Journal of Information and Education Technology*, *7*(6). http://hdl.handle.net/20.500.12661/2365

Nikolopoulou, K. (2020). Secondary education teachers' perceptions of mobile phone and tablet use in classrooms: benefits, constraints and concerns. *Journal of Computers in Education, 7*(2), 257-275. https://doi.org/10.1007/s40692-020-00156-7

Noesgaard, S. S., & Ørngreen, R. (2015). The Effectiveness of E-Learning: An Explorative and Integrative Review of the Definitions, Methodologies and Factors that Promote e-Learning Effectiveness. *Electronic Journal of E-learning, 13*(4), 278-290. https://core.ac.uk/download/pdf/60617756.pdf

Nurdyansyah, N., Mandarani, V., & Rais, P. (2020). How to Make Use of Animation to Improve Primary School Students' English Achievement? *JEES (Journal of English Educators Society), 5*(1), 53-59. https://doi.org/10.21070/jees.v5i1.365

Obaydullah, A., & Rahim, M. A. (2019). Use of ICT for Primary science Teaching and Learning at the Primary Schools in Bangladesh. *International Journal of Advance Research and Innovative Ideas In Education, 5*(1), 642-651. https://www.researchgate.net/publication/331210394_Use_of_ICT_for_Primary_science_Teaching_and_Learning_at_the_Primary_Schools_in_Bangladesh

Osborne, J., & Hennessy, S. (2003). *Literature review in science education and the role of ICT: Promise, problems and future directions* (Vol. 6). London, United Kingdom: Futurela. https://www.nfer.ac.uk/publications/futl74/futl74.pdf

Otrel-Cass, K., Khoo, E., & Cowie, B. (2012). Scaffolding with and through videos: An example of ICT-TPACK. *Contemporary Issues in Technology and Teacher Education, 12*(4), 369-390. https://www.learntechlib.org/p/40416/

Oye, N., Iahad, N., & Rabin, Z. A. (2011). A model of ICT acceptance and use for teachers in higher education institutions. *International Journal of Computer Science & Communication Networks, 1*(1), 22-40. https://core.ac.uk/download/pdf/20081946.pdf

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal, 29*(2), 36-65. https://hdl.handle.net/10520/EJC-c5c2b5952

Pedrelli, M. (2001). Developing countries and the ICT revolution: Final study. *European Parliament, 296.* https://www.europarl.europa.eu/RegData/etudes/etudes/join/2001/296692/DG-4-JOIN_ET(2001)296692_EN.pdf

Peeraer, J., & Van Petegem, P. (2011). ICT in teacher education in an emerging developing country: Vietnam's baseline situation at the start of 'The Year of ICT'. *Computers & Education, 56*(4), 974-982. https://doi.org/10.1016/j.compedu.2010.11.015

Perienen, A. (2020). Frameworks for ICT Integration in Mathematics Education-A Teacher's Perspective. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(6), 1845. https://doi.org/10.29333/ejmste/7803

Portz, J. D., Bayliss, E. A., Bull, S., Boxer, R. S., Bekelman, D. B., Gleason, K., & Czaja, S. (2019). Using the technology acceptance model to explore user experience, intent to use, and use behavior of a patient portal among older adults with multiple chronic conditions: descriptive qualitative study. *Journal of Medical Internet Research, 21*(4), e11604. https://www.jmir.org/2019/4/e11604

Rahman, A. t. S. A., & Harun, R. N. S. R. (2018). Tesl Pre-Service Teachers' Tpack: A Review. *International Journal of Academic Research in Business and Social Sciences, 8*(2), 795-804. https://doi.org/10.6007/IJARBSS/v8-i2/3986

Ramnarain, U., & Moosa, S. (2017). The use of simulations in correcting electricity misconceptions of grade 10 south African physical sciences learners. *International Journal of Innovation in Science and Mathematics Education, 25*(5). https://openjournals.library.sydney.edu.au/index.php/CAL/article/view/11580/11436

Richtberg, S., & Girwidz, R. (2019). (2019, August). Learning physics with interactive videos–possibilities, perception, and challenges. In *Journal of Physics: Conference Series 1287*(1),012057, IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1287/1/012057/meta

Salehi, H., & Salehi, Z. (2012). Challenges for using ICT in education: teachers' insights. *International Journal of e-Education, e-Business, e-Management and e-Learning, 2*(1), 40. http://www.ijeeee.org/Papers/078-Z00061F10037.pdf

Sangrà, A., Vlachopoulos, D., & Cabrera, N. (2012). Building an inclusive definition of e-learning: An approach to the conceptual framework. *International Review of Research in Open and Distributed Learning, 13*(2), 145-159. https://doi.org/10.19173/irrodl.v13i2.1161

Santos, I., Escudeiro, P., & de Carvalho, C. V. (2014, June). ICT in science classrooms[Paper Presentation]. *2014 9th Iberian Conference on Information Systems and Technologies (CISTI)*. Barcelona, Spain. https://doi.org/10.19173/irrodl.v13i2.1161

Savec, V. F. (2017). The opportunities and challenges for ICT in science education. *LUMAT, 5*(1), 12-22. https://repozitorij.uni-lj.si/IzpisGradiva.php?id=94477&lang=eng

Schmidt, M. J. (2017). The perils of outcomes-based education in fostering South African educational transformation. *Open Journal of Political Science, 7*(03), 368-379. https://doi.org/10.4236/ojps.2017.73030

Serdyukov, P. (2017). Innovation in education: what works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning. 10*(1), 4-33. https://www.emerald.com/insight/content/doi/10.1108/JRIT-10-2016-0007/full/html

Shu, X., & Radio, Z. (2016). An action research on TPACK's influence on teachers of National Open University: Exemplified with an English teacher of Zhejiang Radio and TV University. *Open Access Library Journal, 3*(01), 1. http://dx.doi.org/10.4236/oalib.1102336

Smetana, L. K., & Bell, R. L. (2012). Computer simulations to support science instruction and learning: A critical review of the literature. *International Journal of Science Education, 34*(9), 1337-1370. https://doi.org/10.1080/09500693.2011.605182

Staker, H., & Horn, M. B. (2012). Classifying K-12 blended learning. *Innosight Institute*. http://192.248.16.117:8080/research/handle/70130/5105

Tebabal, A., & Kahssay, G. (2011). The effects of student-centered approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion. *Latin-American Journal of Physics Education, 5*(2), 9. https://dialnet.unirioja.es/servlet/articulo?codigo=3696010

Tezci, E. (2010). Attitudes and knowledge level of teachers in ICT use: The case of Turkish teachers. *Journal of human sciences, 7*(2), 19-44. https://www.j-humansciences.com/ojs/index.php/ijhs/article/view/797

The Clayton Christensen Institute. (2016). *The Clayton Christensen Institute: Learning, Blended*. https://www.christenseninstitute.org/blended-learning/

Tondeur, J., Forkosh-Baruch, A., Prestridge, S., Albion, P., & Edirisinghe, S. (2016). Responding to challenges in teacher professional development for ICT integration in education. *Educational Technology and Society, 19*(3), 110-120. https://www.jstor.org/stable/jeductechsoci.19.3.110

