

**THE GRADE 11 LIFE SCIENCES TEACHERS' USE OF INFORMATION  
AND COMMUNICATION TECHNOLOGY (ICT) IN BEAUFORT WEST  
HIGH SCHOOLS, WESTERN CAPE**

by

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Submitted in accordance with the requirements

for the degree of

MASTER OF EDUCATION

in the subject

NATURAL SCIENCES EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

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2022

## DECLARATION

I declare that the thesis entitled, 'The Grade 11 Life Sciences teachers' use of Information and Communication Technology (ICT) in Beaufort West high schools, Western Cape' is my own work and that all the sources that I have used or quoted are indicated and acknowledged by means of complete references and a reference list.

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## **ACKNOWLEDGEMENTS**

- First and foremost, I thank God for this opportunity; nothing is impossible if you have Him on your side.
- Next, I extend my profound gratitude to my supervisor, Dr AR Molotsi, for the timely support, inspiration and encouragement throughout the entire work. I could not have done this without your patience and understanding.
- I am particularly grateful to my family for their support to keep the study going without any delay.
- I want to thank my best friend for her input and support during my studies.
- I am sincerely grateful to all the educators who participated in my study.
- I thank the Circuit Manager and Principals for allowing me to conduct my research at the high schools concerned.
- I also thank UNISA for awarding me a bursary to complete my studies.

## **ABSTRACT**

This study sought to investigate how Grade 11 Life Sciences teachers integrate ICTs in their teaching and learning. The lens that was used to frame this study was Technological Pedagogical and Content Knowledge (TPACK) theory; the research paradigm was interpretivist; and the qualitative design case study was followed. Three high schools in Beaufort West in the Western Cape were the natural settings where the study was conducted. The data collection strategies that were used were non-participant observation, semi-structured interviews, and document analysis. Three teachers who participated in the study were purposely sampled as they taught Grade 11 Life Sciences using ICT. During this study, trustworthiness was maintained by applying credibility. Ethical clearance was also taken into consideration by using voluntary participation, anonymity, informed consent, and confidentiality. The research question addressed in this study was: How do Grade 11 Life Sciences teachers integrate ICT in their teaching and learning? The results indicate that teachers integrate ICT into their teaching and learning through various ICT tools such as videos, laptops, data projectors, using interactive and normal whiteboards, and displaying pictures. Teaching experience can assist in the choice of ICT for the presentation of a lesson and in engaging with learners during lessons. The use of ICT in teaching Life Sciences makes teachers comfortable as they deliver their lessons. The results also indicated that having ICT policies at school is important as this information can assist in the use of ICT in schools. The recommendations of this study are that teachers must be trained on how to use ICT optimally in teaching and learning.

Key words: Grade 11; high schools; information and communication technology; Life Sciences, teachers.

## OKUCASHUNIWE

Lolu cwaningo luphenye izindlela othisha beBanga le-11 beSayensi yezeMpilo abadidiyela ngazo ubuchwepheshe boLwazi noBuchwepheshe bokuXhumana (ICT) ekufundiseni nasekufundeni kwabo. Ingilazi eqoqa ukukhanya esetshenziswe ukwenza uhlaka lwalolu cwaningo kwakungokucatshangwayo Kolwazi Lokufundisa Nokuqkethwe Kwezobuchwepheshe (TPACK). Umbono wocwaningo walesi sifundo bekungowokutolika, kwase kwamukelwa ukusongoza kwecebo lemininingwane ngokusebenzisa ukuxhumana okuvulekile nokuxoxa. Lolu cwaningo lwenziwe ezikoleni ezintathu zamabanga aphezulu eBeaufort West eNtshonalanga Kapa. Amasu okuqoqwa kwemininingwane ahlanganisa ukubhekwa kwabangahlanganyeli, izingxoxo ezingahleliwe, nokuhlaziywa kwemibhalo. Othisha abathathu bathathwa njengamasampula ngenhloso njengoba besebenzisa i-ICT ukufundisa iBanga le-11 iSayensi yezeMpilo. Lolu cwaningo luthembekile ngoba izinga eliphezulu lokwethembeka lagcinwa. Izimiso zokuziphatha nazo zacatshangelwa ngenxa yokubamba iqhaza ngokuzithandela, ukungaziwa, imvume yokwaziswa, nokugcinwa kuyimfihlo. Umbuzo wocwaningo okukhulunywa ngawo kulolu cwaningo wawuthi: Othisha beBanga le-11 beSayensi yezeMpilo bayihlanganisa kanjani i-ICT ekufundiseni nasekufundeni kwabo? Imiphumela yabonisa ukuthi othisha bakwenza ngamathuluzi ahlukahlukene e-ICT afana namavidiyo, amakhompyutha aphahekayo, amaprojektha eminingwane, amabhodi amhlophe asebenzayo navamile, nangokubonisa izithombe. Isipiliyoni sokufundisa sinquma ukukhetha kwe-ICT ukwethula isifundo nokuxhumana nabafundi. Ukusetshenziswa kwe-ICT ekufundiseni iSayensi yezeMpilo kunikeza othisha ukuzethemba okukhulu ukwethula izifundo zabo. Ngokwemiphumela, izinqubomgomo ze-ICT zikhuthaza ukusetshenziswa kwe-ICT ezikoleni. Isiphakamiso salolu cwaningo ukuthi othisha baqeqeshwe ngendlela efanele yokusebenzisa i-ICT ekufundiseni nasekufundeni iSayensi yezeMpilo.

### **Amagama asemqoka:**

Ibanga -11; Izikole zamabanga aphezulu; Ulwazi nobuchwepheshe bokuxhumana;  
ISayensi yezeMpilo; Othisha.

## OPSOMMING

Hierdie studie het maniere ondersoek waarop onderwysers wat Lewenswetenskappe vir Graad 11-leerders aanbied, Inligtings- en Kommunikasietegnologie (IKT) in hul onderrig en leer integreer. Die lens wat as uitgangspunt vir hierdie studie gebruik is, was die Tegnologiese Pedagogiese en Inhoudskennis (*TPACK*)-teorie. Die navorsingsparadigma vir hierdie studie was interpretief, en 'n kwalitatiewe ontwerp is gebruik. Hierdie studie is by drie hoërskole in Beaufort-Wes in die Wes-Kaap uitgevoer. Die data-insamelingstrategieë wat gebruik is sluit in: nedeelnemer-waarneming, halfgestruktureerde onderhoude, en dokumentontleding. Drie onderwysers is by doelbewuste steekproefneming ingesluit aangesien hulle IKT gebruik om Graad 11-Lewenswetenskappe te onderrig. Hierdie studie is betroubaar, omdat 'n hoë mate van geloofwaardigheid gehandhaaf is. Etiek is ook in ag geneem, ten opsigte van vrywillige deelname, anonimiteit, oorwoë toestemming, en vertroulikheid. Die navorsingsvraag wat in hierdie studie ter sprake was, is soos volg: "Hoe integreer Graad 11-Lewenswetenskappe-onderwysers IKT in hul onderrig en leer?". Die resultate het daarop gedui dat onderwysers dit doen met behulp van verskeie IKT-hulpmiddele soos video's, skootrekenaars, dataprojektors, interaktiewe en gewone witborde, en deur prente te wys. Onderrigervaring bepaal die keuse van IKT vir lesaanbieding en interaksie met leerders. Die gebruik van IKT in die onderrig van Lewenswetenskappe gee aan onderwysers meer selfvertroue om hul lesse aan te bied. Te oordeel aan die resultate, bevorder IKT-beleide die gebruik van IKT in skole. Die aanbeveling van hierdie studie is dat onderwysers opgelei moet word in die optimale gebruik van IKT vir die onderrig en leer van Lewenswetenskappe.

**Sleutelwoorde:** Graad 11; hoërskole; Inligtings- en Kommunikasietegnologie; Lewenswetenskappe; onderwysers.

## ACRONYMS

BEd	Bachelor of Education
BSc	Bachelor of Science
CK	Content Knowledge
DBE	Department of Basic Education
DER	Digital Education Revolution
FCUBE	Free Compulsory Universal Basic Education
FET	Further Education and Training
GDE	Gauteng Department of Education
HOD	Head of Department
ICILS	International Computer and Information Literacy Study
ICT	Information and Communication Technology
IT	Information Technology
KET	Knowledge of Educational Technology
KSA	Kingdom of Saudi Arabia
NDP	National Development Plan
PGCE	Postgraduate Certificate in Education
PK	Pedagogical Knowledge
TB	Tuberculosis
TCK	Technological Content Knowledge
TK	Technology/Technological Knowledge
TPACK	Technological Pedagogical Content Framework
TPK	Technological Pedagogical Knowledge
USB drive	Universal Serial Bus drive
WCED	Western Cape Education Department

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# CHAPTER 1

## INTRODUCTION TO THE STUDY

### 1.1 INTRODUCTION

In this chapter the researcher introduces the study by providing background information on the study and stating the research problem and the rationale for the study. The research question, sub-questions, and the purpose, aims and objectives of the study are also discussed. The researcher provides a preliminary literature review of the study and also discusses the theoretical framework that was used in the study. She also discusses the research method and design, the population and sampling, and the data collection and procedure used during the study. The researcher explains how data analysis and interpretation was conducted. The research ethics and ethical considerations of the study as well as the possible limitations and delimitations of the study are also included in this chapter.

### 1.2 BACKGROUND INFORMATION

The use of technology is continuously changing the world. Technology is used daily in classrooms for different purposes, such as PowerPoint presentations and data projectors to deliver effective and meaningful lessons to learners. Technology is crucial in modern everyday life (Briesta, 2016), whether it is WhatsApp, Facebook, Twitter, or simply using Google to search for information. Mukhari (2016) states that the use of ICT in teaching and learning is seen as an important part of a country's development and social growth with regard to individuals. According to Kennah (2016), ICT is a diverse set of technological tools and resources that are used to communicate, create, disseminate, store, and manage information. Simon (2014) claims that ICT has been used widely to access information, to communicate and to stay connected in and with the global community. Kennah (2016) further believes that ICT may be used to support the teacher's delivery of content and pedagogic knowledge for effective teaching in the classroom and to enhance the learning environment for learners.

According to the South African National Integrated ICT White Paper, the South African National Development Plan (NDP) emphasises the government's goal to create a more inclusive society by 2030, to eradicate poverty and reduce inequality (Department of Telecommunications and Postal Services of South Africa, 2016). This study sought to

investigate how Grade 11 Life Sciences teachers integrate ICT in their teaching and learning.

ICT comprises both hardware and software technologies that are required for the delivery of voice, audio and internet services, to name a few. It connects the globe via electronic means, evolving into a global village because of ICT development (Berahman et al., 2017). Berahman et al. (2017) affirm that technology is defined as a set of processes, procedures, tools, and equipment used to create or provide a product or service (Berahman et al., 2017). ICT is referred to as a component of learning and occurs in a variety of ways. It has three characteristics: it is often used for organisations, management, and schools; it is not related to the learning process per se, but it does assist learning in the classroom; the use of ICT emerges as a goal in some courses (Berahman et al., 2017).

For Bhattacharjee and Deb (2016), ICT serves as a portal to the world of knowledge, allowing teachers to stay up to date. It raises knowledge of new teaching techniques, assessment mechanisms, and other aspects of professional growth. ICT facilitates teacher–student interaction. Bhattacharjee and Deb (2016) further point out that ICT enables teachers to plan their lessons, provide feedback to learners, and foster the ability to apply software and hardware in the teaching–learning process. When teachers use ICT, they gain experience in using it and they are being professionally developed. ICT skills assist teachers to teach in an innovative manner. It contributes to the classroom's efficacy and enables a positive learning environment (Ghavifekr & Rosdy, 2015; Bhattacharjee & Deb, 2016).

In addition, Ghavifekr and Rosdy (2015) state that the major goal of ICT implementation in education is to declare the government's vision and missions for promoting ICT in education for the following purposes: to surround schools with dynamic and innovative learning environments for students to become more motivated and creative; to enable students to gain a broader range of knowledge and access to the internet in order to develop a global outlook; to nurture students who have the ability to process information more effectively and efficiently; and to develop students' attitudes and abilities to process information more effectively and efficiently (Ghavifekr & Rosdy, 2015). Based on the information above, teachers should be well informed and should implement ICT according to the vision and mission of the government.

### **1.3 RESEARCH PROBLEM STATEMENT**

As a former Life Sciences student and now a Natural Sciences and Technology teacher, the researcher noticed that most schools do not possess ICT equipment. During the researcher's four years of teaching practice, doing a BEd Further Education and Training (FET) degree majoring in Life Sciences, only two of the schools where the researcher did her practice teaching had ICT resources. At these two schools, the researcher noticed that the learners enjoyed the lessons that were delivered using ICT. At another school, the researcher had to use the teaching and learning resources that were available. It was difficult as learners did not understand certain examples that the researcher used, such as 'sponges' when explaining phyla in multicell animals. The researcher could not integrate ICT in teaching owing to the lack of resources at that school. However, the researcher used examples that learners were familiar with. Most teachers in the area where this study was conducted have been trained in the use of ICT tools, but they still seem to lack the skills or confidence to use them. They still use the traditional blackboard, although the researcher was trained in how to use integrate interactive whiteboards in teaching and learning.

### **1.4 RATIONALE OF THE STUDY**

Farmery (2014) contends that there are four reasons for the use of ICT in a science classroom. First, the use of ICT prepares students for the use of ICT in everyday life and in their social life. Second, the use of ICT prepares students to use ICT at work. Third, the use of ICT improves teaching and learning, which refers to the pedagogical knowledge of the teacher. Lastly, the use of ICT refers to the fact that ICT can change what is taught and how it is taught (Farmery, 2014). This links up with what Olofsson et al. (2018) state, namely that digital tablets are the technology that will prepare the new generation for their future.

The use of ICT refers to how teachers use their technology to teach effectively (Ghavifekr & Rosdy, 2015) and this can be applied to teaching Life Sciences in the classroom. Farmery (2014) found that newly appointed teachers are equipped with the knowledge of ICT and that older teachers find it difficult to integrate ICT as they were not formally trained in its use at university as the new teachers are. This puts pressure on the older teachers to obtain training and makes the use of ICT in the classroom a challenge (Farmery, 2014). Teachers are generally regarded as the most influential factor in classroom learning and, as such, they play a critical role in ensuring that students use

ICT effectively in the classroom (Yuen & Hew, 2017). This encourages teachers to become equipped with ICT skills.

According to the South African White Paper on e-Education (2004), ICT has enhanced the quality of education and training, just as it has other areas of social and economic growth. For these reasons, the government has been quick to recognise the relevance and practical advantages of information and communication technology (ICT) as a fundamental component of teaching and learning in the twenty-first century. The researcher found that the new generation is more ICT inclined and technologically advanced. The idea of e-Education in South Africa centres on the use of ICT to expedite the accomplishment of national educational goals, which includes using computers, laptops, interactive whiteboards, etc. In the South African White Paper on e-Education (2004), the goal was to ensure that by 2013, every South African learner in the General and Further Education and Training bands would be ICT competent (that is, they will be able to use ICT confidently and creatively to help them develop the skills and knowledge they need to achieve their personal goals and to participate fully in the global community) (e-Education, 2004). This study sought to investigate how Grade 11 Life Sciences teachers integrate ICT in teaching and learning as a directive from the White Paper on e-Education.

As a former Life Sciences teacher, the researcher noticed that modern technology changes almost daily. Items are replaced by technology; sometimes people are replaced as well in some work environments; most learners are equipped with the latest technological devices. In the researcher's teaching experience at university, she noticed that learners learn more effectively through the use of ICT, which enables them to do research on their own. In observing the use of ICT, the researcher found that learners like to explore and do activities on their own. They enjoy how figures change shapes, for instance, which can be demonstrated using digital tools.

The researcher is a science teacher and found that the normal 'talk and chalk' method of teaching does not produce results, whereas interactive teaching and using different media encourages learners to learn independently. It also triggers their curiosity and helps to develop their critical thinking skills; it helps them to think 'out of the box'. The use of ICT might help them to overcome obstacles such as language barriers and enable them to succeed in the field of science. In the researcher's teaching experience as a science teacher, she found during teaching practice that many learners found it difficult to understand terms in Life Sciences.

In science many concepts can be better explained by a video on the internet than by what is written in the textbook. During the researcher's teaching experience, she noticed that ICT attracts and keeps the learners' attention. When doing interventions or simple revision on a concept, it is easier to show pictures or videos to help learners remember. The researcher wants learners to enjoy Life Sciences.

## **1.5 THE RESEARCH QUESTIONS**

### **1.5.1 Research Question**

How do Grade 11 Life Sciences teachers use ICT in their teaching and learning?

### **1.5.2 Sub-questions**

1. How do Grade 11 Life Sciences teachers overcome the challenges when they integrate ICT in teaching and learning?
2. What are the Grade 11 Life Sciences teachers' views on the use of ICT in teaching and learning?
3. How are Grade 11 Life Sciences teachers supported in the integration of ICT tools in teaching and learning?

## **1.6 PURPOSE, AIMS AND OBJECTIVES OF THE STUDY**

**Aim:** This study seeks to investigate how Grade 11 Life Sciences teachers integrate ICT in teaching and learning.

**Objectives:**

1. To establish the challenges that Grade 11 Life Sciences teachers experience when they integrate ICT in teaching and learning.
2. To determine the views of Grade 11 Life Sciences teachers when they integrate ICT in teaching and learning.
3. To explore how the Grade 11 Life Sciences teachers are supported when using ICT in teaching and learning.

## **1.7 PRELIMINARY LITERATURE REVIEW**

The researcher scrutinised ICT policies of the following countries: South Africa, Ghana, Scotland, and Australia, and how they implement the use of ICT. A short outline of the

nations and their ICT instrument execution is given below. These strategies are discussed extensively in Chapter 2.

### **1.7.1 South Africa**

The efficiency with which information and communication technology (ICT) is used in teaching and learning is relevant to South Africa's recent educational advances (Oja & Adu, 2018), especially in the South African education system. The proportion of learner to computer is inordinate, which makes computer innovation troublesome and, other than having difficulties with financing ICT, the achievement of coordinating ICT into instructing and learning relies on the mentalities of the instructors because not all educators are enthusiastic about utilising innovation in their teaching, particularly the more seasoned educators (Mukhari, 2016; Okwara, 2016). The introduction of ICT into South African education was promoted by various role players (Gent & Meyer, 2016). The adequacy of the utilisation of Information and Communication Technology (ICT) in educating and learning is appropriate to the new instructive developments in South Africa, and ICT has been redirected from being a technology of information and communication alone to being a creator of curriculum innovation and a delivery system for both teachers and learners. High schools in South Africa that do not employ ICT in teaching and learning have contributed to the country's ineffectiveness in recent educational growth and advancement (Ojo & Adu, 2018).

### **1.7.2 Ghana**

The use of ICT in teaching and learning is critical because it enables unlimited access to relevant material and subject-area growth (Natia & Al-hassan, 2015). Ghana's Ministry of Education began investing in ICT intensely to foster the country's human resources, subsequently setting them up equipped to tend to the expectations of the advanced data age (Ministry of Education, Ghana, 2015). The Education Strategic Plan (2003–2015) and (2010–2020) of the Ghana Education Service distinguished the requirement for ICT in training to help accomplish the goals of the Education Strategic Plan, which are divided into Access, Quality, Gender and Inclusiveness, and Education Management. It is undoubted that the utilisation of ICT in instruction has the capacity to improve the nature of individuals' lives through education and learning (Peprah, 2016).

### **1.7.3 Scotland**

According to the Scottish Government (2016), their instructors, not the technology, hold the key to unlocking this potential. Digital technology, when utilised properly, can be a powerful, versatile and engaging tool for educators, enhancing what they already do well: teach children and young people (Government, 2016). ICT in education institutions exists to create teaching and learning that prepares learners and students for the 'knowledge society' where they can acquire the knowledge and skills that are clearly stated in the Scottish education system (Mukhari, 2016).

### **1.7.4 Australia**

Australia, likewise, is a developed country and the Australian Policy expresses that every school, regardless of whether private or public, should have ICT assets. As indicated by Thomson (2015), the Australian government has a ten-year intent to implement ICT in all schools, from pre-essential to optional. Most Australian schools are wealthy in ICT assets, according to the International Computer and Information Literacy Study (ICILS) report, which was led in 2014. By and large, every three students are allocated to one computer, contrasting with the global mean of eighteen for every computer (Thomson, 2015), which is the situation in most public schools. Basic ICT tasks, such as 'looking for and finding information they wanted on the internet; searching for files on a computer; generating or modifying documents and text; and posting text, photos, and videos to an online profile' were confidently performed by Australian students (Thomson, 2015). Thomson (2015) further states that the capacity of people to utilise ICT appropriately is to get to, oversee, incorporate and assess data, foster new understandings, and speak with others to participate viably in the public eye. Farmery (2014) identifies different phases of ICT implementation, which are discussed in greater detail in Chapter 2.

## **1.8 THEORETICAL FRAMEWORK: TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK)**

The theoretical structure that the researcher used was Technological Pedagogical and Content Knowledge (TPACK.) The following is an outline of what TPACK is and how it is divided into various components.