Tsai, S., & Machado, P. (2002). E-learning, online learning, web-based learning, or distance learning: Unveiling the ambiguity in current terminology. *E-learn Magazine*. 3. https://doi.org/10.1145/566778.568597

Van Teijlingen, E., & Hundley, V. (2002). The Importance of Pilot Studies. *Nursing standard (Royal College of Nursing), 16*, 33-36. https://doi.org/10.7748/ns2002.06.16.40.33.c3214

Waddell, G. (2018, December 29). Lecture 3 for the course PH203 critical thinking: *What is Action Research.* https://www.youtube.com/watch?v=Ta21Oat1bro

Appendix   1:
Gatekeeper's Permission from Department of Education

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma	Tel: 033 392 1063	Ref.:2/4/8/4136

Mr NV Zungu
PO Box 3091
SUNDUMBILI
4491

Dear Mr Zungu

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"UNDERSTANDING TEACHERS' INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN NATURAL SCIENCES IN GRADE 7"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 15 June 2020 to 01 July 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

ILEMBE DISTRICT

Dr. EV Nzama
Head of Department: Education
Date: 15 June 2020

...Leading Social Compact and Economic Emancipation
Through a Revolutionary Education for All...

KWAZULU-NATAL DEPARTMENT OF EDUCATION
Postal Address: Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
Physical Address: 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201
Tel.: +27 33 392 1063 • Fax: +27 033 392 1203• Email: Phindile.Duma@kzndoe.gov.za •Web: www.kzneducation.gov.za
Facebook: KZNDOE....Twitter: @DBE_KZN....Instagram: kzn_education....Youtube: kzndoe

Appendix   2:
Ethical Clearance Certificate

UNIVERSITY OF
KWAZULU-NATAL ™

INYUVESI
YAKWAZULU-NATALI

09 September 2020

Mr Nkosinathi Victor Zungu (220108390)
School of Education
Edgewood Campus

Dear Mr Zungu,

Protocol reference number: HSSREC/00001513/2020
Project title: Understanding Teachers integration of Information and Communication Technology in Natural Sciences in Grade 7
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 11 June 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 08 September 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

Professor Dipane Hlalele (Chair)

/ms

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: http://research.ukzn.ac.za/Research-Ethics/

Founding Campuses: ■ Edgewood   ■ Howard College   ■ Medical School   ■ Pietermaritzburg   ■ Westville

INSPIRING GREATNESS

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7

Project Information Statement/Letter of Invitation to School Principals

My name is Nkosinathi Zungu, and I am a Masters student at the University of KwaZulu-Natal (UKZN). I am conducting research on integrating Information and communication technology in teaching Natural Sciences in Grade 7 under the supervision of Prof. Nadaraj Govender and Mrs Mary-Anne Good. The Provincial Department of Education has been approached for approval of my research. I invite you to consider allowing me to conduct this research in your school. This study will meet the requirements of the Research Ethics Committee of UKZN.

Aims of the Research

The research aims to:

- To determine teachers' understanding of ICT integration.
- To investigate how teachers can be supported to integrate ICT in teaching Grade 7 Natural Sciences.
- To determine teachers' experience of using ICT after support in an action research process.
- To determine how teachers develop TPACK as a result of being supported.

Benefits of the Research to Schools

- The world is being transformed by digital technologies at an expeditious rate therefore the role of technology in learning and teaching is greatly significant today. Keeping this in mind it is important to question how these changes have influenced Science teachers in the classroom.
- The White Paper on E-Education (2004) stresses the importance of ICT integration in teaching and learning. The role of education is no longer just about imparting content, but to develop critical thinking individuals who are ready for a life outside of school.
- Teachers who will participate will get development on how they integrate ICT in Grade 7 Natural Sciences as this study will focus on finding solutions to their practical problems.

Research Plan and Method

The four types of data generation that will be used are; semi-structured interviews, questionnaire, lesson observations and document analysis. Permission will be sought from teachers prior to their participation in the research. Only those who consent will participate. Two lessons per teacher will be observed and lesson plans and work schedules will be analysed. The interview will last 30 minutes. All information collected will be treated in strictest confidence and neither the school nor individual teachers will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty. The role of the school is voluntary and the School Principal may decide to withdraw the school's participation at any time without penalty.

School Involvement

Once I have received your consent to approach teachers to participate in the study, I will

- arrange for informed consent to be obtained from participants
- arrange a time with your school and the participants for data collection to take place

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number HSSREC/00001513/2020).

You may also contact the Humanities and Social Sciences Research Ethics Committee whose contact details are as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Further information

Attached for your information is a copy of the participant's Informed Consent Form.

It will be appreciated if you would please complete and return the attached form should you consent to your school's participation in this research.

Thank you for taking the time to read this information. Your co-operation will be appreciated. Best regard
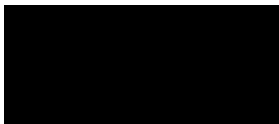
Nkosinathi Zungu   Mrs Mary-Anne Good   Prof Nadaraj Govender
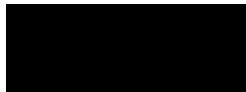
Researcher   Co-supervisor   Supervisor

UKZN   UKZN   UKZN
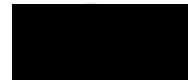
Appendix 4:
Gatekeeper Letter for School Principals

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7

School Principal Consent Form

I give consent for you to approach Grade 7 Natural Science teachers to participate in the above research.

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- I may decide to withdraw the school's participation at any time without penalty
- Grade 7 Natural Science teachers will be invited to participate and permission will be sought from them
- Only teachers who consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The teachers' names will not be used and individual teachers will not be identifiable in any written reports about the study.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the school.
- Further information on the project may be sought from Nkosinathi Zungu on 083 5454 968.

_____ _____

Principal Signature

_____

Date

Appendix   5:
Invitation Letter for Teachers

Informed Consent Document

Dear Sir / Madam

My name is Nkosinathi Zungu. I am a Masters student studying at the University of KwaZulu-Natal, Edgewood Campus.

The title of my research is: Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7.

The aim of the study is to understand how Grade 7 Natural sciences teachers integrate ICT in their teaching and how they develop their TPACK while teaching Grade 7 Natural Sciences. I am interested in interviewing you and observing a lesson so as to share your experiences and observations on the subject matter.

Please note that:

- The information that you provide will be used for scholarly research only.

- Your participation is entirely voluntary. You have a choice to participate, not to participate or stop participating in the research. You will not be penalized for taking such an action.

- Your views in this interview will be presented anonymously. Neither your name nor identity will be disclosed in any form in the study.

- The interview will take about 30 minutes.

- The record as well as other items associated with the interview will be held in   a password-protected file accessible only to me and my supervisor. After a period of 5 years, in line with the rules of the university, it will be disposed by shredding and burning.

- If you agree to participate please sign the declaration attached to this statement (a separate sheet will be provided for signatures)

I can be contacted at: University of KwaZulu-Natal, Edgewood Campus, Pinetown

Email: nat.zungu@gmail.com

Cell: 083 5454 968

My supervisors are Prof. Nadaraj Govender and Mrs Mary-Anne Good who are located at the Edgewood College Campus of the University of KwaZulu-Natal.

Professor's Contact details:

Email govendern37@ukzn.ac.za

Phone number: 031 260 3469

Mrs Good contact details:

Email Goodm@ukzn.ac.za

Phone number: 0312603427

The Humanities and Social Sciences Research Ethics Committee contact details are as follows:

Ms Phumelele Ximba, University of KwaZulu-Natal, Research Office,

Email: ximbap@ukzn.ac.za,

Phone number +27312603587.

Thank you for your contribution to this research.

Yours sincerely,

███████████

_____   _____

Mr Nkosinathi Zungu   Date

Appendix   6:
Letter of Informed Consent for Teachers

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

DECLARATION

I…………………………………………………………………………………… *(full names of participant)* hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire. I understand the intention of the research. I hereby agree to participate.

I consent / do not consent to have this interview recorded (if applicable)

SIGNATURE OF PARTICIPANT   DATE

_____   _____

Appendix   7:
Questionnaire for Grade 7 Natural Sciences Teachers

Project Title

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7.

This questionnaire is trying to answer the following research questions.

- **What ICT tools do teachers' use in Grade 7 Natural Sciences teaching?**

Please read and answer each question carefully and seek help if you do not understand or seek clarity. Answering this questionnaire requires about 20 minutes. All responses will remain confidential.

Your input is really important for this study.

BIOLOGICAL INFORMATION

Please tick the appropriate box

1. Age (years)
   ☐ Under 30   ☐ From 30 to 39   ☐ From 40 to 49   ☐ Over 50

2. Gender

   ☐ Female   ☐ Male

3. Number of years teaching, including this year.

   ☐ Less than 1 year
   ☐ 1-5 years
   ☐ 6-10 years
   ☐ 11-20 years
   ☐ 20+ years

   For how many years have you been teaching Natural Science in Grade 7?
   ☐ Less than 1 year
   ☐ 1-5 years
   ☐ 6-10 years
   ☐ 11-20 years
   ☐ 20+ years

EXPERIENCE WITH THE USE OF ICT FOR TEACHING.

4. How long have you been using ICT for teaching?

☐ Less than 1 year

☐ 1-3 years

☐ 4-6 years

☐ More than 6 years

5. Have you attended any staff development in the use of ICT?

☐ YES   ☐ NO

6. How often do you use ICT and/or the internet in your classes?

Never	
Rarely – Once in 5 lessons	
Sometimes – Twice in 5 lessons	
Often – Four in 5 lessons	
All the time	

7. How frequently do you use each of the following ICT resources?

ICT resource	Never	Once or twice	A few times	often	always
YouTube videos					
Educational TV programs					
Computer software					
Computer simulations					
Internet websites					

8. (a) Do you have any specific computer programmes/software that you use in teaching Natural Sciences?

☐ YES   ☐ NO

(b) IF the answer to question 8(a) was yes, please list them below

Name of Software/ program

9. How often do you do the following activities?

	Never	Rarely	few times	Often	Always
Browse/search the internet to collect information to prepare lessons					
Communicate online with learners					
Download/browse material from a learning platform					
Look for online professional development Opportunities					

10. To what extent are you confident in the following?

	None	A little	Somewhat	A lot
Use a spreadsheet (e.g., Excel)				
Create a presentation with simple animation functions				
Create a presentation with video or audio clips				
Download and install a software programme in a computer				
Assist someone in the use of ICT				

11. Please tick the most relevant to you answer.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am comfortable using ICT in teaching Grade 7 Natural Sciences.					
I think ICT integration improves my teaching.					
I think getting information on internet can improve my content knowledge of Natural Sciences.					
I believe the use of ICT allows me to take great control of my science teaching.					
I would like to use ICT more in my teaching of Grade 7 Natural Sciences.					
It is important to find different ways to integrate ICT in teaching of Natural Sciences in Grade 7					
Learning how to integrate ICT is a teacher's professional goal to accomplish.					

RESOURCES

12. Are the learners allowed to use the personally owned devices listed below at school for learning?

	YES	NO
Laptop, tablet, netbook, notebook		
Mobile or Smartphone		

13. Do you have Internet access in your school?

Yes☐   No☐

14. Which of the following ICT tools do you use for teaching Grade 7 Natural Sciences?

	Never	Rarely	Often	Always
Digital Projector				
LCD screen/ Television				
Tablet/ Smartphone				
Radio/Audio devices				
Laptops/ computers				
Smartboard				

15. Which of the following programme/Software/websites are you familiar with?

Programme/Software/webpages	Known about it		Don't know it
	Have used	Never used	
PhET simulator			
Vodacom e-School			
YouTube			
Nect.org.za			
Mind-set E-Learning			
Coursera			
Other……			

Appendix   **8:**
Lesson Observation Schedule

Project Title

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7

The focus of the lesson observation will be to observe how teachers use the knowledge gained from the support in their teaching of Grade 7 Natural Sciences. The purpose is to understand how teachers will be using ICT to support content and pedagogy in teaching Grade 7 Natural Sciences. This is the observation tool that will be used to assess how teachers apply Technology, Pedagogy and Content Knowledge (TPACK) in the classroom practice.

1. **General Information**

Name of the school		Date of Observation	
Teacher's name		No of Learners	
Topic			

2. **Technology Knowledge (TK)**

	Poor	Fair	Good	Excellent
The teacher has essential technology tools for the lesson				
Technology is used to support teaching strategy				
Teacher uses technology without any problems				
Are ICT activities stimulating and motivating in order to engage pupils' interest?				
Comments (If any):				

3. Technology Content Knowledge (TCK)

	Poor	Fair	Good	Excellent
Technology used to explain complex content of science				
Technology used to allow learners to observe things that would otherwise be difficult to observe.				
Teaching aids include digital graphics that are attractive and support the content of the lesson.				
Comments (If any):				

4. Technological Pedagogical Knowledge (TPK)

	Poor	Fair	Good	Excellent
The lesson combined appropriate technology, subject content and teaching method.				
Lesson well prepared with lesson plan and able to manipulate technology to present relevant subject content.				
Teacher showed confidence in using Technology to deliver content in the classroom.				
Comments (If any):				

5. Teacher pedagogical approaches that were used in the delivery of the lesson

Pedagogical Approach	
Leading (includes lecturing, directing class activities)	
Facilitating	
Other approaches (Specify)	

Appendix   **9:**
Document Analysis Tool

Project Title

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7.

1. General Information

Name of the school		Date	
Teacher's name			

2. Lesson Plan analysis

QUESTIONS	YES	NO	COMMENTS
DOES THE LESSON PLAN HAVE THE FOLLOWING?			
Date			
Grade and Subject			
Are the list of ICT tools to be used indicated?			
Is the topic relevant in line with the prescribed content?			
Are learner activities indicated?			
Do learner activities includes the use of ICT for the learners?			