There are three significant TPACK components which will be examined. They are *Technological knowledge (TK)*, *Technological Pedagogical knowledge (TPK)* and *Technological Content knowledge (TCK)*, and these components are discussed

extensively in Chapter 2. These components additionally show how they interlink with technology to frame this study. Graham et al. (2014) state that the TPACK framework focuses on the interplay of content, pedagogy and technology but that the components of technology should not be treated separately (Graham et al., 2014).

## **1.9 RESEARCH METHODS**

### **1.9.1 Research Method and Design**

The research paradigm was interpretivist. The researcher employed the qualitative research approach. The multiple case study comprised three high schools in Beaufort West and it examined how participants in the Life Sciences study used ICT in their teaching and learning. The research method and design are discussed more clearly in Chapter 3.

### **1.9.2 Population and Sampling**

For the research, the population that the researcher used was Grade 11 Life Sciences teachers. The researcher used purposive sampling, targeting Life Sciences teachers who use ICT in teaching and learning.

### **1.9.3 Data Collection and Procedure**

For data collection the researcher used semi-structured interviews, non-participant observation, and document analysis. She focused only on Life Sciences participants who taught Grade 11 learners in Beaufort West at the three designated high schools. For this data collection technique, the researcher used a checklist to gather the data, and open-ended questions (Creswell, 2014) focusing on the use of ICT integration in teaching Grade 11 Life Sciences.

### **1.9.4 Data Collection Strategies**

#### **1.9.4.1 Document Analysis**

The first data collection strategy was document analysis. These were documents that were used at the selected high schools, namely the minutes of staff meetings and the ICT policies. The researcher studied and read these documents and used a checklist to organise the collection of the data.

#### **1.9.4.2 Non-participant Observation**

The second data collection strategy was non-participant observation. The researcher used the checklist during the non-participant observation and observed the participants as they presented their Life Sciences lessons.

#### **1.9.4.3 Semi-structured Interviews**

The semi-structured interviews were the third data collection strategy. The researcher interviewed three participants on how they integrate ICT in teaching and learning Life Sciences. More discussions about data collection strategies and how they were undertaken are presented in Chapter 3.

### **1.10 TRUSTWORTHINESS IN THE STUDY**

A definition of trustworthiness in a study refers to the degree of confidence in the data, as well as the interpretation and the methods used to ensure the quality of a study (Connelly, 2021). In this study, one of Babbie and Mouton's (2012) principles of trustworthiness in research was employed, namely credibility. To ensure trustworthiness the researcher focused on three items of credibility namely triangulation, referential and member check.

### **1.11 RESEARCH ETHICS**

Ethical consideration in the research involves good behaviour, moral issues, and the benefit of participants (Creswell, 2014). In this study the researcher was expected to follow the correct procedures in order to achieve the intended objectives. Regardless of the research methodology, the researcher carefully took cognisance of the participants taking part in the research.

### **1.12 POSSIBLE LIMITATIONS AND DELIMITATIONS OF THE STUDY**

#### **1.12.1 Limitations of the Study**

The following may be some of the study's potential flaws. Since there are few schools equipped with ICT services in the Beaufort West area, the analysis was limited to three schools. It is possible that not all Life Sciences researchers would choose to take part; hence, one of the study's potential flaws may be that participants could choose whether or not to participate. Participants may have felt compelled to respond in a certain manner,

and their responses may not have been honest. It was also difficult to find time for interviews and insights.

### **1.12.2 Delimitations of the Study**

The researcher observed Life Sciences lessons and she was present during all of the lessons.

### **1.13 CHAPTER SUMMARY**

In Chapter 1 the researcher set out an introduction to the study that the researcher wanted to conduct by defining ICT. The researcher provided background information on the study and also explained the research problem statement referring to Simon (2014), who was of the view that ICT adds value to both teaching and learning science in the classroom. The researcher provided the rationale of the study. She created a research question (How do Grade 11 Life Sciences teachers integrate ICT in their teaching and learning?) as well as sub-research questions to address the objectives of the study. In the preliminary literature review, the researcher discussed of all the resources that were consulted during the study as well as the theoretical framework that was used in this study, namely TPACK. The researcher then briefly pointed out the research design and methodology that was used and followed throughout the research, namely the qualitative research approach using multiple case studies. These instruments were used for data collection: semi-structured interviews, non-participant observations, and documentary analysis. Ethical considerations were discussed to ensure that all participants were protected during the research process. The possible limitations and delimitations were also discussed. The next chapter presents the literature review.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

In Chapter 1 the researcher introduced the study, which consists of background information, the research problem statement and the rationale of the study. The researcher also provided a preliminary literature review which is discussed in detail in this chapter, as well as the research methods and design, trustworthiness in the study, research ethics, limitations of the study, and a theoretical framework to support the study.

The following are discussed in this literature review: the integration of ICT across developing and developed countries; integrating ICT in teaching and learning of Life Sciences, the role of teachers and how they integrate ICT in Life Sciences; the benefits that ICT provides for teaching and learning; the challenges that teachers face when implementing the use of ICT resources; and finally, the TPACK framework, which is the lens for this study.

#### **2.2 THE INTEGRATION OF ICT ACROSS DEVELOPING AND DEVELOPED COUNTRIES**

The researcher examined ICT policies in science classrooms in four developing countries (South Africa, Ghana, Saudi Arabia, and Chile) and two developed countries (Scotland and Australia).

##### **2.2.1 Developing Countries – South Africa, Ghana, Saudi Arabia and Chile**

###### **2.2.1.1 South African ICT Integration in Teaching and Learning**

The South African White Paper on e-Education policy defines ICT as a set of networks, hardware and software, as well as communication, collaboration and engagement tools that allow data, information, and knowledge to be processed, managed, and exchanged, and e-Education as connecting learners to other learners, teachers to professional support services, and offering venues for learning (DoE, 2004).

Various stakeholders have advocated the use of ICT in South African education (Gent & Meyer, 2016). The efficiency with which Information and Communication Technology

(ICT) is used in teaching and learning is relevant to South Africa's recent educational advances and ICT has evolved from purely Information and Communication Technology to a driving force behind curriculum innovation and delivery for both teachers and students. ICT gadgets assist teachers in communicating efficiently with learners in a unique way that enhances learning. High schools in South Africa that do not employ ICT in teaching and learning contribute to the country's ineffectiveness in recent educational growth and advancement (Ojo & Adu, 2018). Outcomes-Based Education saw the twenty-first century as a time of rapid change and development, emphasising teachers' other responsibilities as learning mediators, curriculum interpreters, leaders, managers, and administrators, masters of their subject areas, scholars, facilitators of learning, subject experts, lifelong learners, learning designers, programme innovators, and teaching material developers, as stated in the National Curriculum Statement (NCS) of 2003. This is why it is commonly acknowledged that information and communication technology (ICT) may be used as a catalyst in teaching and learning to improve teacher productivity and learner achievement (Ojo & Adu, 2018).

This explains the importance of ensuring that public schools receive ICT tools, whether they are interactive whiteboards or just plain whiteboards with data projectors. As an educator, the researcher found that using the interactive whiteboard and developing PowerPoint slides increases learners' attention. They pay more attention and enjoy the displayed work. According to Mathevula and Uwizeyimana (2014), owing to the constant changes in the technology industry, teachers must be lifelong learners in order to keep up with technological advancements and innovative teaching approaches (Mathevula & Uwizeyimana, 2014). In South Africa's senior high school education system, the use of ICTs in teaching and learning is rapidly becoming one of the most pressing concerns (Ojo & Adu, 2018). When learners enter high school, they can pick from a variety of subjects in Grade 10, including Life Sciences, Physical Sciences and Computer Applications Technology. As an educator in the field of ICT, the researcher knows that the South African ICT policies exist but that they should be implemented correctly. The effective and successful implementation of the ICT policy can ensure that this generation of learners and those to come are prepared, especially for the work environment. The researcher feels that ICT should be introduced and used at the primary school level for the progress of learners, especially for the current generation.

### **2.2.1.2 Ghanaian ICT in Education Policy**

Ghana's Ministry of Education has begun to spend extensively on ICT in order to enhance the country's human resources and to prepare people to meet the needs of the digital and information era. They also claim that all Ghanaians have the right to benefit from the constitution-mandated Free Compulsory Universal Basic Education (FCUBE) (Ministry of Education, Ghana, 2015). The Ministry of Education has implemented a number of policy and programme interventions, which are aimed at increasing access and equity and improving the quality of education through integrating ICT in education to provide computer laboratories, internet and network access to schools, laptops to teachers and students, and teacher capacity-building to support effective teaching, learning and management (Ministry of Education, Ghana, 2015). This ensures that all learners, both in public or private schools, receive quality education with regard to ICT in the classroom and that all learners benefit and experience ICT tools, as we live in a world that is dominated by technology.

In a few well-established schools in Ghana the use of ICT is completely integrated into the curriculum of private and pre-tertiary schools (Ministry of Education, Ghana, 2015). According to the Ministry of Education in Ghana (2015):

ICT has been identified as a key driver of Ghana's growth, and a number of interventions have been identified and provided for, including investment in ICT infrastructure to support education and other sectors, youth and other professionals in the Ghanaian workforce training, and the convergence of ICT into the fabric of government and social service provision, among others (Ministry of Education, Ghana, 2015)

ICT was recognised by Ghana's Ministry of Education in two ways: first, ICT is seen as a learning and operating tool:

This would allow ICT (including software and hardware devices) to be utilised as a tool to assist in the management of educational environments (Ministry of Education, Ghana, 2015).

Second, ICT must be integrated into the teaching and learning of all subjects:

This permits ICT to be incorporated into all topics across the national curriculum, giving teachers and educational policymakers the ability to employ ICT or other appropriate educational technology tools in the teaching and learning of all subjects (Ministry of Education, Ghana, 2015).

Not all schools are equipped with ICT tools, but the Ghanaian Education Department is trying to provide all schools with ICT tools in order to ensure that all learners benefit from the ICT curriculum and that ICT is integrated into all subjects at school. Laboratories can also help by using ICT tools to display experiments that are too dangerous to do in the classroom.

According to Ghana's Ministry of Education, there are many stages at which ICT should be introduced throughout the country. Three phases were recognised, as follows: The first phase aimed to improve institutional and system-wide preparedness to employ ICT for teaching, learning and administration. This includes:

Creating a system of education and training to facilitate the use of ICT in teaching and learning, and the belief of teachers and administrators in the use of ICT. Establishing an ICT presence in schools and developing a framework for teacher development in the integration of ICT into the curriculum (Ministry of Education, Ghana, 2015).

The second phase of implementation was to guarantee that ICT was integrated into teaching and learning across the board:

The Curriculum Research and Development Division should develop an ICT integration curriculum guideline. ICT is integrated into management and the curriculum by teachers and managers. Every school with an ICT facility has a full-time teacher who oversees the facility and promotes the use of ICT in the classroom (Ministry of Education, Ghana, 2015).

The last phase of ICT implementation in Ghana was to integrate ICT at all levels of the education system, including management, teaching, learning, and administration, as follows:

ICT is used in many aspects of education, including planning, management, communication, and monitoring and evaluation. ICT skills are available to all students and instructors and in all schools, ICT is integrated into teaching and learning (Ministry of Education, Ghana, 2015).

This three-phased plan, according to the Department, is seen as crucial. It involves not only teachers but all the staff in an education setting. These implantation stages are a means to increase ICT usage and to involve all staff with regard to professional development. It is important that all staff, especially teachers, receive training in ICT. As an educator, the researcher found this to be the most important aspect of the ICT

curriculum. Ghana decided to integrate ICT at all levels of the education system. This will ensure that all staff members in the education sector are ICT trained.

The Basic School Computerisation Policy in Ghana was established in 2011 with the goal of incorporating computers and e-Learning throughout the whole educational system in order to encourage training and lifelong learning. The Ghana Education Service's Education Strategic Plans (2003–2015) and (2010–2020) highlight the need for ICT in education to assist in accomplishing the Education Strategic Plan's objectives, which are divided into Access, Quality, Gender and Inclusiveness, and Education Management. Ghana's government established the ICT for Accelerated Development Policy (ICT4AD) (2003), which defines plans and strategies for using ICT to help the country achieve its objective of transforming Ghana into an ICT-literate information- and knowledge-driven nation. Promoting ICT in education is the second cardinal pillar of the ICT4AD strategy, which stresses the implementation and use of ICT in education. The Ministry of Education created the ICT in Education Policy in 2008 as a method of addressing the ICT needs in education, with the goal of promoting ICT in education. One area where ICT has made an appearance is in education, where it is improving efficiency in teaching, learning, and research (Natia & Al-hassan, 2015).

According to this policy created by the Ghanaian Education Department, they are investing heavily in ICT for schools to ensure that all schools are equipped according to a certain timeframe and that ICT is integrated at all levels of the education system. The ICT4AD policy was created to put Ghana on the map and to transform Ghana into an ICT nation. This policy was also created to address the country's ICT needs and to promote ICT in education. As an educator, the researcher believes that using ICT enhances the learners' learning and opens their minds to new possibilities and ways to use ICT tools for educational purposes.

### **2.2.1.3 ICT Policy in Education in Saudi Arabia**

Saudi Arabia is neither a developing nor a developed country (it was categorised as a third-world country by the UNDP in 2020), but it has made significant progress in terms of resources, infrastructure, and education. In terms of ICT, all their schools are equipped with ICT tools and resources. There are three key reasons why countries must use ICT in education, according to Mofarreh (2016): the economy's perceived demands and most firms' expressed necessity for employees with ICT skills and expertise; ICT has become a key requirement for involvement in society and the workplace; and ICT

has the ability to alter educational methods and to expand the scope and depth of classroom teaching and learning (Mofarreh, 2016). Saudi Arabian schools have implemented the ICT policy in all schools. They further believe that ICT has the students' literacy, confidence, and ICT skills at heart, which they have the potential to develop.

The Saudi Arabian government made sure to include in their ICT policy that all schools must be equipped with ICT tools and devices. ICT skills are needed to advance, not only at school but also in the workforce. According to the government, ICT aids the country's economy and helps individuals to become ICT inclined. Their main objective is to make sure that ICT education is in accordance with the country's needs.

The overall objective of the education policy in the Kingdom of Saudi Arabia (KSA) is to make education more efficient, to satisfy the country's religious, economic, and social needs, and to eliminate illiteracy among Saudi adults (Mofarreh, 2016). In Saudi Arabia, most primary and intermediate schools employ technology for learning, while students in high schools' study ICT as a subject. At school level, ICT is implemented mostly through teaching and the usage of textbooks (Mofarreh, 2016). Previously, there were no ICT policies or equipment in Saudi Arabian schools. Secondary schools adopted ICT as a subject to study because it was not offered in primary schools. The curriculum was first offered to students at special secondary schools in three stages: an introduction to computer sciences, the fundamentals of programming and systems programming, and the usage of information systems (Mofarreh, 2016). The Saudi government is committed to raising educational standards. The Ministry of Education is implementing high-quality teacher-training programmes to help teachers improve their skills in evaluating students and to increase the use of educational technology and resources. This is in accordance with the Ministry of Education's Ten-Year Plan (2004–2014) to develop and implement modern technologies in education (Mofarreh, 2016).

All ICT policies mentioned strive to improve the curriculum by adding ICT to it and by enhancing the knowledge of every learner. With the focus on South Africa, the ICT policy is mainly trying to eradicate poverty and trying to include all learners from public to private and primary to secondary schools. Since South Africa is so diverse, it needs a curriculum that includes all, as mentioned in the White Paper on e-Education.

#### **2.2.1.4 Chile's ICT Policy in Education**

Simon (2014) highlights a study on ICT usage in education conducted in Chile, which found that instructors use ICT more frequently for particular tasks, which provides an

opportunity to promote ICT use in schools. The Chilean studies also indicated that instructors' ICT activities are identical, indicating a lack of diversified ICT teaching techniques. According to Simon (2014), both teachers / educators and student teachers used and incorporated ICTs for a variety of purposes, including planning, organising and storing learning content that could be accessed and used again, as well as improving specific courses. Simon (2014) indicates that science instructors, in particular, utilise ICT for finding and choosing, organising and exploring, utilising models and modelling, and managing and monitoring classes. Another reason for incorporating ICT into the classroom is for teacher research, planning, and development, as well for as the integration of ICT in educational instruction, learner ICT literacy, and educational management (Simon, 2014). She discovered that South African schools employ ICT for simulations as well as using data recorders during practical work, for the conceptual comprehension of science and, most significantly, for student interest in science (Simon, 2014). There are numerous reasons that instructors can or must utilise ICT, according to Simon (2014). She mentions the following: that teachers use ICT for course preparation and instructional assistance, such as generating quizzes, accessing the internet for lesson plans and materials, making presentations, altering sounds and music, and hosting websites (Simon, 2014).

## **2.2.2. Developed Countries: Scottish Government and Australia**

### **2.2.2.1 Scottish ICT in Education Policy**

The Scottish government is dedicated to enhancing education in Scotland and to ensuring that all their children and young people have the greatest possible life opportunities. Their vision is to ensure that every child meets the highest standards in literacy and numeracy, as defined by the Curriculum for Excellence levels, as well as the appropriate range of skills, qualifications, and achievements to enable them to succeed and attain equity. They do so by ensuring that every child has the same chance to succeed, with a special focus on narrowing the achievement gap caused by poverty (Government, 2016). Their objective regarding the ICT policy is to improve access to digital technology for all learners; to ensure that digital technology is a central consideration in all areas of curriculum and assessment delivery; and to develop the skills and confidence of educators in the appropriate and effective use of digital technology. Teachers are expected to support learners by using digital technology.

The Scottish government's ICT policy ensures that all learners receive the highest possible quality of education from a very young age, and, from a teacher's point of view, the researcher agrees with this. The earlier the learners have exposure to ICT, the easier it will be to use ICT tools at primary and secondary school level for both the learner and the teacher.

According to Mukhari (2016), the Scottish government established an ICT mission focused on educating students for the changing digital environment, which will help them not just at school but also at work. If teachers use technology in teaching and learning, they are not only preparing learners for their future careers but also for participating in society with their technology skills.

This Strategic Action Plan was created by the Highland Council Care and Learning Service to ensure that all learners have access to the technology they need to master these important skills. Owing to the pervasiveness of current digital lives and the changing young culture, education is experiencing a transition. It is critical that learning incorporates culturally appropriate technology and considers the requirement for students to learn about technology in preparation for future employment. The Scottish Government recently implemented new curricular frameworks that would require teachers and students to be confident and proficient in their use of technology. It is expected that by offering technology-rich settings in schools, students would have more access to knowledge, be able to share / create material, and be more independent in their learning. The use of ICT in education, along with improved pedagogies, may empower teachers and learners, changing teaching and learning processes from teacher-centred to learner-centred processes (James & Templeton, 2015).

The Strategic Action Plan by the Scottish government ensures that teachers are confident to use ICT tools. This is accompanied by the fact that teachers should receive ICT training constantly, especially to keep up with the learners and with any new knowledge or software that might be available. The Scottish government also offers technology-rich / ICT-rich classrooms to accommodate teachers and learners; this encourages teachers to move from a teacher-centred to a learner-centred environment within the classroom.

The following are the Scottish Government's ICT in Education Objectives:

The first objective is to change the culture of ICT usage.

Expected Benefits: aligning the use of ICT in schools with its use outside of schools; lowering the cost of centrally bought and managed services; delivering efficiency at the local level via increased use of technological solutions (James & Templeton, 2015, p. 11).

In other words, knowledge of ICT can help teachers even outside the classroom.

The second objective is to improve learners', instructors', school leaders' and parents' confidence in the use of ICT.

Expected Benefits: to raise the amount of practice and resource sharing among teachers, leaders and learners in Scotland; to improve the dependability of technology in use; to increase learners' success via the use of technology; to strengthen Scotland's reputation in the broader digital world (James & Templeton, 2015, p. 11).

Sharing of technological knowledge will benefit all of society.

The third objective is to promote innovative teaching behaviours.

Expected Benefits: a quantifiable improvement in the use of technology in learning; greater classroom creativity by instructors and students; higher student success; enhanced sharing and cooperation among teachers to help them grow as learners (James & Templeton, 2015, p. 11).

If teachers use technology, there will be improvement in learners' performance and again, sharing of skills will assist in their becoming lifelong learners.

Objective four is to increase parental involvement.

Expected Benefits: improved communication between schools and families about students' successes; increased parental engagement in their children's education through increased opportunities; increased digital literacy among parents (James & Templeton, 2015, p. 11).

In this case technology will force the participation of all people.

The last objective is to strengthen the position on hardware and related infrastructure.

Benefits include: an increase in the number of devices in use in schools; a decrease in the cost of device maintenance for local governments; an increase in connectivity for schools and local governments; a better understanding of connectivity speeds across the country; published research on the impact of connectivity on education, social and

community services; and a decrease in the cost of centralisation (James & Templeton, 2015, p. 11).

The Scottish government's objectives clearly state that, not only does it want to change the ICT culture, but it also wishes to improve ICT tools such as the software and infrastructure. If all of that is in place, the integration of ICT becomes easy, and teachers are able to use all the ICT tools at their disposal confidently to ensure that quality teaching and learning takes place. It is clear that the Scottish government did extensive research to ensure that all schools are equipped with ICT tools and that teachers receive the necessary training to use ICT effectively.

### **2.2.2.2 Australian ICT Policy in Education**

Australia is a well-developed country. The Australian government, according to Thomson (2015), has a ten-year strategy to integrate ICT into all schools, from pre-primary to secondary school. The ICT strategy of Australia makes it clear that ICT should be integrated into all schools, to every learner, in every classroom, every day. This strategy was put into place so that all learners receive equal teaching and learning. This strategy of 2020–2024 was also developed to ensure that all stakeholders who are involved in education receive the necessary training to gain skills and knowledge to use ICT, not only in public schools but at home as well. This includes communicating with parents so that they can assist the learners at home.

According to the International Computer and Information Literacy Year Study (ICILS), most Australian schools have extensive ICT resources. In Australia, on average, one computer is available for every three learners, compared to an international average of 18 learners per computer (Thomson, 2015). Basic ICT tasks, such as looking for and finding information on the internet; searching for files on a computer; generating or modifying documents and text; and posting text, photos and videos to an online profile, are performed confidently by Australian learners to engage successfully in society (Thomson, 2015). Individuals who use the internet are expected to be able to acquire skills and communicate with others.

It is clear that the Australian government invests much time and funding into ICT to ensure that no learner is left behind. The Australian government also ensures that every learner has access to a computer and that they are exposed at a very young age.

### **2.3 THE INTEGRATION OF ICT IN THE TEACHING AND LEARNING OF LIFE SCIENCES**

According to Kennah (2016), and Simon (2014), the users of ICT must be able to communicate, produce, transmit, store and manage information by using a wide variety of technical tools and resources, and remain connected to people around the world. Kaware and Sain (2015) define ICT as information communicated through a mix of technical tools and resources. It is a jumble of technical tools and resources for communicating, as well as for generating, transmitting, storing, and managing data. For Abdullahi (2014), Information and Communication Technology (ICT) is a crucial instrument for preparing and teaching students the necessary skills for the global workplace. Abdullahi (2014), indicates that ICT has an impact on education, but these effects cannot be overstated. Another definition of ICT is the technologies that allow telecommunications-based access to information, which includes the internet, wireless networks, cell phones, and other technological forms of communication (Mofarreh, 2016).

Both Kennah (2016), and Kaware and Sain (2015), agree that ICT is a means to communicate information through various tools and resources such as Microsoft Office tools and Google platforms such as Google Classroom, to name a few. All of these ICT tools are ways to remain connected with the outside world and to share ideas with people who are in the same work field. Developing and developed countries have the notion that ICT enhances teaching and learning. While this statement seems to be true, ICT not only enhances teaching and learning but delivers a curriculum that prepares learners for the future. In South Africa, this curriculum has an ICT policy that clearly outlines what is expected of the learner, the teacher and everyone involved in the education field. They are known as the National Integrated White Paper of SA and the White Paper on e-Education, which are discussed below.

According to Simon (2014), several industrialised nations such as Chile, Taiwan, Canada, and Australia, as well as developing countries such as South Africa, Kenya, Ghana, and Nigeria, have adopted ICT on the assumption that it enhances both teaching and learning science in the classroom. Social media are seen as part of ICT and other modern technologies such as SlideShare, LinkedIn, and many more (Simon, 2014).

Teachers can use social media to communicate with learners and parents.

A wide range of technologies, including computing and information technology, as well as telecommunications technology (including fixed and wireless telephony and data

communications), are employed, according to this article. Audio and audio-visual content (including broadcasting) as well as the internet are included (as well as the services carried over this platform), in addition to more conventional modes of communication such as mail delivery (Department of Telecommunications and Postal Services of South Africa, 2016).

The ICT policies of South Africa have their own definition of ICT and how it is integrated in the science classroom. In these policies the professional development of teachers is important as it allows teachers to be trained in ICT. The ICT policies also mention that their plan is to provide all schools with ICT tools, even if it is just a whiteboard to start with. Educators are always encouraged to go for training, which allows them to be up to date with the latest technology and trends in the ICT field.

Farmery (2014) states that for schools and teachers, ICT integration is a continuous effort. The following are the three key phases of implementation that she identified: ICT is largely utilised to automate or convert current activities; ICT is also used to make certain modifications to the teaching and learning process within the classroom; and new pedagogical systems are deployed to improve learning (Farmery, 2014). In terms of ICT, she believes that there are two types of approaches. They are the top-down and the bottom-up approaches, respectively. She defines the top-down strategy as the organisation's introduction of technology. This will assist the teachers because it specifies how they should utilise it. She then describes the bottom-up method, in which instructors investigate technology on their own before sharing it with their colleagues (Farmery, 2014). Existing behaviours and the promotion of technology usage must be compatible for ICT integration to be successful. This should be taken into account at both the teacher and school levels, and it necessitates that ICT integration first determines what constitutes 'excellent' learning. Then, rather than focusing on technology's applications, it is necessary to think about how ICT might help with development. This might make instructors feel as though they are expected to utilise ICT for pedagogical objectives rather than for fun and that there should be a connection between pedagogical theory and practice, which will benefit both the school and the instructors (Farmery, 2014). ICT may also be regarded as playing a key role in enhancing education through curriculum reform and the creation of a set of national goals and policies to govern ICT deployment in schools (Mofarreh, 2016). Farmery (2014) explains clearly why it is implemented in three phases and why is it important to do so. Not only does it help with the teachers' pedagogy but also with how they integrate this ICT

pedagogical knowledge. Mofarreh (2016) also mentions that the curriculum can be enhanced through ICT when implemented properly.

Kler (2014) discusses three phases to integrate ICT successfully into teaching and learning. First, there is the creation of a technology infrastructure for the entire institution and the use of ICT in teaching and learning. Second, increased learning via the pedagogical use of infrastructure and the appropriate integration of ICT into teaching and learning activities, and lastly, ICT is used strategically to target various categories of higher education students. The objective at this level is to combine the many aspects of technical companies into a unified educational enterprise (Kler, 2014).

Simon and Ngololo's (2015) findings show that Life Sciences teachers use ICT in their classrooms by using smartboards connected to e-Learning Management Systems and that they cooperated with one another by exchanging notes, but they did not co-teach or produce their own teaching materials (Simon & Ngololo, 2015). Teachers were found to use ICT in science classrooms for simulation, data logging and comprehending science topics, much as they did in South Africa. To accomplish ICT integration, it is important to employ ICT in the Life Sciences classroom. South African teachers were reported as using ICT in their classrooms for a variety of purposes, including simulations, data recorders during practical work, conceptual comprehension of science, and student interest in science. During this study by Simon and Ngololo (2015), teachers were seen presenting lessons using ICT resources such as an interactive whiteboard with presentation software and, during a practical inquiry, simulation software was utilised to better comprehend science topics such as chemical reactions and friction. They came to the conclusion that teachers should use modern pedagogical techniques to incorporate ICT into subject teaching and learning. On the one hand, the data showed that government schools lacked the infrastructure needed for ICT use in the classroom. Private schools, on the other hand, were ahead of the curve in terms of ICT adoption since they received enough assistance and encouragement from their respective administrations.

Computers and internet connections were installed in Namibian secondary schools and teachers used computers to prepare lessons and deliver them to their learners in the Life Sciences classroom (Simon & Ngololo, 2015). Teachers are expected to use ICT in teaching and learning to encourage active participation of learners and collaborative practices. In addition, teachers use ICT in the Life Sciences classroom for simulation

and modelling (Simon & Ngololo, 2015). Working together at school level, teachers are supported by school administrations in their use of ICT because they use technology in their work more than teachers do. It was discovered that the teachers in this study were using and integrating ICT in their Life Sciences classes. Observation revealed that the e-Learning tools enabled online interaction between teachers and students via educational forums such as debates, discussions and dialogues on the school's website, showing that ICT integration had been completed. Teachers should be made aware of the necessity of developing ICT-related objectives that address what they want to teach using ICT in their lesson plans during professional development courses in ICT. This will boost instructors' ICT abilities and confidence. Smart boards connected to e-Learning Management Systems were used by Life Sciences instructors to showcase ICT utilisation in their classes (Simon & Ngololo, 2015).

According to Kler (2014), making effective use of ICT to teach subject matter in a more exciting manner to make learning easy and immediate for the learners is what ICT in teaching and learning entails. Abdullahi (2014) writes on the importance of ICT in science education teaching in Nigerian schools, where he conducted research. He says that ICT has the potential to alter a person's life. This includes the following examples: culture, entertainment, education, research, defence, and global security are all industries that produce communication services (Abdullahi, 2014).

ICT may be defined in many ways. All persons, especially those in the education system, have their own definition of ICT. There are also many ways that ICT may be successfully integrated in the education classroom. Using ICT tools not only widens our learners' knowledge, but it also exposes them to the world of work. ICT prepares them for the workplace. Regarding ICT in the Life Sciences classroom, it is important to integrate and to use it daily. Teachers should not only use ICT tools daily but should also show videos of experiments that are too dangerous to do in the classroom. This helps teachers to get more exposure to the use of ICT tools and encourages them to go for ICT training regularly.

#### **2.4 THE ROLES OF TEACHERS' INTEGRATION OF ICT IN LIFE SCIENCES**

Several roles can also be applied to ICT in Life Sciences. Abdullahi (2014) states that ICT has many roles in education and is of the view that ICT encourages learners to develop their intellectual abilities (Abdullahi, 2014). This may be accomplished through cultivating higher order thinking and problem-solving abilities (Abdullahi, 2014). He

continues by saying that ICT may help students to enhance their communication skills as well as to get a better grasp of the learning tools and topics that must be taught in the science classroom. He adds that the purpose of ICT is to foster a helpful and participatory teaching and learning environment, which may be accomplished by establishing a larger learning communication system that would provide learning aids for learners, particularly those with special needs (Abdullahi, 2014). This author further mentions the usage of computer-generated images to show various types of connections. This may be accomplished through dynamic processes that cannot be depicted only through individual images. To put it in another way, the function of ICT can help to improve school attendance; learners would be more motivated to go to school because schools can help to create a fresh and more effective curriculum that is entertaining and engaging to them (Abdullahi, 2014). Learners at school are more fascinated by the use of technology than their teachers.

ICT integration is seen to develop the learners' thinking abilities and problem-solving skills. This will allow them to think outside the box. ICT also motivates learners to learn and to attend school regularly. This enables them to explore the world through ICT tools and devices and it allows them to communicate via different connection platforms. Additionally, Abdullahi (2014) believes that the function of ICT in education is to provide a more effective interactive learning environment. This may be accomplished in the classroom by using a learner-centred and activity-oriented teaching / learning strategy. Another responsibility of teachers is to immerse learners in a subject through ICT-enabled classrooms (Abdullahi, 2014). ICT may attract learners' attention as they no longer listen to teachers. He further states that ICT aids in the development of a thorough grasp of the subject at hand. This is seen as a crucial function for ICT; and empowering students with ICT knowledge and skills is critical, especially in the twenty-first century global society (Abdullahi, 2014). ICT in education can help to improve the quality of instruction through teacher-centred methods since the teacher is using digital tools to show issues that are difficult to convey from a textbook. Communication is crucial in Life Sciences, particularly when learners and teachers are asked to address specific themes, for example, considering stem cells or stem cell therapy.

ICT enables teachers to keep up to date with new information and abilities, as well as to learn how to use new digital tools and resources. Student teachers will become successful teachers by utilising and gaining understanding about ICT. One of the key drivers of fast change in our society is Information and Communication Technology (ICT)

as it has the potential to alter the nature of education as well as the responsibilities of students and teachers in the teaching–learning process (Bhattacharjee & Deb, 2016). According to the study by Kaware and Sain (2015) , one essential aspect of ICT in education is that it not only supports but also stimulates collaborative learning among students. Since Life Sciences is such a content-heavy subject, these abilities are essential. Communication is crucial in Life Sciences, particularly when learners and teachers are asked to address specific themes, such as considering stem cells or stem cell therapy. Collaborating with other students will assist them in broadening and transferring their expertise. ICT plays a significant role in the process of integrating technology into educational activities, according to Kaware and Sain (2015). Student-centred learning, enabling knowledge creation, a desire to learn, improving higher order thinking abilities, establishing a problem-solving mindset, and fostering curiosity were all underlined (Kaware & Sain, 2015). Administrators must be proficient in the use of technology and must have a wide grasp of the technical, curricular, administrative, financial, and social dimensions of ICT usage in education for ICT integration to be effective and sustainable (Omwenga, et al., 2015). ICT creates a classroom environment that encourages learning. With ICT some concepts, especially in the subject Life Sciences can be enlivened through videos and other ICT tools and software. ICT also facilitates explaining difficult words or concepts and it accommodates all learners' learning abilities. In a much easier to explain method, ICT makes science come alive in a way that is much easier to explain. It is clearly indicated that the role of ICT in Life Sciences is important. It helps to promote knowledge and skills and, as stated above, enhances learners' learning. ICT also helps to make the classroom fun and interesting for both teachers and learners. This ensures that effective teaching and learning takes place. It is also very important to implement the vision that governments have for their country, especially in South Africa. Teachers' roles and use of ICT are very important; they are the ones who use ICT tools daily. Therefore, it is so important for teachers to receive ICT training. The teachers' role in ICT is not only to use ICT but also to create content with those ICT tools and to make sure that they know how to integrate these ICT tools before class. Teachers should always be confident when using ICT tools or devices. This ensures that the learners will be calm and pay attention throughout the lesson. Hence, the importance of continuous professional development, regardless of teachers' years of experience in the education sector.

## 2.5 TEACHERS INTEGRATING ICT INTO LIFE SCIENCES

In order to acquire knowledge of the natural world, primary and high school learners should have meaningful interactions with Life Sciences. Responsive science education is one approach for teachers to help learners address alternative views in Life Sciences (Forbes et al., 2015). The major driver of instructional decision-making is learners' thinking according to what is presented to them. Teachers should elicit learners' views about scientific phenomena constantly, which is a key assumption of responsive science education. Science teachers are expected to amplify the use of ICT in the classroom by acquiring knowledge on a certain topic. Teachers require a solid grasp of the investigative process to adopt an investigative method, according to international literature, since teachers' comprehension of science inquiry is crucial to their teaching of it (Moeed, 2013). They must have more time to teach by utilising ICT rather than planning or preparing lessons. When it comes to integrating ICT into the science classroom, teachers are the most crucial component. In most situations, using technology in the science classroom creates a strain on teachers, on their abilities and their expertise (Farmery, 2014).

Prior knowledge plays an essential role in teaching science, as learners are encouraged to remember what they have learned (Forbes et al., 2015). Farmery (2014) continues by saying that ICT professional development is necessary for teachers as their use of ICT will assist in improving their own ICT skills. This leads to an improvement in personal abilities which, in turn, leads to increased confidence and the possibility of adopting ICT in the classroom (Farmery, 2014). ICT is used by teachers to make the teaching and learning process easier and more entertaining, and teachers must be familiar with the usage of ICT in their subject areas such as science in order to assist learners in learning more successfully (Bhattacharjee & Deb, 2016). This also explains why Ghavifekr and Rosdy (2015) state that teachers' roles are becoming more significant, particularly in the use of ICT in pedagogy, which has the potential to improve students' success, creativity, and critical thinking abilities (Ghavifekr & Rosdy, 2015).

On the teachers' use of ICT in teaching Life Sciences, Simon (2014) discovered that ICT may be used in a variety of ways in education. She lists the following ICT uses for teachers which she separates into two categories: supporting ICT usage and classroom ICT usage. According to her, the supportive use of ICT refers to ICT for proactive / interactive and administrative teaching that facilitates the administration of teaching and learning, such as learner administration, worksheet preparation, development of

evaluation activities, and tracking the learning progress of learners. Classroom ICT is the second category, and it aims at assisting and enhancing the real teaching and learning process. To name a few, this includes the use of computers for demonstration, practical activities, modelling, the depiction of complicated or difficult knowledge aspects, subject discussions, collaboration, project work, and interactive activities (Simon, 2014). There are many uses of ICT in the Life Sciences classroom. Teachers not only use ICT for administrative purposes such as recording learners' marks and doing learner attendance daily, but they also use ICT for teaching and learning processes such as showing videos and demonstrating how to use ICT tools in the subject. This confirms what Olofsson et al. (2018) address: the use of smart phones in schools has a beneficial influence on learners' learning since they live in a world that is continuously changing, and learners will be more prepared for life and work in the twenty-first century if they utilise digital tablets and other mobile devices. This will increase learners' drive to learn because they can search for knowledge anywhere (Olofsson et al., 2018).

According to Farmery (2014), there are four reasons for using ICT in science classrooms: (a) the use of ICT is to prepare learners for using ICT in everyday life, and (b) in their social lives; (c) the use of ICT is to prepare learners for using ICT at work; (d) the use of ICT is to improve teaching and learning, which refers to the teachers' PK (pedagogical knowledge) (Farmery, 2014). ICT plays an important role, especially when it comes to planning content and creating activities for the learners. This allows the teacher to be more engaged with ICT tools, and the use of ICT tools daily can only help teachers to become more confident when they utilise them in the classroom. Teachers also use ICT tools to access information on Life Sciences, record marks and develop content PowerPoint slides that are directed at the learners' learning abilities. This is why Olofsson et al. (2018) indicate that ICT is utilised for continuing digital documentation, with Google Drive and the laptop hard drive serving as conveniently available storage and search containers for data needed to complete a school project. ICT is thus used to store and retrieve information for teaching and learning purposes through a platform such as Google Drive. A new platform is now being used for learners and teachers named Google Classroom. The writer found this platform very convenient. The content is uploaded to a folder and can be accessed anywhere and at any time. This makes teaching and learning a little easier as it is a means to reach all one's learners, especially those who are absent or those who need to catch up with the lessons, as mentioned by Olofsson et al. (2018).

ICT is also utilised to supplement oral presentations and taking notes for assessment purposes during lectures. Kennah (2016) is of the view that ICT may be utilised to support the content and PK (pedagogical knowledge) of the teacher in the classroom for effective educational practices and to improve the learning environment for learners (Kennah, 2016), which corresponds to what Farmery (2014) explains above. The researcher also found that Life Sciences teachers use ICT to assess practical work. Farmery (2014) clearly explains four main reasons why ICT is used in the classroom as stated above, and as a science educator, the researcher agrees with her. We live in a digital or 'tech-savvy' world, which is constantly changing. These changes require teachers to keep up to date with technology and to prepare our learners for the future. This is once again why ICT training for teachers is important.

Kennah (2016) notes that when it comes to education, ICT is split into two primary approaches: ICT *for* education, and ICT *in* education. ICT *in* education refers to components of Information and Communication Technology that are utilised in practical work in teaching and learning processes, which concurs with what Simon (2014) mentions: demonstrations in the classroom using ICT can be a very effective teaching method to enhance learning. Gent and Meyer (2016) also have an approach to ICT in education, and this may be utilised in the following ways: (a) instructive approaches, where teachers integrate technology in a passive and teacher-centred manner (e.g., teaching from technology); (b) cognitive approaches, using technology as a mind tool (e.g., using technology to represent authentic contexts and activities in learning, such as learning with technology); and (c) mediative approaches, using technology to mediate the construction of knowledge (e.g., use of tools to solve problems) (Gent & Meyer, 2016). ICT *for* education refers to the development of Information and Communication Technology for learning and teaching reasons (Kennah, 2016), and this is the reason that teacher training in ICT is important: to ensure that ICT is being used effectively.

ICT is a tool for assisting in the teaching and learning process and, according to Gent and Meyer (2016), there are different uses for ICT. They list them as collecting management information, such as learner records and other academic reports; automating management activities, such as preparing financial statements; development of school timetables, calculating and paying teachers' salaries, and reporting management information at various levels of the system, such as to the school head (Gent & Meyer, 2016). Gent and Meyer (2016) also state that ICT is utilised to create knowledge-generating workforces that are ICT-rich and that have ICT skills that are

introspective, creative and skilled at problem solving. ICT skills also enable people to utilise ICT to become more educated and resourceful, allowing them to better manage their own lives; to encourage all citizens to engage in society actively; to influence ICT choices that impact their lives; and to develop cross-cultural understanding of ICT (Gent & Meyer, 2016). There is also a method to employ technology as a facilitator of the educational process, implying that pedagogy and the teacher's role are crucial, as also mentioned by Farmery (2014). In terms of ICT, one of the most important success elements is that solutions must be adapted to the preparedness of schools to use technology (Gent & Meyer, 2016). It is clear that ICT is beneficial in both classroom and work settings. ICT makes daily tasks easier and more accessible regardless of where one is. It takes teaching from being teacher-centred to being learner-centred. It not only develops learners' thinking but also how teachers use ICT tools to extend the learners' thinking. ICT also provides Life Sciences learners with access to learning materials and to interacting with other learners. ICT makes group work easy, because then the teacher can create the groups on a platform such as Google Classroom where they can interact. In this way the teacher can also monitor the learners' responses and assist where necessary.