3. Teacher's Learning Portfolio

	YES	NO	COMMENTS
Does the teacher participate in activities which foster professional growth?			
Does the teacher have a projected Personal Growth Plan?			
Does the PGP include the growth on teaching using ICT?			
Does it mention what a teacher has already achieved on the use of ICT in teaching Natural Sciences?			
Does a teacher have a Development Support Group?			
Do they discuss the development of the teacher in the use of ICT?			

Appendix 10:
Semi-structured Interview Schedule

Project Title

Understanding Teachers' integration of Information and Communication Technology (ICT) in Natural Sciences in Grade 7.

1. **RESEARCH QUESTION 3: WHAT ARE TEACHERS' EXPERIENCES OF ICT INTEGRATION IN TEACHING GRADE 7 NATURAL SCIENCES IN THE ACTION-RESEARCH PROCESS?**

   I. Can technology be used to enhance the teaching and learning of Natural Sciences? Please explain your answer.
   II. What role does technology play in the teaching of Natural Sciences in terms of the following:
   Content delivery?
   Pedagogy?

   How was your experience of Implementing ICT learning in your classroom after the support?

   III. Do you think the Professional development has enhanced your use of ICT in classroom teaching?
   IV. In your own experience, do you believe the use of ICTs proves to be a better method of teaching as compared to the traditional methods of teaching? Why?
   V. Suggestion: Do you believe that the use of ICTs in teaching has improved your teaching when compared to previous approaches used?

2. **RESEARCH QUESTION 4: HOW DO TEACHERS DEVELOP TPACK AFTER THEY HAVE BEEN SUPPORTED?**

3. **Suggestion: Why did you choose the ICTs used in the lesson?**

4. **Do you believe it was suitable for the content covered?**

   I. How and why do the technologies used in this lesson were most suitable for the content objectives?
   II. Did the ICTs used, improve the teaching strategy employed?
   Please explain. How does the ICT used improve the teaching strategy?)
   III. Can you briefly explain how do teaching method, ICT and learning objectives fit in this lesson? (Suggestion: Can you explain how you integrated ICTs with your teaching methods and learning objectives?)
   IV. How has ICT changed your perspective on teaching and learning?

5. RESEARCH QUESTION 5: WHY DO NATURAL SCIENCE TEACHERS IN GRADE 7 DEVELOP TPACK THE WAY THEY DO?

I. Why did you decide to use ICT in your teaching?
II. How has ICT changed your perspective on teaching and learning?
III. Can you reflect on your initial experience in the use of ICT and how it has affected the way you use ICT in the followed lessons?
IV. What do you think of the way you initially used ICTs in your classroom? Has it affected the way you use ICTs in subsequent lessons? How?
V. When planning to use ICT in your teaching, what were your personal objectives?
VI. What opportunities, if any, have the use of Technology in your classroom presented to you?

Appendix 11:
Language Clearance Certificate

25 Maple Crescent
Circle Park
KLOOF
3610

Phone 031 – 7075912
0823757722
Fax 031 - 7110458
E-mail:
dr1govender@telkomsa.net
sathsgovender4@gmail.com

Dr Saths Govender

10 MARCH 2022

TO WHOM IT MAY CONCERN

LANGUAGE CLEARANCE CERTIFICATE

This serves to inform that I have read the final version of the dissertation titled:

Understanding Teachers' Integration of Information and Communication Technology (ICT) in Teaching Grade 7 Natural Sciences by Nkosinathi Zungu, student number: 220108390.

To the best of my knowledge, all the proposed amendments have been effected and the work is free of spelling and grammatical errors. I am of the view that the quality of language used meets generally accepted academic standards.

Yours faithfully
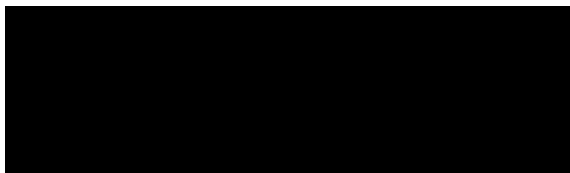
DR S. GOVENDER
B Paed. (Arts), B.A. (Hons), B Ed.
Cambridge Certificate for English Medium Teachers
MPA, D. Admin.

Semi- structured Interview Transcripts

Miss Mbambo's transcript.

Interviewer: " Morning Miss, thank you for allowing this time for this interview. I know how busy you are.

Miss Mbambo: Morning Sir, it's okay. I thought we should get it over and done with (Laughs).

Interviewer: "Okay, thanks again, I think we should get started so I don't take too much of your time. Tell me, what made you decide to start using ICT in your teaching?"

Miss Mbambo:"Information Communication Technology helps me not to spend more time writing on the chalkboard" "I started to use digital projector because it made my work easier. I have too much work load and using digital projector during my teaching relieves pressure and at the same time my learners' focus is drawn towards a lesson

Interviewer: In your opinion, do you believe ICT can be used to enhance the teaching and learning of Natural Sciences?

Miss Mbambo: ICT enhance learning as well as teaching because learners get to excess more information via technology even if they didn't understand me as a teacher in class, by watching video clips which draws their attention and focus. Another advantage is that learners can have excess to these videos and watch them over and over at their time. That means learning has continued even outside the classroom setting. ICT can change the way of thinking as we know they get different version of information explained to them by different people which will instil understanding of a particular topic.

Interviewer: What role does technology play in the teaching of Natural Sciences in terms of Content delivery?

Miss Mbambo: "Technology simplifies topics to learners with less time. For example, if I were to explain about earth revolution around the sun, when learners see a video or animated pictures showing the movement of the earth, that will help learners not to forget the information. I also believe ICT can help especially in the topics that have many misconception or topics that abstract information like term 1 work on fertilisation and pollination "

Interviewer: How was your experience of Implementing ICT learning in your classroom after the support?

Miss *Mbambo:"Wow you know to tell you the truth, I was a bit skeptical about participating in your study. The session was very helpful to me and thank you for that. Right now I am able to use different strategies for teaching and be able to introduce or teach topics in different ways. My notes are more detailed and straight to the point. The most interesting part that always frustrated me was to format a picture after pasting on MS Word. I look forward to setting my*

assessment. Oh! Another thing, downloading videos on YouTube, now I will teach my learners easy with these videos. Remind me again, what is that program you told me about? The one that made things to move (Pause for me to answer) Yes! PHET Simulator. I know how to use it as well. Very happy about that.

Interviewer: In your own experience, do you believe the use of ICTs prove to be a better method of teaching as compared to the traditional methods of teaching? Why?

Miss Mbambo: "From my observation and experience, technology enhanced learning is much better because I have seen learners who are not that bright in the classroom catch up more when they see pictures and video clips." I have noticed that attention or focus on the learners is drawn and they get eager for more information when learning with technology as compared to traditional method where there is lot of theory"

"In traditional method learners are less focus as more time is spend on writing on the board than explaining important information. This means traditional method is more time consuming and less fun for the learners. Learners real enjoy watching colorful animated images and videos; it makes them look forward to learning and makes them not to forget information. You know technology helps learners to learn by seeing objects' move while it is being explained by teacher. This will help to retain the knowledge gain on the lesson. Even learners that are struggling in the classroom are able to catch information easily as compared to be taught in a traditional method."