ICT allows access to a wide range of learning materials and information, as well as access to information sources at any time and from any location. It provides access to online libraries, open courseware, and a variety of educational materials. The teaching of many disciplines is made more engaging. It also provides distance education and online education for learners with impairments, as well as time saving on numerous everyday chores (Kaushlendra & Nawal, 2018). ICT may be defined as technology that assists us in recording, storing, processing, retrieving, transferring, and receiving information using ICT tools (Berahman et al., 2017), as mentioned by Gent and Meyer (2016), and Olofsson et al. (2018) above. ICT can also aid in fulfilling teacher-training goals, according to Kaware and Sain (2015). Ghavifekr et al. (2016) mention different reasons for using ICT tools. They found the following ICT tools being used in ICT classrooms:

Prepare items for a whiteboard that may be used interactively. For pupils to utilise, download or publish curricular content from/to websites or learning systems. Use video or audio clips to make a presentation. To make a graph, use a spreadsheet. To communicate with others, use email. Text with internet links and photos can be edited online (Ghavifekr et al., 2016, p. 50).

The interactive whiteboard is the new ICT device that is being implemented at schools (both primary and high). It facilitates presenting content as learners can engage interactively with the whiteboard. It also has the ability to increase learner participation in the classroom.

People must obtain information via ICT to keep up with the latest advances, according to Mohammadi et al. (2014). They further claim that by utilising ICT, students could learn without regard to time or location, which will better fit their needs. They allude to the employment of ICT in education as a sign of a new age or generation (Mohammadi et al., 2014). Teachers can shift from content-centred and teacher-centred teaching and learning techniques to student-centred learning in the classroom by using ICT. Mohammadi et al. (2014), and Gent and Meyer (2016), claim that Information and Communication Technology (ICT) includes hardware, software, networks and media for collecting, storing, processing, transferring and displaying information (voice, data, text and image), as well as associated services. They also divide ICT into two categories: Information and Communication Infrastructure (ICI) and Information Technology (IT). ICT is utilised in a variety of areas, including generating course materials, delivering and sharing information, communicating with students, professors and the outside world, creating and delivering presentations and lectures, academic research, administrative assistance, and student registration (Mohammadi et al., 2014), which creates an online portal for every learner to access (Kaushlendra & Nawal, 2018). An MEC in Ghana made it clear that teachers need to undertake professional development. This ensures that all teachers receive ICT training and integrate it in the classroom. ICT ensures that inclusive education takes place where it caters for all learners' learning abilities and, with ICT, the teachers are able to determine which difficult concept must be revised and re-taught. The use of ICT is important, especially in the Life Sciences classroom. ICT makes content and pictures come alive by displaying pictures and videos. ICT also facilitates studying for learners as they can do it from anywhere and they can access learning material at any time. This also allows them to communicate with teachers regarding the content. ICT software and hardware are means to teach effectively but also to expose learners to the ICT world and prepare them for it.

## **2.6 BENEFITS OF USING ICT IN CLASSROOMS**

Simon (2014) identifies the benefits of ICT in science education as follows:

For students, ICT may make science more exciting, real, and relevant. ICT provides for additional time in the classroom for observation, debate, and analysis, as well as more opportunities for communication and cooperation (Simon, 2014, pp. 18-19).

Simon (2014) also mentions that there are several advantages for teachers who wish to include ICT for effective impact in science teaching and learning in the classroom. These benefits are as follows: ICT allows teachers to better engage and motivate students; the internet increases access to authentic data for research; simulations allow teachers to demonstrate experiments that would not otherwise be possible in the classroom; data logging and digital video recording provide access to new sources of data in a wider range of experimental settings (Simon, 2014), and this is why students can generate recording notes and share presentations that they can utilise for examinations, either individually or collectively (Abdullahi, 2014). Other advantages of ICT include increased opportunities for teacher-to-teacher and learner-to-learner communication and collaboration, as well as increased opportunities for multiple technologies delivered by teachers; and to provide learners with additional resources to aid resource-based learning in the classroom (Simon, 2014). ICT has many benefits. As regards ICT in the Life Sciences classroom, ICT makes difficult work easier to understand and it allows learners to grasp content at their own learning level. Berahman et al. (2017) explain that ICT accommodates a wide range of learning styles, and that using ICTs assists teachers to become aware of different learners' abilities; in the process they become more flexible and give free, electronic access of information to learners, which make learners work independently as they are provided with the opportunities to use ICT tools (Berahman et al., 2017). ICT not only makes science fun and exciting, but it also allows learners to explore the content on their own. ICT motivates learners to learn and this eventually motivates the teacher to go for ongoing ICT training and to use ICT tools on a daily basis. ICT helps to do simulations and to display experiments that are not safe to demonstrate live in the classroom.

Abdullahi (2014) also identifies other benefits of using ICT: the first benefit is that ICT eliminates location and time constraints. He implies that students can communicate from anywhere on the globe, at any time. Students should be able to reach their teacher at any time and from anywhere if they require assistance. He also says that students may gather and communicate information among themselves at any time and from anywhere, and that ICT provides access to knowledge. Students may access global information through ICT, and ICT makes serving and sharing knowledge simpler. This is why it is so

important for teachers to use ICT to assist learners (Berahman et al., 2017). ICT is seen to be cost-effective in the sense that learners do not need to purchase anything. All the documentation and videos, and so on are uploaded and shared with the learners via a platform that the teacher uses. Therefore, the main benefit for the researcher is that ICT makes connecting and communication easy. Learners are not bound to certain times if the content and assessments are done on time. ICT also encourages learners to communicate more with other learners to share ideas about topics and concepts in Life Sciences.

According Berahman et al. (2017), if a teacher uses ICT in the classroom, learners become active participants rather than passive observers. A teacher's knowledge of using ICT assists learners to focus on their own tasks while also allowing them to help one another. ICT helps learners to become more self-reliant rather than depending entirely on a teacher (Berahman et al., 2017). Mofarreh (2016) offers reasons for what ICT can provide in a classroom setting. First, given the global transition into the digital age, ICT can provide teachers with a platform to both operationalise and construct practices to develop constructivist learning settings, and students can use ICT to satisfy the expectations of a knowledge society in terms of social, educational and workplace demands (Mofarreh, 2016). ICT improves students' self-confidence in teaching and learning by providing opportunities for them to address problems and to re-teach the learning curriculum in which they have difficulties. ICT may also be used to solve problems by using subjective or critical thinking. ICT plays an important role in enhancing, extending, and maintaining learning by providing motivation (Berahman et al., 2017). Other advantages of ICT include: (a) the development of an autonomous learning environment within the classroom; (b) cost-effectiveness, as mentioned by Berahman et al. (2017) above; (c) independence from distance and climate; (d) quick and fast access to information everywhere, as mentioned by Abdullahi (2014), and (e) the removal of social and economic obstacles (Kaushlendra & Nawal, 2018).

In addition, Kler (2014) highlights the following benefits of incorporating ICT into the teaching and learning process:

It is clear, according to Simon (2014), Berahman et al. (2017), and Kler (2014), that ICT motivates learners to study. Being able to display pictures and videos interests them and allows them to participate in the class. ICT also allows them to study at their own pace and time which causes the content to be delivered effectively. Being a teacher means to assess learners' work, when using ICT. It can make assessing work easy, and this also

allows the teacher to provide feedback to the learners through ICT tools. ICT makes delivering content easy. This can be done through PowerPoint presentations, for example, which increases the learners' interest, and this also allows the teacher to create content to the learners' learning ability. Using ICT can make communicating easy. ICT tools can be used to create communication platforms where the learners can communicate with each other as well as with the teacher (Kler, 2014).

Abdullahi (2014) concurs with Kler, (2014) about the importance of this. ICT makes sending content to learners easy, especially if the learner was absent and could not attend class. This ensures that the learner receives the content and can still catch up on work. ICT and its tools can also offer new teaching and learning methods. This would require the teacher to undergo teacher training to discover new techniques for teaching and learning. ICT can have a significant impact on the role of both the teacher and the learner. This allows the learner to explore further studies without the assistance of the teacher, which results in less teacher management (Kler, 2014).

This is why it is so important for teachers to use ICT to assist learners. ICT is seen to be cost-effective in the sense that learners need not purchase any material. All the documentation and videos, etc. are uploaded and shared with the learners via a platform that the teacher uses.

## **2.7 CHALLENGES OF INTEGRATING ICT IN TEACHING LIFE SCIENCES**

Kler (2014) identifies the same challenges as Simon (2014). She mentions that a lack of confidence has been mentioned by teachers as a key barrier to adopting ICT in the classroom. Another problem is a lack of teacher competence in the pedagogical integration of ICT in education, which is directly connected to teacher confidence (Kler, 2014). As previously stated, many teachers lack confidence in their ability to use ICT tools, which is why ICT training is critical (Okwara, 2016). Confidence also plays an essential role in the attitude of teachers when they share information. In addition, teachers' feelings about the use of ICT may affect teachers' attitudes toward their classroom activities might be either good or negative. The attitudes of teachers can thus either help or hinder the adoption of innovations, such as ICT (Okwara, 2016). Teachers' attitudes should be considered when it comes to the teaching and learning of students. Okwara (2016), and Kler (2014), explain that teachers' attitudes may be a barrier towards ICT, especially the teachers who have been in the field for a long time. Some of

them feel that they do need to know how to use ICT if they can teach the content from the heart, and some teachers are resistant to change or to new technology for teaching and learning, which makes ICT integration difficult. The researcher finds that this makes professional development and training very challenging. Teacher attitudes determine how the content will be delivered and how the learners will receive that knowledge. If teachers are negative about ICT, the learners will become so too.

Moreover, she discovered that teachers face two types of challenges when it comes to using ICT in the classroom: teacher-level challenges, which include a lack of teacher confidence and other competencies, which pose a challenge for most teachers. This is also mentioned by Kler (2014): that teachers do not obtain adequate ICT training (Kler, 2014). This training affects their integration of ICT in teaching and learning. Teachers are also affected by not always having access to ICT equipment that they can use to present a lesson. Moreover, the technical challenges also hamper integration of ICT in teaching and learning. As a result, they are forced to deal with ICT difficulties on their own. Consequently, instructors are hesitant to employ ICT in the classroom (Kler, 2014). This is true because teachers must prepare for the next day. When it comes to practical assessment, the teacher is required to prepare the classroom and get all the equipment ready, and this also is time consuming at school (Simon, 2014). This is supported by Abdullahi (2014), and Kler (2014), who mentions a few of the problems that teachers encounter with ICT, including the lack of time to acquire confidence and expertise with technology. In addition to the lack of time, there is also a lack of appropriate instruction, accessibility and technological assistance. Teachers do not have adequate time to use ICT; they spend the majority of their time preparing classes rather than incorporating technology (Abdullahi, 2014).

The science curriculum is overburdened with content assessment, requiring teachers to avoid utilising technology, as well as a lack of subject-specific advice for using ICT to assist classroom learning (Simon, 2014). Another issue that teachers face is the lack of money for ICT resources. The effectiveness of ICT in science education programmes relies heavily on money, which is not always available (Abdullahi, 2014). According to Abdullahi (2014), providing teaching materials is also a difficulty, he further claims that teachers require certain resources, facilities and equipment to show, explain and emphasise the lesson to ensure that learners understand it completely. The lack of time for teachers is a real problem in most schools, especially if a handicap such as load shedding happens. Teachers really lack time to use ICT tools effectively. Some become

discouraged owing to ICT tools or devices that might not work at a certain point. This causes more time to be lost as the teacher needs to fix the problem to be able to continue with the lesson. The challenge with ICT is also that most teachers do not want to be trained in ICT. They prefer to teach in the traditional way and are scared to change with the times (Kler, 2014), which results in time being wasted in writing on the blackboards.

There is a need to enhance science educators' working circumstances, such as overcrowding in classes and to recognise that their working circumstances have a direct impact on the quality of public education, yet some teachers have to work in really bad conditions (Abdullahi, 2014). Abdullahi (2014) further points out that the government must rehabilitate the image of teachers, particularly in the field of science. This may be accomplished through improving the working conditions of science teachers in the classroom. The teacher-to-learner ratio in schools is currently the greatest issue that instructors are facing (Abdullahi, 2014). He believes the teacher-to-learner ratio should be 1:35, while most schools have a ratio of 1:50. Nigeria has a teacher-to-learner ratio of 1:80. Currently, the ratio for teacher to learner is 1:54 in the public schools and this poses a real challenge for teachers as they do not have computer laboratories that are big enough to accommodate all the learners, according to (Abdullahi, 2014). Simon (2014) found that the use of ICT in Namibian classrooms is still restricted for a variety of reasons including a lack of ICT resources, teacher training, and ICT classroom competency. She also discovered that teachers lack ICT training and so lack the essential abilities to integrate technology in their classrooms. She furthermore discovered that professors at Teacher Training Colleges are not educated in ICT; hence, they lack the essential competence to train teacher candidates, making it impossible to teach or to use ICT in the classroom (Simon, 2014). Funding is a great challenge, not only in the ICT field but also in the education sector itself. Thus teachers feel uncomfortable even asking for resources. Some schools do not want to spend money on ICT equipment owing to a lack of finance.

One of the difficulties that Simon (2014), and Farmery (2014), also discovered was that a sluggish network made it impossible to use ICT tools during classes. Teachers encounter the following problems in a secondary school environment, according to Farmery (2014), which may be applied to Life Sciences classrooms: the lack of access to hardware and software, as well as bad software design, lack of a common vision for ICT usage, appropriate professional development, leadership, and support (Farmery, 2014; Simon, 2014). Simon (2014) also mentioned that time was another issue that

teachers had to deal with. This meant that teachers require extra time to prepare for handing out notes and developing assessment activities using ICT technologies to provide successful instruction (Simon, 2014). Once again, teachers' attitudes and views about ICT are equally essential, and there are additional problems that are particular to teachers, such as their beliefs about ICT. Teachers' time and PK are affected because of their lack of confidence in their own ICT abilities, which leads to their fear of losing power as their position in the classroom shifts (Farmery, 2014). Teachers might get the idea that ICT is there to replace them, making them hesitant to go to training opportunities. This will have an impact on the teachers' confidence as well as on their knowledge about ICT.

In the South African National Integrated ICT White Paper (2016), the following challenges are experienced with regard to ICT implementation in our schools:

ICT implementation in schools is very low. E-learning, especially in public schools is a challenge since there is ICT in the economic sector that overlaps with the education sector. The use of ICT can help alleviate educational disparities in schools and promote professional development for educators. This is a way to communicate with other people and to exchange ideas, but the cost of all ICT implementation and teacher training is very costly and poses a real challenge in the education sector (Department of Telecommunications and Postal Services of South Africa, 2016).

Both the National Integrated ICT White Paper and the White Paper on e-Education clearly outline that the government plans to improve ICT resources at schools. These policies must be revised to ensure that all the challenges are dealt with to ensure the smooth transition of an integrated ICT curriculum in all schools.

According to Gent and Meyer (2016), teaching and learning encounter obstacles at classroom level regarding the integration of ICT. To begin with, the integration of ICT is not always apparent to teachers, and programmes do not address this issue adequately. Second, teachers are slower to adopt or comprehend ICTs than learners are. Third, teachers have varying levels of ICT expertise. Fourth, teachers lack confidence in their ability to employ ICT in the classroom in front of their learners (Gent & Meyer, 2016). Other challenges of ICT integration, according to Gent and Meyer (2016), include a lack of integration of ICT in schools and districts; and school management teams making little use of ICT in carrying out their responsibilities. Finally, teachers and principals are isolated from district e-Learning units, resulting in a lack of knowledge of e-Education policies (Gent & Meyer, 2016). This links to Mofarreh (2016), who identified three key

impediments to ICT: instructors' lack of confidence in utilising ICT; teachers' lack of proficiency with ICT equipment (i.e., computer literacy skills); restricted access to support services; and ICT resources in science classrooms (Mofarreh, 2016). Other challenges mentioned by Berahman et al. (2017), are the lack of hardware and equipment, as well as network and software expansion, whether for schools, at schools, or for learners. They also point out that teachers' and managers' lack of familiarity with ICT is a significant barrier to its adoption (Berahman et al., 2017). Integration of ICT into teaching and learning activities is reliant on curriculum design and support for ICT to be successful and, according to Mofarreh (2016), the most important barrier to ICT deployment in schools is a lack of adequate ICT training for teachers and, he claims, teachers are limited to internet access in schools. Furthermore, there is a shortage of computer equipment for teachers and learners to utilise (Mofarreh, 2016). These are all challenges that teachers experience daily.

Ghavifekr et al. (2016) also mention the following challenges that are experienced when integrating ICT. There is an absence of efficient teacher training and a lack of adequate time to utilise or apply ICT in the classroom, as well as a lack of teachers' ability to use ICT (Ghavifekr et al., 2016). Ghavifekr et al. (2016) also found the following as challenges in using ICT tools for teaching and learning:

1. There are not enough computers
2. An inadequate number of PCs have internet access
3. There are not enough interactive whiteboards
4. There are not enough notebooks
5. Data is lost and / or school computers are in need of repair
6. Teachers have inadequate abilities
7. There is inadequate technical assistance available for teachers
8. Teachers have insufficient pedagogical support
9. Teaching topics and materials are inadequate
10. Pedagogical models on how to utilise ICT for learning are lacking
11. It is too difficult to incorporate ICT usage into curricula

12. The majority of teachers oppose the use of ICT in the classroom
13. There is a lack of enthusiasm evidenced by teachers (Ghavifekr et al., 2016).

Kaushlendra and Nawal (2018) mention that there are other challenges in ICT, namely that it necessitates large investments; it disregards individual differences; it fails to address cultural and social issues; it has accessibility issues, to name a few examples, and the knowledge gap is increasing (Kaushlendra & Nawal, 2018). As a result, when it comes to adopting or using ICT equipment, teachers face several obstacles. Infrastructure is also crucial when integrating ICT tools. ICT infrastructure must be updated constantly as a means to implementing ICT effectively. Not utilising these ICT infrastructures may cause these devices or tools to become mere ornaments.

Personal qualities, such as ICT competency, might potentially be a difficulty, according to Kler (2014). Teachers must be equipped with the required abilities to use computers and have the confidence to utilise ICT tools; thus, computer competency is critical in teaching and learning through ICT. Another issue raised by Kler (2014) is the lack of teaching experience. This relates to the impact of ICT integration on teaching and learning, as well as the experience of teachers with technology. In most education contexts, according to Kler (2014), teachers' workload is an issue. This includes, among other aspects, the acquisition of new skills, continuous upgrading, frequent student mail, the search for teaching techniques, and course maintenance, to name a few (Kler, 2014). All of these aspects make teachers feel overwhelmed and this poses a challenge with regard to teachers' attitudes to using ICT in the classroom.

In the institutions themselves there are certain problems. Institutional difficulties, according to Kler (2014), include the following: (a) continuing education: professional development programmes for teachers are critical because they guarantee that they acquire the required training to adopt properly and to use ICT in teaching and learning; (b) ease of access: not all education institutions have access to ICT integration resources such as hardware and software. They also lack access to infrastructure, which makes it difficult for teachers to use or to integrate ICT in their classrooms; and (c) technical assistance. Teachers are discouraged from utilising ICT in teaching and learning because there is little support from technical teams or institutions. Teachers are also afraid of device failure during classes, which might lead to their not utilising technology in the classroom at all in the future (Kler, 2014). Infrastructure is crucial when integrating ICT tools. ICT infrastructure must be updated constantly to implement ICT

integration effectively. Not utilising these ICT infrastructures, may lead to these devices or tools becoming ornaments.

## 2.8 THEORETICAL FRAMEWORK TPACK

The learning theory that was used for this study was the TPACK model, which stands for Technological Pedagogical Content Knowledge (Koehler & Mishra, 2009). This refers to the technical material that must be taught as well as the methodology that must be used to integrate ICT into teaching and learning (IGI Global, 2014). TPACK has been utilised lately as a conceptual framework in connection with how instructors use technology effectively in their classrooms. Content Knowledge, Pedagogical Knowledge, and Technological Knowledge are all represented in TPACK (Mofarreh, 2016).

Graham et al. (2014) describe the TPACK theoretical framework as the sort of knowledge a teacher needs to integrate technology effectively (Graham et al., 2014). It also emphasises how technological and content knowledge are linked or intertwined. This theoretical framework explains or supports the use of ICT in the classroom.

According to Graham et al. (2014), there are three major knowledge components that create the foundation of the TPACK framework. They are as follows:

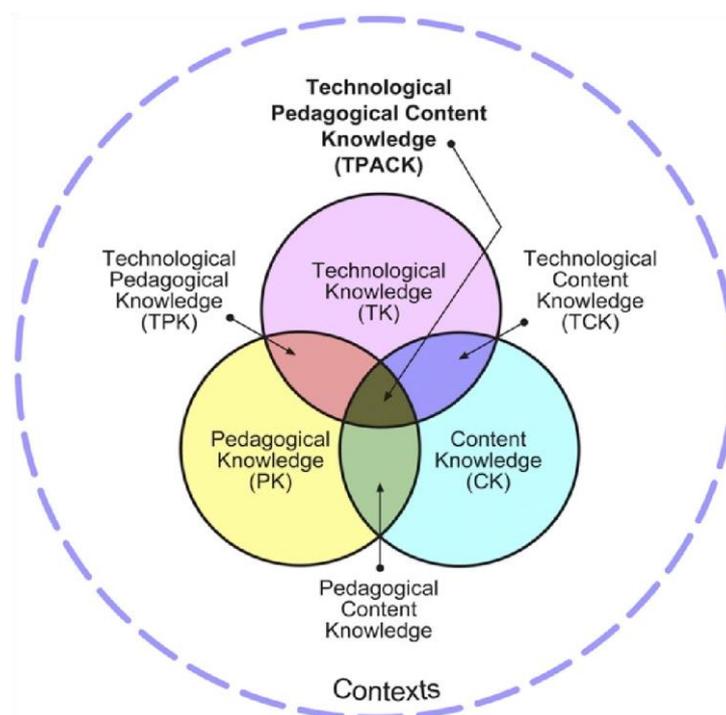
1. *Content Knowledge (CK)*: Any subject knowledge that a teacher is responsible for teaching is referred to as 'subject-matter knowledge'. This also refers to the teacher's subject / content area competence.
2. *Pedagogical Knowledge (PK)*: The teachers' knowledge of a range of instructional techniques, tactics, and procedures to improve learners' learning – the approach or method in which the teacher teaches to ensure that the subject is delivered in an appropriate and understandable manner.
3. *Technological knowledge (TK)*: this refers to a teacher's understanding of old and new technologies that may be integrated into the curriculum; the knowledge or training needed to teach, using technology.

The TPACK framework with its components are used as a lens for this study. The three bodies of knowledge are not to be used separately but they interact, restrict and combine one another (Graham et al., 2014), and (Kurt, 2019) namely:

1. *Technological Knowledge (TK)* refers to a working knowledge and understanding of the use of technology in teaching and learning and how it may both restrict and implement certain ICT educational activities (within the ICT).

2. *Technological Pedagogical Knowledge (TPK)* relates to the concept of knowing how to teach using technology and tailor-making the presentation of lessons to be interesting to learners.
3. *Technological Content Knowledge (TCK)*. Certain topics, problems or concerns are organised, represented and tailored, according to the use of an appropriate technology to accomplish learning outcomes.
4. *Technological Pedagogical and Content Knowledge (TPACK)* refers to a teacher's understanding of the intricate relationships between technology, pedagogy and content that allow a meaningful presentation of a technologically integrated lesson.
5. *Pedagogical Content Knowledge (PCK)* describes the link between pedagogical practices and specific learning objectives.

Figure 1 explains how the framework components are interlinked.



**Figure 1:** *TPACK Framework (Graham et al., 2014)*

This diagram explains the presentation of content to learners with the use of technology. Kennah (2016) defines technological knowledge (TK) as a grasp of both basic classroom technologies such as books and chalk, as well as more sophisticated technologies such as the internet and software. TCK, she continues, means teachers need to know or learn

about the technological tools used in their subject area (Kennah, 2016). TPK entails a teacher's use of technology tools in teaching and learning, as well as picking the appropriate technologies to employ while trying to improve their instructional methods. TPACK is the culmination of these many interests and combinations, relying on them, as well as the three broader underlying domains of content, pedagogy, and technology and this provides an effective foundation for teaching with educational technology (Kurt, 2019). Finally, TPACK refers to the concept of combining what educators know about effective teaching, subject knowledge, and educational technology in order for them to be successful in their classrooms while assisting learners' learning (Kennah, 2016). In this study, the participants were expected to show theoretical knowledge of selecting and using technology in teaching Life Sciences.

## **2.9 CHAPTER SUMMARY**

In this chapter the researcher discussed the ICT policy in education by referring to developing and developed countries, those being South Africa, Ghana, Chile, Saudi Arabia, Australia and Scotland. They have different views about using ICT in the science classroom. In most cases, secondary schools are better equipped with ICT resources than primary schools. The researcher also discussed the integration of ICT in science (Life Sciences) by providing definitions of ICT and how they fit into science education. A teacher has different roles in a classroom setting. The roles of teachers using ICT in the classroom were discussed, indicating that teachers are not only facilitators but also learners. The benefits of using ICT were discussed as well as the challenges that teachers face in the science classroom regarding ICT resources. Finally, the TPACK theoretical framework was discussed, which relates to using technology in the classroom. The next chapter presents the research methodology that was followed in this study.

## **CHAPTER 3**

### **RESEARCH METHODOLOGY**

#### **3.1 INTRODUCTION**

In Chapter 2 the researcher discussed the integration of ICT across developing and developed countries, the integration of ICT in the teaching and learning of Life Sciences, the role of teachers in integrating ICT into Life Sciences, the use of ICT in the Life Sciences classroom, benefits of using ICT in Life Sciences, the challenges of integrating ICT in teaching Life Sciences and the theoretical framework (TPACK). In this chapter, the researcher discusses the research method and design, followed by population and sampling, then data collection and procedure, which include the data collection strategies used. Data analysis and interpretation are also included, while measures to ensure trustworthiness and ethical considerations conclude this chapter.

#### **3.2 RESEARCH METHOD AND DESIGN**

This study used the interpretive paradigm stance. A research method is defined as an approach to designing a study, collecting information and the analysis of the data (McMillan & Schumacher, 2014). This refers to the different ways in which data are collected and analysed. According to Creswell (2014), a research method may be explained as the various forms of data collection, analysis and interpretation that researchers use in their studies. The researcher made use of the qualitative research approach. Qualitative methods are based on gathering data about naturally occurring phenomena (McMillan & Schumacher, 2014). The researcher chose this approach because it uses data that are verbal rather than numerical. Another definition, according to Creswell (2014), is that qualitative methods rely on text and image data that have unique steps in data analysis and draw on a diverse design.

A research design is defined as a plan for interventions and collecting data (McMillan & Schumacher, 2014), which is further regarded as describing the data collection protocols, including when, from whom, and under what conditions data will be gathered (McMillan & Schumacher, 2014). It is employed to collect evidence for data that will be utilised to answer the following study question: How do Grade 11 Life Sciences teachers integrate ICT in teaching and learning?

According to McMillan and Schumacher (2014), a case study refers to a detailed examination of a single aspect (McMillan & Schumacher, 2014). Creswell (2014) defines a case study as a qualitative design in which the researcher explores a programme, event, activity, process or one or more individuals in depth. The integration of ICT is the procedure in this study. Because the researcher employed more than one case study, a multiple case study was employed. Multiple case studies may be explained as different cases that are combined (McMillan & Schumacher, 2014) into a single whole for analysis. The researcher made use of three high schools in Beaufort West. The case studies were also bounded by time and activity with the researcher collecting detailed information using a variety of data collection procedures over a sustained period of time (Creswell, 2014).

### **3.3 POPULATION AND SAMPLING**

Population is defined as a group of people from whom a sample is taken and from whom findings can be extrapolated (McMillan & Schumacher, 2014). In this research, the population that the researcher used was Grade 11 Life Sciences teachers. Sampling refers to a group of individuals from whom data are collected (McMillan & Schumacher, 2014). As mentioned in Chapter 1, the researcher used purposive sampling: three teachers were requested to participate in this study. Life Sciences teachers who taught Grade 11 students and had more than two years of experience teaching Life Sciences were requested to participate in the study. The focus was on their integration of ICT in the teaching and learning of Life Sciences. Purposive or purposeful sampling refers to choosing varied sampling techniques as necessary for research objectives (McMillan & Schumacher, 2014). The three participants were Afrikaans-speaking because Afrikaans is the main language spoken in the local community, although one teacher was teaching in dual medium. A teacher joined the staff from a different high school and taught Grade 11 Life Sciences; hence the ability to use both languages.

### **3.4 DATA COLLECTION AND PROCEDURE**

As mentioned earlier, in this study the researcher conducted semi-structured interviews, and used document analysis and non-participant observation to gather data about the integration of ICT in teaching Grade 11 Life Sciences. After ethical clearance had been allowed at the three schools, the researcher made appointments with the participants to collect data using the data collection strategies. The dates and times were agreed upon.

The researcher also made sure that the schools' teaching and learning activities were not interrupted. The exchange of contact numbers took place for easy communication.

### **3.4.1 Document Analysis**

When referring to document analysis, it is defined as official documents. These official documents are artefacts that assist the researcher with the study (McMillan & Schumacher, 2014). The researcher used a checklist for document analysis. These documents were the minutes of the schools' staff meetings and ICT policies. The researcher requested the documents from the principals of the schools, and she used a checklist to gather data from the documents (Appendix G). The researcher studied and analysed the documents.

### **3.4.2 Non-Participant Observation**

During this study, the researcher was a non-participant observer as she was only observing and did not take part in the study in the classroom. A non-participant observer is an observer who does not take part in the study and may be defined as contrasting with a participant observer (McMillan & Schumacher, 2014). During the observation, the researcher made field notes for the duration of the research (McMillan & Schumacher, 2014). In qualitative observation, the researcher takes field notes on the behaviour and activities of individuals at the research site (Creswell, 2014). In this study the researcher took field notes as the focus was on the observation of the presentations of lessons by the participants. This was accomplished by the researcher physically observing lessons in the classroom when the participants presented their Life Sciences lessons. The researcher used a checklist to gather non-participant observation data (Appendix H). Each observation was undertaken in the presence of a teacher and each lesson was approximately 30 to 55 minutes long. The researcher based the non-participant observation on TPACK theory and observed whether the participants selected the correct ICT tool to present a lesson. This was to find out Technological Knowledge (TK). The researcher again looked at how technology was used to change the presentation of lessons and lastly (TPK), how the use of ICT enhanced the achievement of the lessons' learning outcomes (TCK). The researcher recorded the observations of every lesson and made notes, with the permission of the participants. The researcher observed three Life Sciences lessons. Two of the participants used interactive whiteboards, data projectors and laptops in their classrooms daily, whereas the other participant used the school's library when teaching with ICT tools.

### **3.4.3 Semi-Structured Interviews**

On introduction, the researcher reminded the participants of the purpose of the study and why they were being interviewed. Every participant was asked to choose a date and time for the interview that would not affect formal teaching time. The data from the interview was recorded and transcribed manually by the researcher. Because the interviews were conducted in Afrikaans, the interview transcripts were translated from Afrikaans into English by a professional translator. During the interviews with the participants, the researcher used open-ended questions (Appendix E) to which all the participants responded. The questions were about how the participants used ICT as well as the challenges they face in teaching and learning Grade 11 Life Sciences. The interviews lasted between 30 and 60 minutes as the duration of the interviews depended on the discussion between the participants and the researcher. All the interview sessions were recorded after requesting permission from the participants.

## **3.5 DATA ANALYSIS AND INTERPRETATION**

According to Creswell (2014), data analysis in qualitative research occurs in tandem with other aspects of the development of the qualitative study such as data gathering and report writing (Creswell, 2014). The researcher compiled a summary of the findings and combined it with the literature study to establish how ICT integration was done in the teaching and learning of Life Sciences in Grade 11 in Beaufort West, Western Cape. The researcher used qualitative data analysis, which is also referred to as inductive analysis for which McMillan and Schumacher (2014) emphasise the process of coding, categorising, and interpreting data.

### **3.5.1 Document Analysis**

In terms of data analysis documentation, the researcher used the three schools' checklists to analyse data. She created a table with the three names of schools written as schools A, B, and C. Data from the checklist were analysed in terms of ICT policies at schools and the minutes of the staff meetings. With regard to the ICT policies, the researcher looked at the availability of the ICT policies and whether they were used or not. In terms of the minutes, the focus was on whether, at the schools' meetings, discussions took place about the use of ICT in teaching and learning.

### **3.5.2 Non-Participant Observation**

The researcher was a non-participant observer in this study. The researcher used a checklist to analyse non-participant observation data. In the non-participant observation, the focus was on the participants' technological knowledge, technological pedagogical knowledge, and the technological content knowledge. Data were analysed in tabular form; letters were used and not the participants' names to maintain anonymity and confidentiality (Appendix I). The discussion took place regarding their choice of ICT tools, how they were used and whether there was enhancement of the achievement of learning outcomes.

### **3.5.3 Semi-Structured Interviews**

All interview responses were manually transcribed by the researcher and forwarded to a professional language translator for translation from Afrikaans to English. The participants' names as well as the high schools' names were removed to protect their identity for this study. With regard to analysis of the semi-structured interviews, the researcher used coding to analyse the data. The researcher scrutinised every gathered data document of the semi-structured interview transcript by hand, taking notes and establishing codes for every word, term or phrase (Creswell, 2014). According to Creswell (2014), in qualitative approaches there are several steps of data analysis, ranging from sorting raw data into themes or descriptions to writing up results based on the data obtained. In this study all the responses were organised in a tabular format, to facilitate coding. The same colour was assigned to a theme that included the same word or phrase (Appendix F). From all the coded data, themes emerged as shown in Appendix G. Nine (9) key themes were identified and explored from the topics that arose.

## **3.6 MEASURES TO ENSURE TRUSTWORTHINESS**

Trustworthiness in this study was maintained by employing credibility, which is defined as the degree to which the results resemble reality and are deemed accurate, reliable and reasonable (McMillan & Schumacher, 2014, Korstjens & Albine, 2018). During the research, the researcher implemented prolonged fieldwork. Long-term fieldwork was extended by taking daily field notes and reflecting on them. The researcher did, however, pay a preliminary visit to the schools to create a sense of familiarity. The researcher performed observation for a lengthy period (1 week) to collect data which contributed to the study.

Member checking occurs during data collection when participants' information is informally checked for correctness (McMillan & Schumacher, 2014, Korstjens & Albine, 2018). The researcher returned to the teacher participants with the obtained data for clarification and confirmation of the information. The researcher also used triangulation, relating the use of many data sources to confirm the data (McMillan & Schumacher, 2014). These multiple sources were the non-participant observation notes, open-ended interview answers and document analysis. To corroborate information, the researcher backed up the information with sources in analysing and discussing the results.

### **3.7 ETHICAL CONSIDERATIONS**

Legal and ethical issues, according to McMillan and Schumacher (2014), imply that the researcher is accountable for the welfare and protection of the rights of the participants in the study. According to Creswell (2014), researchers must anticipate the ethical issues that might arise during the study. The researcher applied for ethical clearance from UNISA (Appendix A) and then used this certificate to apply for permission to conduct the study from the circuit manager in Beaufort West (Appendix B) as well as from the principals of the three high schools (Appendix C).

The participants signed a consent form to participate. To ensure the participants' anonymity and privacy, the researcher reassured the participants that no other person would have access to their information and data (Kumar, 2019). The aim of the research was clearly defined, giving the school and teacher participants a clear understanding of what the study was about and why it was being conducted. This protected their privacy, secrecy, and anonymity. Confidentiality and anonymity refer to the fact that the participants should be unidentifiable in print (McMillan & Schumacher, 2014). This was undertaken by assuring the participants that their identities would not be revealed, as disclosed in the consent form. The researcher made sure that the participants understood that the study was voluntary. They were not obliged to participate. The researcher maintained the confidentiality, privacy, and anonymity of the study by only allowing the participants with approved consent forms to participate and only collected documents for the study with the permission of the participants. When participants' identity is secured in the study, it demonstrates privacy, compassion, and justice. The schools and teacher participants were labelled with letters of the alphabet, such as Teacher A and School X. These are referred to as pseudonyms.

### **3.8 CHAPTER SUMMARY**

In this chapter the researcher defined the research design and the method that was used during the study. The researcher applied the qualitative research approach to three high schools in Beaufort West. All the schools possessed ICT equipment. It was a multiple case study, using three participants who only taught Grade 11 Life Sciences with the use of ICT. One participant taught in dual medium. The researcher also explained what instrumentation techniques would be used and how the collected data would be analysed. Measures to ensure trustworthiness and credibility were discussed as well as the ethical considerations and the process the researcher had to follow to gain permission to conduct the study.

## CHAPTER 4

### PRESENTATIONS AND DISCUSSION OF FINDINGS

#### 4.1 INTRODUCTION

In the previous chapter the researcher described the research method and design, followed by the population and sampling, the data collection procedure and the data collection strategies used. The data analysis and interpretation are included in Chapter 3. Measures to ensure trustworthiness and ethical considerations conclude the previous chapter. This chapter further determines how Grade 11 Life Sciences teachers integrate ICT in teaching and learning. The discussions and presentation of findings are set out in this chapter.

The study sought to investigate how Grade 11 Life Sciences teachers integrate ICT in teaching and learning.

The following sub-questions were addressed:

- How do Grade 11 Life Sciences teachers overcome challenges when they integrate ICT in teaching and learning?
- What are the Grade 11 Life Sciences teachers' views on the use of ICT in teaching and learning?
- How are Grade 11 Life Sciences teachers supported in the integration of ICT tools in teaching and learning?

The findings and the discussion are presented simultaneously.

#### 4.2 DESCRIPTION OF PARTICIPANTS AND SITES

##### 4.2.1 Participants' Biographical Details

Three Life Sciences teacher participants volunteered to be part of this study. Table 1 below shows their biographical details, respectively labelled Participant A, B, and C.

**Table 1:** *Participants of the Three High Schools*

Participant	Gender	Age	Years teaching Life Sciences	Qualification
A	Male	30–35	2 years	BSc and PGCE
B	Male	55–60	20 years	Diploma
C	Male	30–35	2 years	BEd degree

The participants' ages ranged from 30 to 60 years. One participant was between 55 and 60 years of age. The other two participants were between 30 and 35 years of age. The participants were all men. Their teaching qualifications differ according to Table 1. Participant B has a Diploma in Education; Participant A has a Bachelor of Science (BSc) degree and a Postgraduate Certificate in Education (PCGE); while Participant C has a Bachelor of Education (BEd) degree in the Further Education and Training (FET) phase.

Regarding their teaching experience, two of the participants have two years' teaching experience, whereas the other participant had more than 20 years' experience. All experience was related to teaching Grade 11 Life Sciences. All three participants were high school teachers who taught Life Sciences to Grade 11 learners and used ICT in their teaching. Two of the participants received ICT training at university, whereas the other participant received ICT training from workshops. Two of the participants teach Life Sciences in Afrikaans and the other participant teaches in dual medium for both Afrikaans and English learners. The reason for choosing Afrikaans is the fact that Beaufort West in the Western Cape is an Afrikaans-speaking community.

#### 4.2.2 Schools

Three high schools were chosen from a minor town in the Western Cape. ICT resources were available at all three high schools that were considered. In the study, each of the three participating high schools and participants were assigned a letter of the alphabet (pseudonym). This was done to safeguard the schools' and the teacher participants' privacy and anonymity.

**Table 2:** *School Roll of the Three High Schools*

<b>School</b>	<b>School X</b>	<b>School Y</b>	<b>School Z</b>
Teachers	16	32	40
Learners	327	954	1 460
HODs (Heads of Department)	2	9	7
Grade Heads	5	5	5

Table 2 illustrates that School X is situated in the urban area of Beaufort West. This is a semi-private school with a school roll of 16 teachers, 327 learners, 2 HODs and 5 Grade Heads (Grades 8–12). The medium of instruction at this school is both Afrikaans and English. School Y is situated in the rural area of Beaufort West. This is a public high

school with a school roll of 32 teachers, 954 learners, 9 HODs and 5 Grade Heads (Grades 8-12). The medium of instruction at this school is Afrikaans. School Z is also situated in the rural area of Beaufort West. This is a public high school with a school roll of 40 teachers, 1 460 learners, 7 HODs and 5 Grade Heads (Grades 8-12). The medium of instruction at this school is Afrikaans. All three high schools have data projectors, whiteboards, and computer laboratories. The significance of the statistics given is to highlight the influence that the number of learners may have when teachers employ ICT resources, as well as the teacher-to-learner ratio, which can have an impact on teaching and learning.

### **4.3 DATA ANALYSIS**

Data analysis was done in the following ways in order to address the research question: How do Grade 11 Life Sciences teachers integrate ICT in their teaching and learning?

#### **4.3.1 Data Analysis Process**

##### **4.3.1.1 Document Analysis**

All six document analysis checklists were written in English and were used at all three high schools; each new day required a new checklist.

The checklists were used to analyse the data of the gathered document. As mentioned earlier in this study, the documents that were studied and analysed were ICT policies and the minutes of the schools' meetings. The researcher requested the aforementioned documents from the principals of the three high schools and also asked for the schools' ICT policy to determine whether the schools had one and how it was being implemented. All three high schools had an ICT policy.

The findings revealed that all three high schools had ICT policies. Two of the high schools (Y and Z) used the ICT policy of the Western Cape Education Department (WCED) with amendments that related to the schools. The amendments were in the form of how ICT devices were used and secured; who is responsible for the ICT tools; and when and where the ICT devices were used, according to CAPS. Other amendments mentioned in the ICT policy are also how teachers file, and that master files should be created for the subject. The WCED policy outlines why it had been created (to protect ICT equipment at the school and to ensure that effective teaching takes place), and how teachers should be monitored in terms of the policy. This includes that teacher must

make sure that learners log into the computers and that teachers should also log onto the main computer, which controls all the other computers in the laboratory.

School X created its own ICT policy. The ICT policy stated which teachers (teachers who were teaching Computer Applications Technology) were responsible for the ICT equipment. The policy also outlined the assessment plan for the year as well as lesson planning and preparation. Every teacher and learner had to sign a form when using the ICT tools, especially learners who took Computer Studies such as Computer Applications Technology. The learners' parents also had to sign a form which indicated that if anything went wrong with the ICT tools, the parents would be responsible for the replacement of these tools. The policy states when the teachers could use these devices and what periods of time were allocated to the use of devices. An example of the form appears in Appendix I. The findings of the staff meeting minutes revealed that teachers were requested to attend ICT workshops and to use ICT in teaching and learning.