1. **RESEARCH QUESTION 4: HOW DO TEACHERS DEVELOP TPACK AFTER THEY HAVE BEEN SUPPORTED?**

Interviewer: You used projector in most of your lessons, is there any other technology you have used before? If there are any, which one do you thing is more suitable?

Miss Mbambo: I have never used any other technology tool in my lesson before.

Interviwer: You mean you have never even used a cellphone to show learners something educational?

Miss Mbambo: Oooh! I have done that. Compared to using a projector, projector is way better as it helps to explain concepts better. In the Presentation I can include notes for everyone to see. When you many classes like I do, it reduce the workload of keep rewriting the same thing in every class I will teach. And for the fact that once I prepare these presentation, I will have them for a very long time makes this the best resource to use. Now armed with the new

knowledge gained in the session we had. My slides will be more interesting and support all learners level of understanding as they will have animated pictures and simulations.

Interviewer: How does the ICT used improve the teaching strategy?

Miss Mbambo: Teaching using digital projector makes my teaching easy and enjoyable for me and my learners. My teaching has improve in a way that because Technology reduces time to explain complex topics, even during these times of COVID-19 with less contact times I manage to finish my curriculum. Even if I don't finish, but I can rest easy knowing what my learners have learnt will be retained in their minds. Results have also improved as that is an indication of improved teaching strategy. Learners' participation has increase a lot as learners are more engaged therefore they have a better understanding and participate better.

Interviewer: Can you briefly explain how do teaching method, ICT and learning objectives fit in this lesson?

Miss Mbambo: "Lesson planning is one of the critical part of the teaching and learning. So to fit all these together need proper planning. Example. If I will be teaching phases of the moon, the objective in this lesson will be to ensure they can name all phases and understand their shapes. Obviously I will need spherical shapes as resources and appropriate video showing how they change. That means now the teaching approach will be a leading method but if I will be teaching electrical conductivity, I will use simulators you showed me and my teaching method will be demonstration method. So it depends on the topic you see.

2. **RESEARCH QUESTION 5: WHY DO NATURAL SCIENCE TEACHERS IN GRADE 7 DEVELOP TPACK THE WAY THEY DO?**

Interviewer: How has ICT changed your perspective on teaching and learning?

Miss Mbambo: "Technology has relieved stress level of running short of methods of example to include in my lesson. Technology is full of fun, more educational and informative. Going to class was very stressful at times, now I look forward to it. I really enjoy my teaching of Grade 7 Natural Sciences."

Interviewer: Can you reflect on your initial experience in the use of ICT and how it has affected the way you use ICT in the followed lessons?

Miss Mbambo:" When I started using digital projector in my teaching, I was very nervous in my first lessons. I was thinking what if things go as I planned in front of the learners. I got used

to it but after the session we had, I am full of confident, I look forward to going to class. I can tell that my learners are really enjoy my latest lessons now.

Interviewer: When planning to use ICT in your teaching, what were your personal objectives?

Miss Mbambo:"At first I wanted to use projector to write corrections for my IsiZulu subject. I used to write lots of corrections on the board, then go to another class and write the same thing. It was time consuming and exhausting for me. Then I started to write these corrections on my laptop to project to my learners. When I saw how much time I had saved up, that is when I thought I should do the same with my Natural Science lessons. So I can say I wanted to minimize the time used to write on the chalk board. After successful using it in the classroom my objectives now is ensure I give my learners an equal chance to learn Natural Sciences using little time.

Interviewer: What opportunities has the use of Technology in your classroom presented to you?

Miss Mbambo: "Oh Yes! I am now able to use computer to type my assessment. I can include pictures on my assessments. I used my computer to punch marks on SASAMS and do print out analysis of my subjects. Ey! There a lot I can think of. My class administration work like class list and typing class timetable. More importantly, I get to store my work on the computer. Technology has presented many opportunities for me.

Interviewer: Thank you very much for your time Miss.

Miss Mbambo: You are welcome and hope we are now done right.

Interviewer: Yes we are done for now. Thank you again and have a good day.

Interviewer: Hi Mem, Hope I didn't call at the bad time.

Miss Shandu: Hi Sir, no it's fine. Let me get to the quiet area.

Interviewer: Okay. I will hold.

Miss Shandu: "Okay we can start now. Is it okay if I refer to my notes I made here?

Interviewer: Yes it's fine.

Miss Shandu: Okay lets start.

Interviewer: I understand you have using ICT to teach for quiet sometimes now, what made you decide to start using ICT in your teaching?

Miss Shandu: "ICT is a good platform of replacing chalkboard with good gadget that will make learners more enhanced and eager to learn. It also makes it easy to use classroom time more efficient and more interactive exercises during teaching and learning. The use of ICT in teaching Grade 7 Natural Sciences saves a lot of time as compared with using normal chalkboard for teaching and learning and instead of using textbook use a computer".

Interviewer: Do you believe ICT can be used to enhance the teaching and learning of Natural Sciences?

Miss Shandu: "Yes! Technology can be used to enhance teaching and learning as it provides different opportunities to make learning more fun and enjoyable using pictures and audio, teaching same thing in a new way. Using Technology can make a student least favourite subject become more interesting to them by using virtual lesson videos to capture students' attention. For example, explaining photosynthesis using virtual pictures is simple for learners to understand"

Interviewer: What role does technology play in the teaching of Natural Sciences in terms of Content delivery?

Miss Shandu: "I believe that ICT plays a vital role in terms of content delivery. Delivering information using technology makes it easy for teachers to deliver content as compared to using textbook. It also makes a lesson to be more democratic than teacher-centred. Both teachers and learners are engaged more in the lesson. Therefore, teaching and learning will be more fun and enjoyable for both parties thus making learners more active in the lesson"

Interviewer: How was your experience of Implementing ICT learning in your classroom after the support?

Miss Shandu: ""The implementation of ICT learning after the support has been of great success. I gave me a platform to learn and to be more confident in terms of content delivery and also in teaching as a whole. I'm confident in my teaching using digital projector. My learners are also learning more and participate eagerly and more actively."

Interviewer: In your own experience, do you believe the use of ICTs prove to be a better method of teaching as compared to the traditional methods of teaching? Why?

Miss Shandu: "Technology enhanced lesson is better that traditional method. Technology provides more platforms for learners to observe and learn about things they see using virtual images. It also gives a platform to explain content using virtual images rather than using a textbook. When using a textbook, it is more theoretical than technology that makes it more virtual and easy for learners to understand concepts."

1. **RESEARCH QUESTION 4: HOW DO TEACHERS DEVELOP TPACK AFTER THEY HAVE BEEN SUPPORTED?**

Interviewer: You used projector in most of your lessons, is there any other technology you have used before? If there are any, which one do you thing is more suitable?