#### **4.3.2 Semi-structured Interviews**

The participants were asked different open-ended questions during semi-structured interviews. Their answers were as follows, according to the themes that emerged, and are linked to the literature review which substantiates the findings.

##### **4.3.2.1 The Use of Traditional Methods of Teaching**

The participants were asked how they overcame the challenges that they experience when they integrate ICT into their teaching. The findings revealed that two of the participants went back to the traditional way of teaching by using the blackboard and making use of WCED programmes to overcome any barriers that they encountered when integrating ICT into their teaching. The other participant (participant C) indicated that the best way to overcome any barrier when integrating ICT into teaching is to use a traditional method of teaching.

When teachers are unable to use technology in the classroom, they make use of the next best thing, which is to resort to using the blackboard and handing out paper worksheets. As an educator, the challenges that the researcher encounters most is the loss of power at school owing to load shedding, as stated by one of the participants:

*If there is no power, I work off the board (blackboard) (Participant A).*

This makes teaching with ICT tools impossible and basically compels the teacher to use the blackboard to deliver the content. This also explains why science teachers need a back-up plan to make sure that the content is conveyed.

According to Simon (2014), commenting on the teachers' use of ICT in teaching Life Sciences, she determined that there are different uses for ICT in education. She listed the following uses of ICT for teachers that may be divided into two categories. The first is the supportive ICT use, and the second is the use of ICT in the classroom. According to her, the supportive use of ICT refers to ICT for the proactive / interactive and the administrative teaching, which makes teaching and learning easy, such as student administration, the preparation of worksheets, developing assessment activities, tracking learners' learning progress and many more. The second category, classroom ICT, is aimed to support and enhance the actual teaching and learning process. These consist of the use of computers for demonstration purposes, practice activities, modelling, the representation of complex or difficult knowledge elements, discussions on topics, collaboration, project work and interactive activities, to mention a few (Simon, 2014).

Another aspect of ICT is that it provides access to ICT in education, which can help individuals to create a competent workforce and increase social mobility to compete in a global economy (Yuen & Hew, 2017). ICT can also enhance learning by providing learners with new sets of skills such as reaching those with poor or no access and facilitating and improving the training of teachers, as well as minimising costs associated with the delivery of traditional instruction (Yuen & Hew, 2017).

#### **4.3.2.2 Teaching Experience**

When the participants were asked how long they had been teaching Life Sciences in Grade 11, the findings revealed that two of the participants (*Participants A and C*) have *two years'* experience of teaching Life Sciences in Grade 11 and one indicated *twenty years'* (*Participant B*) experience of teaching Life Sciences in Grade 11.

Participant A: *I have been teaching Life Sciences for Grade 11 for two years.*

Participant B: *I have twenty years' teaching experience in Grade 11 Life Sciences.*

Participant C: *I have been teaching for two years now.*

Experience in any subject is crucial. When educators are not trained in a subject, they find it difficult to teach the content. They feel incompetent and therefore teachers must receive professional development in ICT (Farmery, 2014) because their lack of

experience may be a barrier to the success of learners. According to the findings, the more experience teachers have in a subject, the more comfortable and equipped they feel to deliver the content. Thus, according to Abdullahi (2014), teachers face difficulty when it comes to gaining experience in ICT. Experience in teaching Life Sciences also assists the participants to know the content very well and could assist them to choose the relevant ICT tool for their lessons. This can make teachers feel that they can use ICT for meaningful pedagogic purposes (Farmery, 2014). That is why teachers' teaching experience is associated with student achievement in subjects. Because of teachers' experience throughout their teaching careers, their learners are more likely to succeed at school (Podolsky, 2016).

#### **4.3.2.3 Knowledge of ICT**

The participants were asked, *in all your years in teaching Life Sciences, have you received training in ICT?* The findings revealed that two of the participants received training during their university years and one participant indicated that he received training in ICT but not at university. Participant C answered, *at university I was trained in Life Sciences ICT.*

Technology is part of our daily lives; it has improved our communication and made education more convenient, such as through online courses (Stojanov, 2017). More and more learners are exposed to the new evolving world of using ICT. This promotes better understanding by learners in the Life Sciences. According to Hanimoğlu (2018), technology is designed to increase students' capacity to make judgments in the future and to boost their successes in many disciplines.

Thus, it is important for educators to be trained in ICT. As mentioned above, the newly trained teachers receive training at their institutions and, according to the findings, ICT-trained teachers find the use of ICT tools in the classroom easy. Older teachers find it more difficult to use the new technology. This explains why Farmery (2014) states that the use of technology places a burden on teachers and that they must receive professional development in ICT. In receiving training in ICT, the teachers are not only trained with new sources of information, but they are also trained in how to utilise resource-based learning in the classroom (Simon, 2014).

#### **4.3.2.4 Increase the Ability to Understand ICT and the Use of ICT**

When the participants were asked how they felt about using technology in the classroom, the findings indicated that all three of the participants found that technology helps to make teaching easier and more interesting. The findings also indicated that technology is what the learners prefer nowadays. Two of the participants answered:

*Technology facilitates my teaching. (Participant A), and Technology is a benefit and helps learners to experience the content virtually. (Participant B).*

Technology helps to explain difficult terms, which makes teaching easier by using different ICT images, sounds, animation, etc. (Yuen & Hew, 2017). The findings show that teachers are keen to use technology in the classroom. It also explains how ICT can broaden the learners' knowledge. ICT makes science come to life, as teacher Participant C explained in the interview and as stated above, technology is what the new generation of learners prefer. ICT also helps to organise administrative work, prepare lessons, create activities electronically and track learners' learning progress, to mention a few (Simon, 2014).

Technology, more specific ICT, makes experiments that are too dangerous to do in the classroom easy, such as using simulations and to record data (data logging) during practical work. About administration work, ICT makes searching for information and monitoring lessons more efficient and easier (Simon, 2014).

#### **4.3.2.5 Experience of Using ICTs in Teaching and Learning**

Every participant was asked how long they had been using ICT tools. The findings revealed that two of the participants (Participants A and C) have been using ICT *since university* and one participant (B) has been using ICTs for *approximately ten years*.

Participant A answered, *From my studies to education (teaching).*

Experience in ICT is very important. Teachers must know how to use it and how to incorporate it into their daily teaching routine. As stated in the first question, the more experience teachers have, the more competent and comfortable they will feel when using ICT. According to the findings, only one teacher was not trained in ICT at university. The teacher had to receive training from the school and through workshops that were offered.

According to Simon (2014), ICT is believed to add value to both teaching and learning of science in the classroom. In Abdullahi's (2014) overview of ICT in education, he defines ICT as a critical tool that is used for preparing and educating students in the skills that are required for the global workplace. According to Farmery (2014), there are two types of approaches about ICT. They are the top-down approach and the bottom-up approach. She explains the top-down approach as the introduction of technology by the organisation. This will help the teachers, as it indicates how teachers are expected to use it. She then explains the bottom-up approach as the teachers exploring the technology themselves and then sharing it among their colleagues (Farmery, 2014). Abdullahi (2014) mentions that ICT can improve communication skills as well as increase the deep understanding of the learning tools and concepts that are required to be taught in the science classroom.

Another role of the teacher is to use ICT more for teaching by gathering information about a certain topic. This will give teachers more time to teach by using ICT, than to do planning or lesson preparations. Teachers are the most important component when it comes to ICT integration in the classroom. In most cases, technology places a burden on teachers, in terms of their skills and knowledge, to use ICT in the classroom (Farmery, 2014). Farmery (2014) views the role of the teacher as receiving professional development in ICT. With professional development, teachers increase their own skills, leading to the increase in personal skills that usually leads to an increase in confidence and the likeliness of using ICT in a classroom setting (Farmery, 2014).

#### **4.3.2.6 The Different Ways of Presenting Subject Content**

When the participants were asked what forms of technology they use and how, the findings indicated that two of the participants use PowerPoint presentations as a form of technology and the other participant revealed that he uses data projectors and whiteboards as forms of technology to deliver content to learners. Two of the participants answered:

*I compile PowerPoint slides containing all the subject content and show it to my learners via the projector (Participant A), and Apart from the common PowerPoints and videos, I also use simulations (Participant C).*

The answers above indicate that two of the three participants use technology daily. Regarding the specification of the question, most participants use laptops, data

projectors and whiteboards to display PowerPoint slides to learners. As stated in the interview questions, all these slides contain content and videos to accommodate every learner's learning ability.

During the interview, one of the participants stated that ICT in Life Sciences will enliven the subject. It is also clearly stated in the article on ICT in Education in Asia that ICT has the potential to bring abstract concepts to life by using images, sounds, movement, animation, and simulations to explain concepts (Open, 2014). Olofsson et al. (2018) state that in the 21st century the use of digital tablets and any other mobile devices prepares learners for further studies and work.

#### **4.3.2.7 The Support from the School**

When the participants were asked what support Grade 11 Life Sciences teachers receive to integrate ICT into their teaching, the findings revealed that two of the participants received support from experienced educators and one participant received support from the Department. Two of the participants answered:

*General ICT training is offered by CTLI (Participant C), as well as experienced educators at the school; and I sometimes get sources from my subject advisor, (Participant A).*

The above findings clearly indicate that the participants did receive ICT support. It is imperative that they do receive support, which makes ICT training and the use of the ICT tools easier in the classroom. This support should be ongoing for professional development training in ICT (Farmery, 2014). Teachers need to receive support from the technical team at institutions (Murungi & Mwoma, 2018) and from the school staff as well.

#### **4.3.2.8 The Use of ICT Tools**

When the participants were asked how the use of ICT could enhance learning in Grade 11 Life Sciences, the findings revealed that two of the participants use data projectors daily, which helps to enliven Life Sciences in the classroom and to improve learners' learning experiences. The other participant indicated that *ICT could enhance learning by stimulation and the eagerness to learn which is promoted in the subject* (Participant B). The findings also indicated that one of the participants uses diagrams and videos to promote learning.

In Life Sciences it is important to do practical work. The learners must see a demonstration or an image physically. The practical work makes science come to life. An example would be the dissecting of a kidney. The learners must open the kidney by cutting and examining the insides. This usually helps learners to understand the content better, but with the help of ICT, this can be done by showing the learners a video instead.

ICT helps to prepare learners for the future, for the use of ICT in everyday life and work and it provides learners with new sets of skills (Farmery, 2014; Yuen & Hew, 2017). ICT makes science interesting and allows time for aspects such as discussions, observation, and analysis in the classroom (Simon, 2014).

#### **4.3.2.9 The Use of ICT Improves Teaching**

When the participants were asked whether their involvement with ICT tools has impacted their teaching and practice in any way and how, the findings indicated that two of the participants' teaching and thinking have been impacted since using ICT. In terms of how the involvement of ICT tools impacted their teaching and teaching, two of the participants indicated that *it has extended visions, it stimulated the learners' behaviour and it also helped to broaden the educator's subject knowledge* (Participant B). The other participant, who indicated that the involvement of ICT tools had impacted him, revealed that the use of ICT creates *a very positive learning environment and maintains the learners' concentration* (Participant C). Only one participant revealed that his thinking and teaching have remained the same; however, his teaching has improved.

From a Life Sciences teacher's perspective, the researcher feels that using ICT facilitates preparing lessons and makes delivering the content fun in an understandable way. ICT also makes explaining difficult concepts easy. This allows for videos to be used and experiments to be recorded beforehand, which might be seen as too difficult to do in the classroom. During observation, the researcher noticed that after every lesson, the participant used a video as a summary of the lesson. After the video, the learners were presented with an activity, which they had to complete at home. Simon (2014) indicated that teachers use ICT more often for specific activities, which represents an opportunity that encourages ICT usage.

#### **4.4 PRESENTATION AND DISCUSSION OF NON-PARTICIPANT OBSERVATION**

Not one of the three participants provided their lesson plans. All three participants used a diary to write down what they intended to do and when they intended to do it. The

diaries were unavailable because at the beginning of every week the participants submitted their diaries to their Heads of Department (HOD) to be checked. The participants also did not have a lesson plan template or a lesson plan file. The researcher made an appointment to go back to the participants to do non-participant observation. A synopsis will be given at the end on the theoretical framework (TPACK).

#### **4.4.1. Lesson Planning**

The findings revealed that Participant A had no formal lesson plan template, and no lesson plan files were used. Participant A's lesson plans were outlined in his diary. Participant A indicated the topic and what would be done every day until the content was covered. It also contained information on what images and videos would be used for every lesson. Participant B indicated that they did not use formal lesson plan templates any longer. All of Participant B's lesson plans were written in his diary. It also outlined what would be done about the practical tasks that Grade 11 learners had to do and what type of questions would be asked in the practical task. Participant C also did not use lesson plan templates. All of Participant C's lesson plans were outlined in his diary and the participant had a separate book for the type of activities that would be provided to the learners to complete.

During the observation, the researcher came to the following conclusions when going through the checklist and notes of the non-participant observation process:

#### **4.4.2. The Participants' Technological Content Knowledge (TCK)**

- During the non-participant's observation, the findings indicated that Participant A possessed excellent knowledge of Life Sciences and the use of ICT in teaching and learning. This is because Participant A first completed his BSc (Bachelor of Science) degree in Biodiversity before completing a PGCE (Postgraduate Certificate in Education). The content was delivered very clearly and was easily understood. Participant A used technology throughout the lesson that illustrated TCK. Participant A created PowerPoint slides that were short and to the point, which made copying the work easier for the learners. The participant explained both the scientific name of the moss plant as well as the common name. The videos that the participant used were short, making watching them easy for the learners. The use of videos showed TCK (Koehler & Mishra, 2009; Kennah, 2016). The sharing of subject content was done in a different way in ensuring that learners were actively involved in the lesson.

- Participant B has sound knowledge of the Life Sciences content as he has been teaching Life Sciences for the past 20 years. Participant B went through the questions with the learners to ensure that they understood what they had to do. The practical task was very interesting as the participant made use of pictures and figures. All the questions were set from low- to high order. The participant explained, however, that after all the content had been covered the participant would take the learners to the computer laboratory to watch videos on the content. The use of videos showed how the presentation of content had been done (TCK) (Koehler & Mishra, 2009; Kennah, 2016).
- The findings also indicated that Participant C has very good knowledge of the Life Sciences content as well as the use of ICT to deliver Life Sciences lessons. ICT tools (laptop, data projector and whiteboard) were used throughout the lessons. Participant C also created PowerPoint slides of the content. He explained that he took textbooks home to prepare the PowerPoint slides. Participant C also adjusted the content information that was received from the participant's subject advisors to the level of the learners. The presentation of Participant C's lesson and adjustment of content showed TCK as he used ICT tools to make the lesson interesting (Koehler & Mishra, 2009; Kennah, 2016).

#### **4.4.3. The Participants' Technological Pedagogical Knowledge (TPK)**

Participant A engaged with his learners throughout the lessons. He also used pictures from the textbook to explain more difficult concepts. Participant C encouraged his learners to take part in the lessons. In the classrooms of both Participants A and C, the learners were actively involved in the lesson, and they constantly asked questions.

#### **4.4.4. Teaching Strategies (TPK)**

- The findings indicated that Participant A used formal teaching and group discussions with the learners as a teaching strategy. Learners were actively involved throughout the lesson, which showed a learner-centred approach. Participant A constantly asked questions to challenge the learners' thinking. Learners also constantly asked him questions as he was explaining the content. The technology was incorporated throughout the lesson since the participant used the ICT tools daily and videos were displayed to the learners after each section of the work had been covered. Participant A used PowerPoint slides to deliver the lessons. This showed how Participant A

revealed his technological pedagogical knowledge (TPK) (Koehler & Mishra, 2009; Kennah, 2016). Instead of standing in front of the class and teaching learners, he changed the way of presenting a lesson. All videos were short summaries of what the topic was about. The participant showed a combination of learner-centred approach and the use of ICT tools (TPK).

- Participant B used formal teaching as a strategy throughout his lessons. In his lesson presentation, both the participant and the learners were actively involved in the lessons. Learners constantly asked questions, especially regarding the life cycle of the fern plant. The participant used a teacher-centred approach as teaching was dominated by the participant using a video.
- Participant C used formal teaching as well as group discussions as a strategy. Participant C also encouraged his learners to do independent reading before coming to class. This made class discussions easier. Participant C used technology daily. During each lesson that was observed, the participant used ICT tools (a laptop, data projector and whiteboard). Participant C also used the whiteboard to draw structures of the viruses and how they attach to their host. The learners took part in the lessons and asked questions as the participant was explaining the content on the PowerPoint slides that he had created. All the important words were written in colour or in bold. Participant C also explained that those words were important to know, especially for the upcoming test cycle. The participant incorporated technology daily, using only ICT tools in the classroom (TPK). (Koehler & Mishra, 2009; Kennah, 2016).

#### **4.4.5. Summaries of Major Important Points**

The findings indicated that the participants' TK was shown using different ICT tools to present their lessons. The TCK was indicated when three participants made use of different ICT tools to make the content easier. TPK was also shown when the three participants delivered their lessons using different ICT tools. The theoretical framework, TPACK, is suitable for this study as it focuses on technology. It also focuses on participants' technological content knowledge (TCK) and how they use technology to present lessons in their classrooms. TPACK is used to interpret the findings by determining the participants' knowledge of technology (TK), as mentioned previously. It is also used to determine how the participants use technology in the classroom and what ICT tools were used to present the content. This is where the TPACK comes in, which describes Technological Knowledge (TK) as having a grasp of the common technologies

that are utilised in classrooms, such as the internet and software, according to Kennah (2016). TPK, she added, entails a teacher's use of technology tools in teaching and learning, as well as picking the appropriate technologies to employ while trying to improve their instructional methods. Therefore, TPACK is important for this study.

#### **4.5 CHAPTER SUMMARY**

This chapter contained the results that were analysed during the research study. The analysis also connects to the research questions, as stated in the introduction. Three high schools were selected in the Western Cape Province, which were each allocated a code name (pseudonym) to protect the identity of the school. From the three high schools, only Grade 11 Life Sciences teachers participated. This resulted in one participant per school, who were also given a code name (pseudonym) to protect their identity. Three Grade 11 Life Science participants were interviewed for this study. All three participants were males with a minimum of two years' experience and a maximum of twenty years' experience in teaching Life Sciences for Grade 11. All interviews were conducted in Afrikaans and had to be translated into English. The checklist that was used was in English.

All the analyses were completed. All data were analysed manually. During the coding process themes emerged and were used to analyse data. Nine (9) themes in the semi-structured interviews resulted from the study: a) Teaching experience, b) Increase the ability to understand ICT and the use of ICT c) Experience of using ICT for teaching and learning, d) The different ways of presenting subject content, e) The support from the schools, f) The use of the traditional method of teaching, g) The use of ICT tools, h) The use of ICT improve teaching and learning.

All the teacher participants received ICT training at various stages of their careers. This resulted in making lessons more interesting for the learners. All three teacher participants used ICT equipment to ensure that all the content was covered. The document analysis data were analysed in this chapter, with the focus on the ICT policies and the staff meeting minutes.

## **CHAPTER 5**

### **CONCLUSIONS AND RECOMMENDATION**

#### **5.1 INTRODUCTION**

In this chapter the researcher discusses the conclusion as well as recommendations. The researcher provides an overview of the study covering all chapters and then discusses the summary of the findings as well as the limitations of the study and recommendations.

#### **5.2 OVERVIEW OF THE STUDY**

In Chapter 1 the researcher introduced the study, which was conducted by providing background information on the study, stating the research problem and the rationale of the study. The research question, sub-questions, and the purpose, aims and objectives of the study were discussed in this chapter. The researcher provided a preliminary literature review of the study and discussed the theoretical framework that was used. The researcher also discussed the research method and design, the population and sampling, the data collection and the procedure that was used during the study. The researcher explained how data analysis and interpretation were undertaken. The researcher also discussed the research ethics and trustworthiness of the study as well as the possible limitations and delimitations of the study.

In Chapter 2, the literature review, the following were discussed: First, the researcher examined different countries and how they integrate ICT within their classrooms. Second, the researcher discussed the role of teachers when integrating ICT into Life Sciences by referring to the different roles that a teacher plays when implementing ICT in the classroom. Third, the chapter explains how ICT is used in the classroom, such as the various ICT tools. Fourth, the benefits that ICT provides for teaching and learning were given. Fifth, the chapter highlighted the challenges that teachers face when implementing the use of ICT resources. Finally, regarding the theoretical framework, the researcher outlined the TPACK, which is the study's framework and also refers to the specific knowledge of technology that teachers need to make teaching and learning successful.

In Chapter 3, the researcher discussed the research method and design used for the research study, which was a qualitative research approach with a multiple case study

design as the researcher conducted the study at three high schools. The site that the researcher chose for this study was Beaufort West, a minor town situated in the Western Cape Province. The researcher explained the data collection strategies and data collection techniques used. Chapter 3 describes the data analysis that the researcher used together with the measures to ensure trustworthiness and credibility of the collected data. The researcher discussed the ethical considerations that were followed in this study.

In Chapter 4, the researcher presented and discussed the findings of the study. The researcher presented a description of the participants and the schools. She also explained how data analysis was done about the semi-structured interviews, document analysis, and non-participant observation. The researcher discussed the presentation of the findings by discussing the non-participant observation analysis and nine themes from the semi-structured interview answers as well as giving a written summary of the findings.

In Chapter 5, the conclusions derived from the findings of this study (in Chapter 4) are discussed. The conclusions were based on the purpose, research question and the results of the study, which are stated in Chapter 1. The limitations of these findings and the resultant recommendations are explained. Recommendations are based on the conclusions and purpose of the study.

This study used the qualitative research approach to answer the following research question: How do Grade 11 Life Sciences teachers integrate ICT in their teaching?

1. The following sub-questions were addressed:
  - How do Grade 11 Life Sciences teachers overcome the challenges when they integrate ICT in teaching and learning?
  - What are the Grade 11 Life Sciences teachers' views on the use of ICT in teaching and learning?
  - How are Grade 11 Life Sciences teachers supported in integrating ICT tools in teaching and learning?

## **5.3 SUMMARY OF RESEARCH FINDINGS**

### **5.3.1 Document Analysis**

The ICT policies' results show that in all three schools, it is indicated when and how the ICT was used. The person who was responsible for the use of ICT was also identified and how the security was undertaken for ICT. There is a form that had to be completed to show who and when an ICT was used. The minutes of the three high school meetings indicated that the staff took cognisance of using ICT in teaching and learning.

### **5.3.2 Non-Participant Observation**

The findings revealed the participants' TK (Technological Knowledge), TCK (Technological Content Knowledge), and TPK (Technological Pedagogical Knowledge). This study highlighted the various TPACK components that have proven to be successful and the value of ICT in making teaching and learning meaningful and interesting.

### **5.3.3 Semi-structured Interviews**

Every theme was discussed in the previous chapter (Chapter 4), which led to the conclusions on how Grade 11 Life Sciences teachers integrate ICT in their teaching and learning. It was clearly stated that two of the participants (Participants A and C) used ICT tools daily to do preparations for the next day's lesson. They also used videos, whiteboards, and pictures to display work. A summary of findings is as follows:

There was a varying level of experience of teaching Life Sciences among participants. The results show the importance of experience in teaching Life Sciences; long Life Sciences' teaching experience can assist in the choice of ICT for the presentation of a lesson. Using ICT in teaching Life Sciences shows how comfortable and equipped participants were when delivering content.

The findings also show that the value of the traditional teaching method is not completely lost and explores its place in the ICT environment. The participants used traditional teaching methods as their way of overcoming the challenges in teaching and

learning using ICT. This research identifies the improvement in the participants' ability to deliver content when using ICT. It also encourages the creativity of the participants and explores the professional development of the respective participants as a direct result of being exposed to and using ICT. The research furthermore shows the value that ICT has added to the personal experience of participants.

The findings show the extent to which ICT can broaden the knowledge base and tools that are available in delivering content. It also shows how the delivery of content on referencing information as well as content preparation and the channels available in the delivery of Life Sciences content can be managed. According to the participants, knowledge of different ICT tools promotes better understanding of the lesson for the learners. The findings also illustrate the time the participants dedicated to the Life Sciences field and the varying degree of the use of ICT tools by the respective participants. The participants' responses also indicated that the use of ICT assisted the participants to explain difficult Life Sciences terms. More clarity was achieved by the participants, which made learning more understandable.

The findings show focus on a specific ICT tool, i.e. PowerPoint and its application in the classroom as well as the expanded options it offers educators in preparation of the content. It shows the various media (videos, data projectors, whiteboards) used in the delivery of prepared content. According to the findings, the participants were supported by other teachers in their schools and by their subject advisors. They were also encouraged to attend teacher training to improve their ability to use ICT in the classroom.

The three participants showed their TK (Technological Knowledge) by selecting and using ICT in their teaching and learning of Life Sciences, for example, the laptops, whiteboard, data projectors, smart board, videos, computer laboratory and PowerPoint slides. When it comes to TCK (Technological Content Knowledge), the participants' experience of teaching Life Sciences added to their ability to choose a relevant ICT tool to enhance the achievement of learning outcomes. Excellent knowledge and understanding of the subject enabled participants to choose the relevant ICT tool for their subject. The participants showed a combination of learner-centred- and teacher-centred approach when they used ICT in teaching Life Sciences.

## **5.4 LIMITATIONS AND DELIMITATIONS OF THE STUDY**

### **5.4.1 Limitations of the Study**

The following aspects were limitations in the study. The study was limited to three high schools in the Beaufort West region as there are not many high schools equipped with ICT resources. At one high school, the Life Sciences participant was busy with a practical assessment and as such, more time was needed to observe this participant. The time for observation should be extended.

### **5.4.2 Delimitations of the Study**

The following were delimitations in the study: The researcher observed the participants' lessons and was present at all the lessons that were taught. The study can be used to determine how Life Sciences teachers can integrate ICT in their teaching and learning, which helps to accommodate learners' learning abilities. All interviews were scheduled after school hours so that no teaching time was interrupted.

## **5.5 RECOMMENDATIONS**

The researcher makes the following recommendation arising from the study:

The findings revealed that the learners enjoyed the ICT tools, so all classrooms should be equipped with ICT tools, especially Life Sciences classrooms. Life Sciences teachers should undergo continuous training in ICT. More support should be given to teachers regarding ICT, especially the older teachers who struggle to use ICT tools. Follow-up sessions should take place to support teachers in the use of ICTs.

## **5.6 CONCLUSION**

In this chapter, the results, limitations and recommendations were discussed. The findings indicate how Grade 11 Life Sciences teachers integrate ICT into their teaching and learning by using ICT tools such as videos, laptops, data projectors, displaying pictures as well as using the interactive and normal whiteboard. During this study, it was clearly shown that newly appointed educators received ICT training at university as this was a compulsory subject. Teaching experience plays a major role when it comes to delivering the content. The participants also indicated that it is important to

receive support from various stakeholders such as subject advisors, experienced educators, the district office, and continuous training at workshops.

The recommendations above were acquired from the data that were analysed during this study. These recommendations should help any educator in the science field to integrate ICT in their teaching and learning. This will allow them to realise every learner's learning ability and to ensure that all the content that was taught is clearly understood.

Technology and the use of ICT is the way forward for the new generation, as this is how learners prefer to learn. The non-participant observation findings showed how important it is to the participants to have knowledge of TPACK and to use it in the teaching and learning of Life Sciences. Document analysis added the need to have an ICT policy and to discuss the use of ICT in staff meetings.

## REFERENCES

- Abdullahi, H. (2014). The role of ICT in teaching science education in schools. *International Letters of Social and Humanistic Sciences*, 19, 217–223.
- Australia, G.O. (2020). Information and Communication Technologies (ICT) Strategy (2020–2024). *Department of Education (Australia)*, 1-16.
- Babbie, E., & Mouton, J. (2012). *The practice of social research*. Oxford University Press.
- Berahman, M., Hashemi, S.A., Mostafa, J., & Sosahabi, P. (2017). The role of ICT in learning – teaching process. *World Scientific News*, 680–691.
- Bhattacharjee, B. & Deb, K. (2016). Role of ICT in 21st century's teacher education. *International Journal of Education and Information Studies.*, 6(1), 1-6.
- Briesta, G. (2016). ICT and education beyond learning: A framework for analysis, development and critique. In E. Elstad (Ed.), *Digital expectations and experiences in education*. (pp. 29-43). Sense Publishers.
- Connelly, L. (2021). Trustworthiness in qualitative research. Retrieved from Gale Academic OneFile:  
<https://go.gale.com/ps/i.do?id=GALE%7CA476729520&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10920811&p=AONE&sw=w&userGroupName=anon%7Ebb829c04>
- Creswell, J.W. (2014). *Research design*. (4th ed.). SAGE.
- Department of Education. (2004). White Paper on e-Education: Transforming Learning and Teaching through Information and Communication Technologies (ICTs). *Government Gazette*, 8-18.
- Department of Telecommunications and Postal Services. (2016). National Integrated ICT Policy White Paper. Retrieved from:  
[https://www.dtps.gov.za/images/phocagallery/Popular\\_Topic\\_Pictures/National\\_Integrated\\_ICT\\_Policy\\_White.pdf](https://www.dtps.gov.za/images/phocagallery/Popular_Topic_Pictures/National_Integrated_ICT_Policy_White.pdf)
- Farmery, R.M. (2014). *The integration and use of ICT across the secondary school*. Cardiff University.

- Forbes, C., Sabel, J., & Zangori, L. (2015). Integrating life sciences content & instructional methods in elementary teacher education. *The American Biology Teacher*, 77(9), 651–657.
- Gent, P. & Meyer, I. (2016). *The status of ICT in education in South Africa and the way forward*. National Education Collaboration Trust.
- Ghavifekr, S., & Rosdy, W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science (IJRES)*, 2(1), 175–191.
- 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*, 38–57.
- Graham, C., Kereluik, K., Koehler, M., Mishra, P., & Shin, T. S. (2014). The technological content knowledge framework. In J. M. Spector, M. D. Merrill, J. Elen & M.J. Bishop (Eds.), *Handbook of research on educational communications and technology*. (4th ed.). (pp. 101-111). Springer.
- Government of Scotland (2016). *Enhancing learning and teaching through the use of digital technology: A digital learning and teaching strategy for Scotland*. : Smarter Scotland.
- Hanimoglu, E. (2018). The impact technology has had on high school education over the years. *World Journal of Education*, 8(6), 96–106.
- IGI Global. (2014). *What is TCPK professors training model?* Retrieved from: <http://www.igi-global.com/dictionary/tcpk-professors-training-model/34905>
- James, L., & Templeton, K. (2015). ICT in Learning Strategic Action Plan 2015. *The Highland Council*, 1–13.
- Kaushlendra, P. & Nawal, K.M. (2018). ICT in educational institution: Need, role and importance. *IOSR Journal of Humanities and Social Science*, 42-46.
- Kaware, S., & Sain, S. (2015). ICT application in education: An overview. *International Journal of Multidisciplinary Approach and Studies*, 2(1), 25–32.

- Kennah, M.R. (2016). *The use of ICT in the teaching and learning process in secondary schools: A case study of two Cameroonian schools*. Institute of Educational Leadership, University of Jyväskylä.
- Kler, S. 2014, September 25. ICT integration in teaching and learning: Empowerment of education with technology. *Issues and Ideas in Education*, 2(2), 255–271.
- Koehler, M.J., & Mishra, P. (2009). What Is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 1(9), 60–70.
- Korstjens, I., & Albine, M. (2018, 12 5). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, 24(1), 120-124.
- Kumar, R. (2019). *Research methodology: A step by step guide for beginners*. SAGE.
- Kurt, S. (2019). *TPACK: Technological Pedagogical Content Knowledge Framework*. Retrieved from [https://educationaltechnology.net/technological-pedagogical-content-knowledge-tpack-framework/#:~:text=Technological%20pedagogical%20knowledge%20\(TPK\)%20describes,%2C%20technological%20content%20knowledge%20\(TCK\)](https://educationaltechnology.net/technological-pedagogical-content-knowledge-tpack-framework/#:~:text=Technological%20pedagogical%20knowledge%20(TPK)%20describes,%2C%20technological%20content%20knowledge%20(TCK)
- Mathevula, M.D., & Uwizeyimana, D.E. (2014, September). The challenges facing the integration of ICT in teaching and learning activities in South African rural secondary schools. *Mediterranean Journal of Social Sciences*, 5(20), 1082–1091
- McMillan, J., & Schumacher, S. (2014). *Research in education: Evidence-based inquiry*. (7th ed.). Pearson Education.
- Ministry of Education, Ghana. (2015). ICT in education policy. Republic of Ghana.
- Moeed, A. (2013). Science investigation that best supports student learning: Teachers' understanding of science investigation. *International Journal of Environmental & Science Education*, 537–559.
- Mofarreh, Y.I. 2016. *Implementation of ICT policy in secondary schools in Saudi Arabia*. University of Wollongong.

- Mohammadi, H., Rezvanfar, A., & Talebian, S. (2014). Information and communication technology (ICT) in higher education: Advantages, disadvantages, convenience and limitations of applying e-Learning to agricultural students in Iran. *Procedia-Social and Behavioral Sciences*, 152, 300–305.
- Mukhari, S.S. (2016). Teachers' experience of information and communication technology use for teaching and learning in urban schools. Doctoral thesis. University of South Africa.
- Murungi, C.G., & Mwoma, T. (2018). Supporting teachers in their use of ICT in teaching mathematics: What kind of support is necessary and when is it required? *International Journal of Pregnancy & Childbirth*, 4(6), 247–251.
- Natia, J.A. & Al-hassan, S. (2015). Promoting teaching and learning in Ghanaian basic schools through ICT. *International Journal of Education and Development using Information and Communication Technology*, 11(2), 113–125.
- Ojo, O., & Adu, E. (2018). The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province. *South African Journal of Education*, 38(2), 1–11.
- Okwara, V.U. (2016). Revisiting the teaching and learning of Life Sciences in schools: The effect of curriculum changes on teachers' attitudes. Doctoral thesis: University of the Free State.
- Olofsson, A., Lindberg, O.J., & Fransson, G. (2018). Students' voices about information and communication technology in upper secondary schools. *The International Journal of Information and Learning Technology*, 82–92.
- Omwenga, E., Nyabero, C., & Okioma, L. (2015). Assessing the influence of the PTTC principal's competency in ICT on the teachers' integration of ICT in teaching science in PTTCs in Nyanza Region, Kenya. *Journal of Education and Practice*, 6(35), 142–149.
- Open, A. (2014). *Information and communication technology (ICT) in Education in*

- Asia: A comparative analysis of ICT integration and e-readiness in schools across Asia*. Asia: United Nations Educational, Scientific and Cultural Organization (UNESCO).
- Peprah, O.M. (2016). ICT Education In Ghana: An evaluation of challenges associated with the teaching and learning of ICT in basic schools in Atwima Nwabiagya District in Ashanti Region. *European Journal of Alternative Education Studies*, 1(2), 7–27.
- Podolsky, T.K. (2016). Does teaching experience increase teacher effectiveness? A review of the research. Learning Policy Institute.
- Simon, W.E. (2014). Teachers' use of ICT in the teaching of Life Science in the Khomas region. Doctoral thesis: University of Namibia.
- Simon, W.E., & Ngololo, E.N. (2015). Teachers' use and integration of ICT in the teaching of Life Science: A case of two urban high schools in Namibia. *Namibia CPD Journal for Educators (NCPDJE)*, 1–14.
- Stojanov, Z. (2017). *The 6 main ways technology impacts your daily life*.  
[http://wagnerela.weebly.com/uploads/2/8/5/7/28577543/the\\_6\\_main\\_ways\\_technology\\_impacts\\_your\\_daily\\_life\\_copy.pdf](http://wagnerela.weebly.com/uploads/2/8/5/7/28577543/the_6_main_ways_technology_impacts_your_daily_life_copy.pdf)
- Stoilescu, D. (2017). June 13-16. An analysis of ICT policies in Canada and Australia secondary education. *Diversity Matters Eden*, 242–246.
- Thomson, S. (2015). Policy insights: Australian students in a digital world. Australian Council for Educational Research.
- UNDP. (2020). *Saudi Arabia*. Retrieved from:  
[https://www.sa.undp.org/content/saudi\\_arabia/en/home/countryinfo.html](https://www.sa.undp.org/content/saudi_arabia/en/home/countryinfo.html)
- Yuen, A.H.K., & Hew, T.K.F. (2017). Information and Communication Technology (ICT) in education in Asia: A comparative analysis of ICT integration and e-readiness in schools across Asia. United Nations Educational, Scientific and Cultural Organization (UNESCO).

# APPENDICES

## APPENDIX A: ETHICAL CLEARANCE



### UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2019/11/13

Ref: **2019/11/13/57604371/01/AM**

Dear Ms Barnard

Name: Ms AD Barnard

Student No.: 57604371

**Decision:** Ethics Approval from  
2019/11/13 to 2022/11/13

**Researcher(s):** Name: Ms AD Barnard  
E-mail address: 57604371@mylife.unisa.ac.za  
Telephone: +27723271117

**Supervisor(s):** Name: Dr. A.R. Molotsi  
E-mail address: molotar@unisa.ac.za  
Telephone: +27 12 429 3265

**Title of research:**

**The grade 11 Life Sciences teachers' integration of ICT to overcome Life Sciences barriers in Beaufort West high schools, Western Cape.**

**Qualification:** MEd in Science and Technology Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2019/11/13 to 2022/11/13.

*The **low risk** application was reviewed by the Ethics Review Committee on 2019/11/13 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.



3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date **2022/11/13**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

*Note:*

*The reference number **2019/11/13/57604371/01/AM** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

  
**Prof AT Motlabane**  
**CHAIRPERSON: CEDU RERC**  
motlhat@unisa.ac.za

  
**Prof PM Sebate**  
**ACTING EXECUTIVE DEAN**  
Sebatpm@unisa.ac.za

Approved - decision template – updated 16 Feb 2017

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www.unisa.ac.za

## APPENDIX B: PERMISSION FROM THE CIRCUIT MANAGER IN BEAUFORT WEST TO CONDUCT THE STUDY

### The Circuit Manager

#### Request for permission to conduct research at

..... High School

Title: The Grade 11 Life Sciences teachers' integration of ICT to overcome Life Sciences barriers in Beaufort West high schools, Western Cape.

Date: 28-01-2020

Dear .....

I, **Arantxa Barnard** am conducting research under supervision of **Dr A.R. Molotsi**, a Senior lecturer in the Department of Science and Technology Education towards an MEd degree at the University of South Africa. I request permission to conduct research at the abovementioned schools. The title of my study is: *The Grade 11 Life Sciences teachers' integration of ICT to overcome Life Sciences barriers in Beaufort West high schools, Western Cape.*

The aim of the study is to determine how Grade 11 Life Sciences teachers integrate ICT in their teaching.

The following schools have been selected....., because these schools are my focus area in the Eden and Central Karoo District in Circuit 7.

The study will entail classroom observation and interview with the Grade 11 Life Sciences teacher on my research topic. I will also be requesting documents such as lesson plans and activities to determine the use of ICT in Life Sciences lessons.

The benefits of this study are to better understand how teachers can use ICT to overcome barriers in Grade 11 Life Sciences.

There are no risks to the participants.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail notifying when the dissertation will be published and a copy will be provided to every participant upon request.

Yours sincerely



Ms A.D. Barnard

072 327 1117 (57604371@mylife.unisa.ac.za)

Researcher

Dr A.R. Molotsi

---

Supervisor

012 429 3265 (molotar@unisa.ac.za)

A handwritten signature in black ink, appearing to read 'A.R. Molotsi', enclosed within a light blue rectangular border.

**CONSENT FORM TO CONDUCT RESEARCH AT ..... HIGH SCHOOL IN BEAUFORT WEST**

(Return slip)

I, \_\_\_\_\_ (Circuit Manager), confirm that the person requests my consent to conduct her research at the above high schools in Beaufort West. The researcher has informed me of the nature, procedure, potential benefits and anticipated inconvenience of the research.

I have read (or had explained to me) and understood the study as explained in the information sheet.

\_\_\_\_\_

\_\_\_\_\_

Circuit Manager Signature Date

## APPENDIX C: PERMISSION FROM SCHOOL PRINCIPALS OF THE THREE HIGH SCHOOLS

**Versoek om toestemming om navorsing te doen by ..... Skool.**

Titel: *Die Graad 11 Lewenswetenskappe-onderwysers se gebruik van IKT om lewenswetenskaplike hindernisse in hoërskole in Beaufort-Wes, Wes-Kaap, te oorkom.*

Datum: .....

Geagte .....

Ek, **Arantxa Barnard**, doen navorsing onder toesig van **Dr A.R. Molotsi**, 'n *Senior Lektor in die Departement Wetenskap en Tegnologie-onderwys* vir 'n MEd-graad aan die Universiteit van Suid-Afrika. Ek nooi u Graad 11 Lewenswetenskappe-onderwyser uit om deel te neem aan 'n studie: *Die Graad 11 Lewenswetenskap-onderwysers se gebruik van IKT om Lewenswetenskaplike hindernisse in hoërskole in Beaufort-Wes, Wes-Kaap, te oorkom.*

Die doel van die studie is om te bepaal hoe Graad 11 Lewenswetenskappe-onderwysers IKT's in hul onderrig integreer.

U skool is gekies omdat u skool my fokusarea is, maar het ook IKT-fasiliteite in die Eden- en Sentraal-Karoo-distrik in Kring 7.

Die studie behels die waarneming van die klaskamer en 'n onderhoud met die Graad 11 Lewenswetenskappe-onderwyser rakende my navorsingsonderwerp. Ek sal ook dokumente soos lesplanne en aktiwiteite aanvra om die gebruik van IKT in Lewenswetenskappe-lesse te bepaal.

Die voordele van hierdie studie is om beter te verstaan hoe onderwysers IKT in Graad 11 Lewenswetenskappe-vakke integreer.