Miss Shandu: "I have used a tablet, smartphone and laptop only. Digital projector is more suitable. It draws learners' attention and makes them eager to learn and they can all see at the same time and pictures are big enough to make them understand easily."

Interviewer: How does the ICT used improve the teaching strategy?

Miss Shandu: "Using digital projector has improved my teaching. It is now easier for the learners to understand content and it is also easier for me to explain complex topics. It saves teaching time by summarizing and explaining using slides and with the help of virtual images."

Interviewer: Can you briefly explain how do teaching method, ICT and learning objectives fit in this lesson?

Miss Shandu: "When planning my lessons; my goal is for my learners to have a better understanding of each and every concept, to be able to grasp faster than learning using a textbook. My objectives of the lesson are what guide me on the ICT resource to use. If it is a topic that will need a video, I will go online to look for the suitable video to use. When I use a video, my teaching method will be that of facilitating instead of lecture method."

2. **RESEARCH QUESTION 5: WHY DO NATURAL SCIENCE TEACHERS IN GRADE 7 DEVELOP TPACK THE WAY THEY DO?**

Interviewer: How has ICT changed your perspective on teaching and learning?

Miss Shandu: "It has changed my perspective a lot. I used to see teaching as stressful sometimes, now it is more fun and enjoyable. It is now easier for both parties in teaching and learning."

Interviewer: Can you reflect on your initial experience in the use of ICT and how it has affected the way you use ICT in the followed lessons?

Miss Shandu: "Before I did not get enough information on how to use technology to make my teaching more efficient and more understandable to learners. Right now I can be able to develop my own slides. Now I can be able to add pictures, virtual images and notes to each and every lesson.

Interviewer: When planning to use ICT in your teaching, what were your personal objectives?

Miss Shandu: "My objective in using ICT was to improve Grade 7 Natural Sciences results. I have an understanding that not all learners learn the same. Others learn through observation while others learn through listening. With the use of digital projector, I was hoping to reach out to all the learners in my classroom. I also wanted to grab learners' attention through the use of videos and these moving pictures."

Interviewer: What opportunities has the use of Technology in your classroom presented to you?

Miss Shandu: "The use of ICT has minimized the use of paperwork at school. The information is now stored safely in the system. I can type my assessments and they are more presentable.

Miss Khumalo's Semi-structured interview transcript

Interviewer: Hi Mem.

Miss Khumalo: Hi Sir

Interviewer: Can we do our interview now if you are not busy?

Miss Khumalo: "Okay. It's fine, I just finished what I was doing.

Interviewer: Okay. Let's start.

Miss Khumalo: Shoot!.

Interviewer: I understand you have using ICT to teach for quiet sometimes now, what made you decide to start using ICT in your teaching?

Miss Khumalo: "Technology has made it easy for me to work at home, I would download some software to use at home. It has also help make my teaching easy as I don't have to repeat things over and over to my kids"

Interviewer: Do you believe ICT can be used to enhance the teaching and learning of Natural Sciences?

Miss Khumalo: "Yes indeed' ICT has helped promote better understanding for me and my kids. As a teacher, internet has also help me to find more information that will help me with the content I did not understand myself. This will make it easy to explain it to my kids if I understand it better. I have downloaded some visual images and used them in my classroom and it has helped to explain content better"

Interviewer: What role does technology play in the teaching of Natural Sciences in terms of Content delivery?

Miss Khumalo: "I can explain content easily and better using visual components I find on the internet"

Interviewer: How was your experience of Implementing ICT learning in your classroom after the support?

Miss Khumalo: "The support session we had did help me learn how to transfer videos and photos from my cell phone and the internet to my laptop. This newly found knowledge has made it easy to download videos and images from the internet and then transfer them to my laptop to use in the lesson. This has helped to improve how I teach my learners and helped improve learner's understanding of the topic"

Interviewer: In your own experience, do you believe the use of ICTs prove to be a better method of teaching as compared to the traditional methods of teaching? Why?

Miss Khumalo: "In my personal experience, I prefer a teaching method that includes ICT. This is because technology enhances teaching by not only teaching theory, but also illustrating to learners what happens in real life. it also gives ideas to learners as to what is happening in real life. I also believe it can even take learners thinking ability to a higher level of thinking"

1. **RESEARCH QUESTION 4: HOW DO TEACHERS DEVELOP TPACK AFTER THEY HAVE BEEN SUPPORTED?**

Interviewer: You used projector in most of your lessons, is there any other technology you have used before? If there are any, which one do you thing is more suitable?

Miss Khumalo: "Yes I have used another technology before.

Interviewer: Which one did you used?

Miss Khumalo: I previously used a laptop only but I strongly believe a digital projector saves time for me. I had to also write notes on the board which consumed a lot of class time. By using a digital projector, I no longer have to write notes on the board for learners. When there is no electricity, I could teach then print notes for the learners later."

Interviewer: How does the ICT used improve the teaching strategy?

Miss Khumalo: "The use of ICT in teaching has improved my ability to capture my learners' attention. My learners are more interested and pay more attention when I'm teaching. The media used in the lesson capture their concentration. It makes them pay more attention during the lesson, thus making content delivery easier.

"When I use a digital projector, my learners are intrigued and they pay more attention than by simply listening"

Interviewer: Can you briefly explain how do teaching method, ICT and learning objectives fit in this lesson?

Miss Khumalo: "I always check and download relevant pictures and videos and use them in my lesson"

2. **RESEARCH QUESTION 5: WHY DO NATURAL SCIENCE TEACHERS IN GRADE 7 DEVELOP TPACK THE WAY THEY DO?**

Interviewer: How has ICT changed your perspective on teaching and learning?

Miss Khumalo: "I believe using ICT has made my teaching more interesting for learners and for me as a teacher and using resources from internet has made it easier for me to explain difficult concepts."

Interviewer: Can you reflect on your initial experience in the use of ICT and how it has affected the way you use ICT in the followed lessons?

Miss Khumalo: "I can now make my teachings more interesting. That is because now I can use resources that learners can see clearly. My teaching skills have improved a lot compared to before. I feels as though I'm now the best teacher.

Interviewer: When planning to use ICT in your teaching, what were your personal objectives?

Miss Khumalo: "I wanted to get learners the best education that they can sustain for a very long time. The education that can be compared to these model c schools. I just wanted to give them that kid of experience"

Interviewer: What opportunities has the use of Technology in your classroom presented to you?

Miss Khumalo: "Ever since I started using technology, I can now type my own papers, download my own teaching videos, keep the records of assessments in my computer and lastly, it has help me with time to help my struggling learners.

Annexure A:
Teacher's lesson Plans

Miss Shandu's lesson plan

DAILY LESSON PLAN

Subject:	NATURAL SCIENCES		Teacher's Name		
Grade : Seven			**Strand : Planet Earth and Beyond**		
Date: 17/11/2020					
Duration : 1hr			**Topic: Earth's movement**		
			Sub-topic (Content): Rotation and revolution		
Specific Aim(s)(tick √)	**Process skills (from CAPS)**		*Teacher activity:* **Activities**		**Resources**
SA1	Accessing and recalling information		**Introduction**		CAPS document
SA2	√		Will discuss the earths movement		Platinum NS textbook
SA3			Will explain how seasons are formed		PowerPoint Presentation
New concepts/terminology			**Lesson development**		
lRotation, Revolutions			Will explain the keywords and their definitions.		
			Explain kinds of living things		
			Will discuss the seven processes of life.		
Inclusivity			**Learner Activity**		**Assessment**
Animated Images will be used in the lesson to explain concepts			Answer questions posed on them,		Do Activity 3 on page 83 on
			Watch the video prepared for them		Platinum NS text book
			Ask questions		
Reflection					

Miss Khumalo's lesson plan

Name: Miss K.   Grade7   2020

DR BW VILAKAZI PRIMARY SCHOOL NATURAL SCIENCES &TECHNOLOGY LESSON PLAN

TIME ALLOCATION: 3 hours   **DATE:** 14/10/2020   **TOPIC:** Relationship of the Sun and earth

KNOWLEDGE STRANDS			
NATURAL SCIENCE STRANDS		**TECHNOLOGY STRANDS**	
LIFE AND LIVING		STRUCTURES	
MATTER AND MATERIALS		PROCESSING	
ENERGY AND CHANGE		SYSTEMS AND CONTROLS	
PLANET EARTH AND BEYOND	X		

SPECIFIC AIM 1		SPECIFIC AIM 2		SPECIAL AIM 3	
Doing science & Technology		Understanding & Connecting Ideas	X	Science, Technology & Society	X

New words/Concept:
Equator, revolve, axis, orbit
Teacher Activity:
Introduction
Will review previous work on solar system.
Discuss length of the day in seasons
Lesson development
Will explain the importance of the sun to earth
Will discuss the relationship between sun and life on earth
Will discuss the food cycle
Discuss water cycle
Learner Activity
Answer questions posed on them,
Watch the video prepared for them
Ask questions
Resources needed
Chart, textbook, PowerPoint Presentation
Assessments (Formal and informal)
Classwork page 197 Activity 3,
Reflection:

HOD signature: _____   Date: ___18/10/2020___

Miss Mbambo's lesson plan

NATURAL SCIENCES: DURATION: 30 MINUTES CAPS SENIOR PHASE		GRADE 7 STRAND: EARTH & BEYOND TERM 4	
Lesson Plan 18 **TOPIC:** Relationship of the Sun to the Earth **SUB TOPIC:** Tides	**OBJECTIVES: LEARNERS MUST BE ABLE TO:** • Explain how the gravitational pull of the Moon and the Sun, along with differential gravitational forces, affect the movement of the ocean's • Describe how high tide and low tide occur		

REFERENCES			
TERMINOLOGY:	Gravitational pull, Tides, Tidal bulge, High tide, Low tide		
SPECIFIC AIMS	1. DOING SCIENCE		✓
	2. KNOWING THE SUBJECT CONTENT & MAKING CONNECTIONS		✓
	3. UNDERSTANDING THE USES OF SCIENCES & INDIGENOUS KNOWLEDGE		

SCIENCE PROCESS SKILLS					
Accessing & recalling Information	✓	Identifying problems & issues		Doing Investigations	
Observing	✓	Raising Questions		Recording Information	
Comparing		Predicting		Interpreting Information	
Measuring		Hypothesizing		Communicating	
Sorting & Classifying		Planning Investigations			

NATURAL SCIENCES: DURATION: 30 MINUTES CAPS SENIOR PHASE		GRADE 7 STRAND: EARTH & BEYOND TERM 4
CONTENT AND CONCEPTS	**ACTIVITIES**	**RESOURCES**
• tides are the predictable, repeated rise and fall of sea and ocean levels	3. Teacher projects two pictures the same beach at different times of the day on a screen 4. Ask learners to compare the two pictures, make observations and come up with an explanation about what caused the changes in the pictures. - Learners write down the differences and similarities of picture A and picture B - Learners identify the phenomena in the pictures	Sasol Inzalo Explore Text books Video clip Tennis ball and string Scientific and English Dictionaries Any other available resource

Annexure   B:
Participant Teachers' portfolios

Miss Shandu

10. PERSONAL GROWTH PLAN (PGP)

NAME OF EDUCATOR: _____ PERSAL NO. 6 5 _____ 14 _____ DATE: _____

NAME OF SCHOOL: D _____ P. School

LEARNING AREA/S & GRADES: Mathematics and Natural science grade s

01. I need to improve in the following areas: I need improvement interms of differentiated planning, diversity and discipline and also in the utilisation of resource (science kit) and to do more practicals interms of simplifying concepts.

DEVELOPMENT PROGRAMME

DEVELOPMENT ACTIVITY	INDIVIDUAL/STRUCTURE	RESOURCES
Directed Reading	SMT	Science kit
Peer Observation – interclass visitation	Grade Teachers (Team teaching)	
Classroom observation and Coaching	Subject Advisor	
Team teaching	DSG.	
Micro-teaching		
Interschool visitation		
Inset or Tertiary course		
Union Workshop		
Department (District/Province) workshop		
Support from SEM/Subject Adviser		

02. If support and assistance is provided, improvement will be effected by: End of term.

03. Contextual factors hampering progress: learning space (overcrowded classes, discipline, as learners are crowded in one class discipline tend to lack.

04. Improvement has been effected in the following area/s: Discipline has improved but not in a highest rate as overcrowded or overcrowding is still an issue

05. Further improvements is/are required in the following area/s: The utilisation of resources (science kit) most often when explaining concepts.

06. New area/s for development: Utilisation of a projector to show learners some videos related to each topic.

Progress has been monitored regularly:

Dates: (1) _____ (2) _____ (3) _____

Name of Educator: _____ Signature: _____ Date: _____

Name of Senior: _____ Signature: _____ Date: _____

Name of Peer: _____ Signature: _____ Date: _____

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10. PERSONAL GROWTH PLAN (PGP)

Name of educator:_____ Persal no:_____

Name of school: Dr _____ School

Learning area/s & grades: _____

Date of PGP compilation:_____

NO.	PERFOMANCE STANDARD				
01	Creation of a positive learning environment	(A)	B	(C)	D
02	Knowledge of curriculum and learning programmes	A	B	C	D
03	Lesson planning, preparation and presentation	(A)	B	C	D
04	Learner assessment/learner achievement	A	B	C	D
05	Professional development	A	B	C	D
06	Human relations and contribution to school development	A	B	C	D
07	Extra-mural and co-curricular participation	A	B	C	D
08	Administration of resources and records	A	B	C	D
09	Personal	A	B	C	D
10	Decision making and accountability	A	B	C	D
11	Leadership, communication and service to governing body	A	B	C	D
12	Strategic & financial planning & education management dev.	A	B	C	D

01. I need to improve in the following areas:
Diversity and discipline

02. I need assistance from the following Individuals/Structures
From the school management team.

03. I need the following resources to achieve my improvement
School Policy

04. I need to implement the following actions/tasks/activities to achieve my improvement
I need to implement discipline interms of giving extra work

05. My improvement has been achieved in the following area/s
I can see the improvement interms of mathematics and conduct

06. I need to further improve in the following area/s
overcrowded classes interms of task marking

07. The following contextual factors need to be addressed to achieve my improvement
overcrowded classes as learners tend to misbehave.