Die deelnemers hou geen risiko's in nie.

Daar sal geen vergoeding of aansporings vir deelname aan die navorsing wees nie.

Terugvoeringsprosedure sal insluit om die deelnemers in kennis te stel wanneer die proefskrif gepubliseer sal word en 'n eksemplaar sal op versoek aan elke deelnemer voorsien word.

Die uwe

---

Mej A.D. Barnard

Navorsers

072 327 1117 ([57604371@mylife.unisa.ac.za](mailto:57604371@mylife.unisa.ac.za))

Dr A.R. Molotsi

Supervisor

012 429 3265 ([molotar@unisa.ac.za](mailto:molotar@unisa.ac.za))

**TOESTEMMING / VERGUNNING OM NAVORSING VIR STUDIE TE DOEN:**

..... **SKOOL.**

Ek, \_\_\_\_\_ (Prinsipaal), bevestig dat Mej. A.D Barnard my toestemming vra om haar navorsing by ..... skool te doen en my ingelig het oor die aard, prosedure, potensiële voordele en die verwagte ongerief van die navorsing.

Ek het die studie gelees (of dit is aan my verduidelik) en verstaan soos in die inligtingsblad uiteengesit.

Ek verstaan dat my personeel se deelname vrywillig is en dat hulle vry is om enige tyd te onttrek sonder boete (indien van toepassing).

Ek is bewus daarvan dat die bevindings van hierdie studie verwerk sal word tot 'n navorsingsverslag, tydskrifpublikasies en / of konferensieverrigtinge.

Handtekening:

\_\_\_\_\_ (Prinsipaal)

\_\_\_\_\_ (Datum)

\_\_\_\_\_ (Navorser)

\_\_\_\_\_ (Datum)

## APPENDIX D: THEMES OF CODING FOR PARTICIPANTS

Interview questions	Teacher A	Teacher B	Teacher C	Themes
1. How long have you been teaching Life Sciences Grade 11?	2 Years.	I would have to say about 20 years. Last year I had a Grade 12 class. Every year me and my colleague change grades which gives us the opportunity to take each grade straight to matric. E.g. Grade 10–12.	2 years	Teaching experience
2. In all your years in teaching Life Sciences, have you received training in ICT?	During my BSc degree studies at Stellenbosch.	Yes.	At university I was trained in Life Sciences ICT; it was quite common at school level.	Training at university in ICT
3. How do you feel about using technology in the classroom?	It facilitates my teaching and that is what children prefer nowadays.	It is a benefit and helps learners to experience the content visually and thus increase their ability to understand the content better.	Generally I'm keen on technology and its use in the classroom, it exposes worlds to our learners and helps enormously with discipline and entertainment in the subject.	Facilitation of work ICT tools
4. How long have you been using ICT tools/ devices?	From my studies to education (teaching).	Depending on its availability and accessibility in the school, approximately 10 years. Depending on the type of equipment, the period may be different, owing to different kinds of devices (it was discussed by schools at a specific time).	For 8 years.	ICT usage ICT tools
5. What forms of technology do you use, and how?	I compile PowerPoint slides containing all the subject content and show it to my learners via the projector.	Usually mostly data projector as well as whiteboard, if available (only limited number of classrooms are currently equipped with whiteboards). Cell phones are currently school policy but this is changing (currently learners may not use their cell	Apart from the common PowerPoints and videos, I also use simulations to build and explain electric circuits and connections; Google Maps enables us to 'study' different geographic areas virtually in the class; the interactive whiteboard offers	types of Technology used

Interview questions	Teacher A	Teacher B	Teacher C	Themes
		phones in class, for specified reasons, e.g. the size of the class for proper monitoring, approximately 55 to 60 learners in Grade 8 to 10 (is currently being reviewed).	many interactive activities.	
6. When using technology, how do you accommodate each learners learning ability?	I <b>show diagrams</b> along with the content on every slide. Some learners learn better with <b>diagrams</b> and the others prefer content.	By accessible and available use of <b>devices</b> ; Learners are also exposed to <b>computers</b> .	The <b>use of ICT</b> in the classroom accommodates each learner, including the visual learner, auditive learner, physical and verbal learner; multidisciplinary teaching instrument.	Types of technology ICT tools
7. What are the challenges that Grade 11 Life Sciences teachers experience when they integrate ICT in their teaching?	<b>Technology</b> is not always reliable or sometimes there is no power and then I have to work from the <b>board (blackboard)</b> .	Not an adequate number of <b>devices</b> . Learners must exchange or share <b>devices</b> , but that's changing.	Many of the resources are only in English- language barrier. Learners often do not know how to use the <b>technology</b> .	ICT tools Types of technology
8. What support do Grade 11 Life Sciences teachers receive to integrate ICT in their teaching?	I sometimes get sources from my <b>subject advisor</b>	From the <b>regional office and specialist educators</b> .	The school has the necessary/basic resources. General ICT training is offered by CTLI, as well as <b>experienced educators</b> at the school.	Support received
9. How do Grade 11 Life Sciences teachers overcome barriers they experience as they integrate ICTs in their teaching?	If there is no power, I work of the <b>board (blackboard)</b> .	By using <b>programs and projects</b> presented by the WCED (Western Cape Education Department), e.g. the Telematics programs in collaboration with the US (University of Stellenbosch).	The only way to overcome these obstacles is to teach them.	ICT Tools
10. How can the use of ICT enhance learning in Grade 11 Life Science learners?	It is important for Life Sciences to <b>show diagrams</b> and <b>videos</b> regularly via the <b>projector</b> that will improve the learners' learning experience.	Stimulation and eagerness to learn are promoted in the subject.	ICT in Life Sciences will enliven the subject, especially to the learner who feels that it is a boring subject. This will capture new learners in the subject that is dying out. The simplicity of a WhatsApp group that transfers the	ICT tools

Interview questions	Teacher A	Teacher B	Teacher C	Themes
			school and education to the comfort of a learner's home. Stimulate creative and critical thinking by the use of <b>technology</b> . Creates problem-solving skills.	
11. What strategies do you use to facilitate learner participation, using ICT tools?	Sometimes I show only <b>diagrams</b> and then I ask the learners to give me the labels.	By making it more accessible and attractive to learners and by making ICT <b>devices</b> available to learners.	Make sure that the learner is familiar with the <b>devices</b> .	ICT tools
12. Do you think your involvement with ICT tools/devices has impacted your thinking and practice in any way? If so, how? Can you explain?	My thinking has remained the same but my <b>teaching</b> has improved.	Yes. It <b>extends vision</b> , stimulates learners' behaviour and, of course, helps to broaden the educator's subject knowledge. In other words, it will be an indispensable part of <b>teaching</b> in the future.	The use of ICT in Life Sciences creates a very <b>positive learning environment</b> , helps much with classroom discipline and maintain learner's concentration.	Impact of ICT tools
13. Your thoughts on using ICT in the lesson.	It facilitates my work. I have all the content of the subject on my <b>slides</b> that learners can copy; I therefore only have to amend the <b>slides</b> every year.	May be very supplementary and stimulating if applied correctly; learners' knowledge, insight and understanding in the subject are extended.		ICT tools

## APPENDIX E: INTERVIEW ANSWERS OF PARTICIPANTS

Interview questions	Teacher A	Teacher B	Teacher C
1. How long have you been teaching Life Sciences Grade 11?	2 Years.	I would have to say about 20 years. Last year I had a Grade 12 class. Every year me and my colleague change grades which gives us the opportunity to take each grade straight to matric. E.g. Grades 10-12.	2 years.
2. In all your years in teaching Life Sciences, have you received training in ICT?	During my BSc degree studies at Stellenbosch.	Yes.	At university I was trained in Life Sciences ICT; it was quite common at school level.
3. How do you feel about using technology in the classroom?	It facilitates my teaching and that is what children prefer nowadays.	It is a benefit and helps learners to experience the content visually and thus increase their ability to understand the content better.	Generally I'm keen on technology and its use in the classroom, it exposes worlds to our learners and helps enormously with discipline and entertainment in the subject.
4. How long have you been using ICT tools/ devices?	From my studies to education (teaching).	Depending on its availability and accessibility in the school, approximately 10 years. Depending on the type of equipment, the period may be different, owing to different kinds of devices (it was discussed by schools at a specific time).	For 8 years.

5. What forms of technology do you use, and how?	I compile PowerPoint slides containing all the subject content and show it to my learners via the projector.	Usually mostly data projector as well as whiteboard, if available (only limited number of classrooms are currently equipped with whiteboards). Cell phones are currently school policy but this is changing (currently learners may not use their cell phones in class, for specified reasons, e.g. the size of the class for proper monitoring, approximately 55 to 60 learners in Grade 8 to 10 (is currently being reviewed).	Apart from the common PowerPoints and videos, I also use simulations to build and explain electric circuits and connections; Google Maps enables us to 'study' different geographic areas virtually in the class; the interactive whiteboard offers many interactive activities.
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Interview questions	Teacher A	Teacher B	Teacher C
6. When using technology, how do you accommodate each learners learning ability?	I show diagrams along with the content on every slide. Some learners learn better with diagrams and the others prefer content.	By accessible and available use of devices; Learners are also exposed to computers.	The use of ICT in the classroom accommodates each learner, including the visual learner, auditive learner, physical and verbal learner; multidisciplinary teaching instrument.
7. What are the barriers that Grade 11 Life Sciences teachers experience when they integrate ICT in their teaching?	Technology is not always reliable or sometimes there is no power and then I have to work from the board (black board).	Not an adequate number of devices. Learners must exchange or share devices, but that's changing.	Many of the resources are only in English- language barrier. Learners often do not know how to use the technology.
8. What support do Grade 11 Life Sciences teachers receive to integrate ICT in their teaching?	I sometimes get sources from my subject advisor.	From the regional office and specialist educators.	The school has the necessary/basic resources. General ICT training is offered by CTLI, as well as experienced educators at the school.
9. How do Grade 11 Life Sciences teachers overcome barriers they experience as they integrate ICTs in their teaching?	If there is no power, I work of the board (black board).	By using programs and projects presented by the WCED (Western Cape Education Department), e.g. the Telematics programs in collaboration with the US (University of Stellenbosch).	The only way to overcome these obstacles is to teach them.

<p>10. How can the use of ICT enhance learning in Grade 11 Life Science learners?</p>	<p>It is important for Life Sciences to show diagrams and videos regularly via the projector that will improve the learner's learning experience.</p>	<p>Stimulation and eagerness to learn are promoted in the subject.</p>	<p>ICT in Life Sciences will enliven the subject, especially to the learner who feels that it is a boring subject. This will capture new learners in the subject that is dying out. The simplicity of a WhatsApp group that transfers the school and education to the comfort of a learner's home. Stimulate creative and critical thinking by the use of technology. Creates problem-solving skills.</p>
<p>11. What strategies do you use to facilitate learner participation, using ICT tools?</p>	<p>Sometimes I show only diagrams and then I ask the learners to give me the labels.</p>	<p>By making it more accessible and attractive to learners and by making ICT devices available to learners.</p>	<p>Make sure that the learner is familiar with the devices.</p>
<p>12. Do you think your involvement with ICT tools/devices has impacted your thinking and practice in any way? If so, how? Can you explain?</p>	<p>My thinking has remained the same but my teaching has improved.</p>	<p>Yes. It extends vision, stimulates learners' behaviour and, of course, helps to broaden the educator's subject knowledge. In other words, it will be an indispensable part of teaching in the future.</p>	<p>The use of ICT in Life Sciences creates a very positive learning environment, helps much with classroom discipline and maintain learner's concentration.</p>
<p>13. Your thoughts on using ICT in the lesson.</p>	<p>It facilitates my work. I have all the content of the subject on my slides that learners can copy; I therefore only have to amend the slides every year.</p>	<p>May be very supplementary and stimulating if applied correctly; learners' knowledge, insight and understanding in the subject are extended.</p>	

## APPENDIX F: CODING OF INTERVIEW ANSWERS

Questions	Teacher A	Teacher B	Teacher C
1. Years teaching Grade 11 Life Sciences?	2 years.	About 20 years.	2 years.
2. Training in ICT?	From university.	Yes. But does not specify when.	From university.
3. Technology use in the classrooms?	Facilitates teaching.	Helps learners experience content visually.	Exposes learners to new things, helps to maintain discipline and entertainment.
4. Forms of technology used?	Laptop, Data projector, Videos, PowerPoint slides.	Whiteboard, Data projector.	PowerPoint slides, videos, simulations and interactive whiteboard.
5. Accommodating learning abilities?	Show diagrams.	Exposing learning to ICT tools.	Use PowerPoint slides, videos and whiteboard for drawing.
6. Barriers when using ICT?	Unreliable technology. No power at school.	Number of devices available at school per learner.	Language barrier-resources only in English and learners are unfamiliar with devices.
7. Support received?	Resources from Subject Advisor.	Regional office, specialist teachers.	The school, CTLI training and experienced educators.
8. Overcoming barriers?	Use next best thing-black board.	Using programs and projects from WCED.	To teach them.
9. Using ICT to enhance learning?	Show diagrams and videos via ICT tools.	Promotes stimulation and eagerness to learn from the learners.	ICT makes LS become alive, using WhatsApp at comfort of learners homes, develops problem-solving skills and creativity.

**APPENDIX G: DOCUMENT ANALYSIS OF TEACHING STRATEGIES AND ICT IN THE CLASSROOM**

DOCUMENTS	SCHOOLS		
	SCHOOL X	SCHOOL Y	SCHOOL Z
ICT policies	<p>Yes</p> <p>Own ICT policy</p>	<p>Yes</p> <p>WCED policy</p>	<p>Yes</p> <p>WCED policy</p>
Minutes of the staff meetings	<p>ICT workshop</p> <p>Use of ICT in teaching and learning</p>	<p>ICT workshop</p> <p>Use of ICT in teaching and learning</p>	<p>ICT workshop</p> <p>Use of ICT in teaching and learning</p>

## APPENDIX H: ANALYSIS OF NON-PARTICIPANT OBSERVATION

	<b>Teacher A</b>	<b>Teacher B</b>	<b>Teacher C</b>
1. Lesson planning.	No formal lesson plans available. Lesson plans were outlined in diary.	No lesson plans. Lesson plans were written in diary.	No formal lesson plans-uses diary.
2. ICT materials	Laptop and data projector.	Library computers	Laptop, data projector and whiteboard.
3. Knowledge of subject content	very excellent knowledge of subject content.	Very good knowledge of subject content.	Very good knowledge of subject content.
4. Interaction with learners	Learners were actively involved throughout the lesson.	Learners asked questions throughout the lesson.	Learners were actively involved throughout the lesson asking questions.
5. Teaching strategies	Formal teaching, group discussions.	Formal teaching	Formal teaching, group discussions, independent reading.
6. Summaries of major/important points	Major points summarised at the end with a video.	Major points summarised at the end.	Major points summarised at the end with a mind-map.

## APPENDIX I: PERMISSION TO USE ICT FACILITIES

# Acceptable Use Policy of Computer Facilities

### LEARNER:

I understand and will abide by the rules and stipulations as set out in this document as pertains to myself and *Insert your school name here*.

I further understand the consequences of violating any of the above conditions and that violation of *Insert your school name here*. AUP will result in either:

- Cancellation of my privileges to use the computer facilities at *Insert your school name here*.
- Disciplinary action to be taken against me as per the school policy and rules.
- Legal action taken in the case of extreme cases as outlined in the AUP.

Learner name (Please print)

Date

---

---

Signature (Learner)

---

As the parent or legal guardian of the learner who has signed this document, I fully understand the terms and conditions as listed in this document. I understand that learners should obey these terms and conditions and will be prosecuted if any of the terms and conditions are violated.

I hereby give permission that my child uses/accesses the school network/computers.

Parent or Guardian name (Please print)

Date

\_\_\_\_\_

\_\_\_\_\_

Signature (Parent or Guardian)\_\_\_\_\_

## APPENDIX J: PERMISSION OF PARTICIPANTS

Date: \_\_\_\_\_

Title: The Grade 11 Life Sciences teachers' integration of ICT to overcome Life Sciences barriers in Beaufort West high schools, Western Cape.

### DEAR PROSPECTIVE PARTICIPANT

My name is **Arantxa Barnard** and I am conducting research under the supervision of **Dr. A.R. Molotsi**, a *senior lecturer in the Department of Science and Technology Education* towards a MEd degree at the University of South Africa. I am inviting you to participate in a study entitled: The Grade 11 Life Sciences teachers' integration of ICT to overcome Life Sciences barriers in Beaufort West high schools, Western Cape.

The aim of the study is to determine how Grade 11 Life Sciences teachers integrate ICTs in their teaching.

You are invited because my focus is on Grade 11 Life Sciences teachers and how they integrate ICT into teaching Life Sciences.

I obtained your contact details from your principal. The study will consist of three high school Grade 11 Life Sciences Teachers.

The study involves non-participant observation and unstructured interviews. The following are an indication of what sort of questions will be asked:

1. How do Grade 11 Life Sciences teachers overcome the challenges when they integrate ICT in teaching and learning?
2. What are the Grade 11 Life Sciences teachers' views on the use of ICT in teaching and learning?

3. How are Grade 11 Life Sciences teachers supported in the integration of ICT tools in teaching and learning?

The duration of the study will be one week whereby the non-participant observations and an unstructured interview will be done. The interviews will be scheduled after school so that no teaching time will be affected. The duration of the interviews with the Grade 11 Life Sciences teachers will be 30 minutes each.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

The benefits of this study are to better understand how teachers can use ICT to overcome barriers in Grade 11 Life Sciences. Teachers will be more encouraged to engage in ICT training and using ICT tools in their classrooms.

There will be no negative consequences if the participant decides to take part in this research project. There is no risk related to this research project. No human-being will be harmed in any way. All information and data that will strictly be confidential according to UNISA's rules and regulations. All participants will remain anonymous.

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research (*confidentiality*) **OR** Your name will not be recorded anywhere and no one will be able to connect you to the answers you give during this research (*anonymity*).

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet or a safe at the premises of the researcher for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

There will be no compensation or any incentive contribution for the participant regarding the participation of this research project.

This study has received written approval from the Research Ethics Review Committee of the College of Education Department, UNISA. A copy of the approval letter can be obtained from the researcher if you so wish.

If you would like to be informed of the final research findings, please contact **Ms A.D. Barnard** on 0723271117 or email [57604371@mylife.unisa.ac.za](mailto:57604371@mylife.unisa.ac.za). The findings are accessible for (will be communicated).

Should you require any further information or want to contact the researcher about any aspect of this study, please contact **Ms A.D. Barnard** on 0723271117 or [57604371@mylife.unisa.ac.za](mailto:57604371@mylife.unisa.ac.za).

Should you have concerns about the way in which the research has been conducted, you may contact **Dr A.R. Molotsi** on 0124293265 or [molotar@unisa.ac.za](mailto:molotar@unisa.ac.za).

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

---

Ms A.D. Barnard

## CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, \_\_\_\_\_ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the non-participant observation and;

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print) \_\_\_\_\_

Participant Signature: \_\_\_\_\_ Date : \_\_\_\_\_

Researcher's Name & Surname (please print) \_\_\_\_\_

Researcher's signature: \_\_\_\_\_ Date: \_\_\_\_\_

# APPENDIX K: TURNITIN REPORT

The screenshot displays the Turnitin Feedback Studio interface. The main document area shows the title: "THE GRADE 11 LIFE SCIENCES TEACHERS' USE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN BEAUFORT WEST HIGH SCHOOLS, WESTERN CAPE" by ARANTXA DEIDRÉ BARNARD. The document is marked as "Submitted in accordance with the requirements for the degree of". The right-hand panel shows a "Match Overview" with a 26% match rate. Below this, it lists "Currently viewing standard sources" and a "View English Sources (Beta)" button. A "Matches" table lists the following sources and their percentages:

Match Number	Source	Percentage
1	uir.unisa.ac.za (Internet Source)	5%
2	hdl.handle.net (Internet Source)	3%
3	repository.unam.edu.na (Internet Source)	1%
4	Submitted to University... (Student Paper)	1%
5	files.eric.ed.gov (Internet Source)	1%
6	ujcontent.uj.ac.za (Internet Source)	1%

At the bottom of the interface, it shows "Page: 1 of 107", "Word Count: 32352", and "High Resolution" is turned "On".

## APPENDIX L: DECLARATION OF PROFESSIONAL EDITING

Dr A.R. Molotsi  
Faculty of Education  
University of South Africa

### Editing of a Master's dissertation

I, Marietjie Alfreda Woods, hereby certify that I have completed the editing and correction of the dissertation: **The Grade 11 Life Sciences Teachers' Use of Information and Communication Technology (ICT) In Beaufort West High Schools, Western Cape** by **Arantxa Deidré Barnard**, submitted in fulfilment of the requirements of the degree **Master of Education** at the **University of South Africa**.

It is believed that the dissertation meets with the grammatical and linguistic requirements for a document of this nature.

**Name of Editor:** Marietjie Alfreda Woods

**Qualifications:** BA (Hons) (Wits)

Copy-editing and Proofreading (UCT)

Accredited Text Editor (English) (Professional Editors' Guild)



**Signature:**

**Contact Number:** 083 312 6310

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**Date Issued:** 19 February 2022