REVIEW DATES:1)_____ 2)_____ 3)_____

EDUCATOR'S SIGNATURE:_____ DATE:_____

PEER'S SIGNATURE:_____ DATE:_____

SENIOR'S SIGNATURE: C_____ DATE:_____

Miss Khumalo's portfolio

10. PERSONAL GROWTH PLAN (PGP)

NAME OF EDUCATOR: Miss K. _____ PERSAL NO. 6 ___ 262 ___ DATE: _____

NAME OF SCHOOL: L _____ PRIMARY SCHOOL

LEARNING AREA/S & GRADES: N.S.T _____ GRADE 5 _____

01. I need to improve in the following areas: _____

I need to improve in dealing with learners who are Struddlers.

DEVELOPMENT PROGRAMME

DEVELOPMENT ACTIVITY	INDIVIDUAL/STRUCTURE	RESOURCES
Directed Reading		
Peer Observation – interclass visitation		
Classroom observation and Coaching	Departmental head	L.T.S.M.
Team teaching		
Micro-teaching		
Interschool visitation		
Inset or Tertiary course		
Union Workshop	Unions	Policies
Department (District/Province) workshop	Subject advisors	
Support from SEM/Subject Adviser		

02. If support and assistance is provided, improvement will be effected by: As soon as possible

03. Contextual factors hampering progress: Overcrowding, Language barrier, Insufficient Resources.

04. Improvement has been effected in the following area/s:
Diversity

05. Further improvements is/are required in the following area/s:
Workshops internal and external

06. New area/s for development:
Curriculum.

Progress has been monitored regularly:

Dates: (1) _____ (2) _____ (3) _____

Name of Educator: Mr _____ Signature: _____ Date: 06.11

Name of Senior: _____ Signature: _____ Date: 6.11

Name of Peer _____ Signature: _____ Date: 17.5

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10. PERSONAL GROWTH PLAN (PGP)

Name of educator: _____ Persal no: _62__

Name of school: _____

Learning area/s & grades: _NS.   GRAD_

Date of PGP compilation: _____

NO.	PERFOMANCE STANDARD	A	B	C	D
01	Creation of a positive learning environment	A	B	Ⓒ	Ⓓ
02	Knowledge of curriculum and learning programmes	A	Ⓑ	C	D
03	Lesson planning, preparation and presentation	A	B	C	D
04	Learner assessment/learner achievement	A	Ⓑ	C	D
05	Professional development	A	B	C	D
06	Human relations and contribution to school development	A	B	C	D
07	Extra-mural and co-curricular participation	A	B	C	D
08	Administration of resources and records	A	B	C	D
09	Personal	A	B	C	D
10	Decision making and accountability	A	B	C	D
11	Leadership, communication and service to governing body	A	B	C	D
12	Strategic & financial planning & education management dev.	A	B	C	D

01. I need to improve in the following areas:

Diversity , Discipline, skills and knowidge of Assement Techniques.

02. I need assistance from the following Individuals/Structures

Cluster, DSG, D.H.

03. I need the following resources to achieve my improvement

Power point over head eg. Projector, Computer Literacy.

04. I need to implement the following actions/tasks/activities to achieve my improvement

Workshops

05. My improvement has been achieved in the following area/s

Curriculum in terms of ATP, Assessment Programme etc.

06. I need to further improve in the following area/s

Projector and computer Literacy

07. The following contextual factors need to be addressed to achieve my improvement

_____

REVIEW DATES:1)_____ 2)_____ 3)_____

EDUCATOR'S SIGNATURE:_____ DATE:_____

PEER'S SIGNATURE:_____ DATE:_____

SENIOR'S SIGNATURE:_____ DATE:_____

(17)

Miss Mbambo's portfolio

10 PERSONAL GROWTH PLAN (PGP)

Name of educator: _____ Persal no: _____

Name of School: _____

Learning area/s & grades: Isizulu and Natural Sciences Grade 7

Date of PGP compilation: _____

NO	PERFOMANCE STANDARD				
01	Creation of a positive learning environment	A	B	C	D
02	Knowledge of curriculum and learning	A	B	C	D
03	Lesson planning, preparation and presentation	A	B	C	D
04	Learner assessment/ learner achievement	A	B	C	D
05	Professional development	A	B	C	D
06	Human relations and contribution to school development	A	B	C	D
07	Extra-mural and co-curricular participation	A	B	C	D
08	Administration of resources and records	A	B	C	D
09	Personal	A	B	C	D
10	Decision making and accountability	A	B	C	D
11	Leadership, communication and service to governing body	A	B	C	D
12	Strategic and financial planning & education management	A	B	C	D

01 I need to improve in the following areas

Assesment and Setting tasks

02 I need assistance from the following individuals/ structure

SMT

03 I need the following resources to achieve my improvement

Caps documents

04 I need to implement the following actions/ tasks/ activities to achieve my improvement

I need a workshop.

05 My improvement has been achieved in the following area/s

Preparing teacher's file.

06 I need further improve in the following area/s

I need proper training on the use of digitel projector.

07 The following contextual factors need to be addressed to achieve my improvement

_____

REVIEW DATES: 1) _____ 2) _____ 3) _____

EDUCATOR'S SIGNATURE: _____ DATE: _____

PEER'S SIGNATURE: _____ DATE: _____

SENIOR'S SIGNATURE: _____ DATE: _____

07. RECORD OR EVIDENCE OF PRE-EVALUATION MEETINGS

Name of Educator: _____ Persal No. 6. ___ 10 _____

Post Level: _____ Date: _____

DSGMembers : Name of Senior /HOD/Superior: M___ ___ _____

Name of Peer: M___ ___ _____

Pre- Observation Meeting

01. Date of submission of educator portfolio and sample of learning portfolio: _____

02. Date of Classroom visit: _____

03. Period Number or Lesson Number: Period 4 _____

04. Subject /Learning Area: Life Orientation _____

05. Lesson Topic and Activities

Prevent environmental health problems
Activity: The importance of clean water
(Activity 23 page 95 in learner book).

06. The Performance Standards were discussed (ring)

i.	Criteria for each Performance Standard were discussed	YES	NO
ii.	Levels of Performance Standards were discussed	YES	NO
iii.	Educator/Peer/Senior has a common understanding of each Performance Standard, Criteria and Scores applied	YES	NO
(iv).	The instrument to be used during the classroom observation was discussed.	YES	NO

07. General or Comments: The meeting went well. All
expectations from educator were discu

08. Name of Educator: _____ Signature _____ Date _____

Name of Peer: Ma___ _____ Signature _____ Date _____

Name of senior _____ Signature _____ Date _____

(12)