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Investigating practising teachers' willingness to teach genetics with the use of ICT



MASTER RESEARCH REPORT

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Abstract

This study aimed to investigate practising teachers' willingness to teach the topic of genetics with the use of ICT. I wanted to find out if teachers consider themselves sufficiently prepared to use ICT in the classroom. The motivation for investigating practising teachers' willingness to teach the topic of genetics with the use of ICT was to determine whether teachers appreciate the value of ICT and its relevance in the classroom. If teachers do not see the value and relevance of ICT in education, hopefully, this study will help the Department of Education in facilitating a better alignment between research and practice and provide training that will adequately train and prepare teachers for the use of ICT. The Department of Education supports the use of ICT in classrooms and this is also part of the current international drive for education. Data was collected through interviews and classroom observations. There were four participant teachers within the age range of 25- 50 years category; two participants were female and the other two were males. Participants had to teach grade 12 Life Sciences as a subject for them to be part of this study. Findings show that teachers in my study, both males and females, were willing to teach the topic of genetics with the use of ICT. However, only one teacher considered himself sufficiently prepared to teach with ICT. The study showed that although the other three teachers valued and appreciated ICT in the classroom, they still needed further training on how to incorporate ICT in their lessons. Findings also showed that teachers faced several challenges when using ICT. Issues such as load shedding and the internet either being slow or expensive are some of the cited challenges. The study recommends that during in-service workshops, teachers need to be provided with proper and adequate information about the function, usage and benefits of ICT. In addition, there is a need for the Department of Education to start investing and providing schools with backup generators so that lessons are not disturbed due to load shedding. Finally, free data or the internet needs to be made available and accessible so that teachers and learners may be able to view pre-recorded video lessons and access learning materials such as past question papers from various reputable websites.

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Table of acronyms

CAPS: Curriculum and Assessment Policy Statement

DoE: Department of Education

GDE: Gauteng Department of Education

ICT: Information Communications Technology

MEC: Member of the Executive Council

4IR: 4th Industrial Revolution

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Chapter 1

1 INTRODUCTION TO THE STUDY

1.1 Introduction

This study seeks to explore the Life Sciences teachers' preparedness to integrate Information Communications Technology (ICT) in the teaching of Grade 12 with the focus being on the topic of genetics. In this chapter, I introduce the study providing the background of the study, the purpose of the study, the problem statement and discuss the rationale of the study plus the research question and sub-questions. Chapter 1 gives an orientation and overview of the focus of the study. According to Grover (2015), it provides an insight into how the problem in the research will be addressed. The terms *willingness* and *preparedness* have been used in this report interchangeably.

1.2 Background of the study

The introduction of ICT for teaching and learning in Gauteng schools is currently an on-going process and supported by key policy documents such as the **Curriculum and Assessment Policy Statement (CAPS)** document. According to Niess (2005), the 21st-century tools are different, and communication is advanced. Koehler and Mishra (2008) further suggest that the 21st century is filled with rapid, continued innovation and advances in the domains of information, knowledge and technology. Given this shift, Niess (2005) proposes that education must shift to incorporate computer-based and electronic technologies within the context of various subject areas because as Chow (2015) suggests, technology in the form of laptops, tablets, cellphones and televisions is all around us in all corners of life. A study conducted by Koehler and Mishra (2008) showed that many educators do not consider themselves sufficiently prepared to use ICT in the classroom and do not appreciate its value and relevance to the classroom. As a result, they are resistant to change and ignorant of the transformative power of technology. According to Koehler and Mishra (2008), this can be attributed to the fact that many teachers obtained their qualifications at a time when educational technology was at a very different stage of development than it is today, thus, some teachers lack

experience with using technology for teaching and learning. Kirova and Veselinovska (2016) define ICT in educational settings as a term used to denote all computer and communication technologies. The Gauteng Department of Education (DoE) supports the use of ICT in classrooms and this is also part of the current international drive for education. Seeing that there is advocacy for the 4th Industrial Revolution (4IR) worldwide including South Africa, the process of teaching and learning should be modified because ICT integration changes traditional classrooms into smart classrooms and also improves the teaching-learning process (Senthamaraikannan, Senthilkumar & Sivapragasam, 2014). Senthamaraikannan, et al., (2014) contend that ICT brings rich material in the classroom to be used by both the teacher and the learner as such Life Science teachers need to know how ICT is used as a teaching and learning tool for their purposes and also in helping learners to use ICT in their learning of Life Sciences. In this regard, Life Sciences teachers need to be competent in the use of ICT. According to Ertmer (2005), although the conditions for successful technology integration appear to be in place including ready access to technology, increased training for teachers and a favorable policy environment, high-level technology use is still low. This suggests that additional barriers specifically related to teacher's pedagogical beliefs may be at work. As such, this study will be focusing on investigating practising teachers' preparedness in teaching the Life Sciences topic of genetics using ICT.

1.3 Research problem/ Problem statement

Koehler & Mishra (2008) contend that a science classroom is a natural place for technology use since so much of science today depends on technology. They further suggest that technology has a place in science classrooms when it is integral to the science being taught. It will be vital in the sense that it can make the learning of science easier or when it addresses a particular pedagogical issue. The part of the pedagogical problem is especially important for this study because my observation as an undergraduate student and now as a teacher who explores and incorporates technology in the classroom is that when I use ICT to teach especially those topics that are abstract like meiosis, my learners perform better compared to when I teach without the use of technology. This supports a point made by Chow (2015) that technology in the classroom

has the potential to allow content to be taught much more efficiently. A study conducted by Garraway-Lashley (2014) has also shown that there was a significant difference between the academic performance of Life Sciences learners who were exposed to computer technology and those exposed to the traditional method of teaching. Senthamaraikannan, et al., (2014) contend that ICT has opened new avenues like online learning, e-education, e-learning and e-journal to mention a few. This makes the learning of Life Sciences easier and provides opportunities for learners to be well conversant with modern electronic knowledge and embrace computer technology. As such, ICT can improve the quality of teaching, learning and management in schools and so help raise performance standards (Livingstone, 2012). According to Ertmer (2005), ICT serves as a 'valuable and well-functioning instructional tool' in schools and classrooms, hence Chow (2015) proposes that the need for technologically literate teachers is becoming more important since technology is progressing at an alarming rate. A study conducted in the United States of America (US) shows that the majority of teachers (85%) now report feeling "somewhat well-prepared" to use technology for classroom instruction. What about Gauteng East Rand Life Sciences teachers - are they also prepared to use technology for classroom instruction?

1.4 Purpose of the study

The objective of this study is to investigate East Rand practising teachers' willingness in teaching genetics using ICT. Genetics, which is taught to grade 12 Life Sciences learners, is an abstract topic that many learners face challenges with. It is abstract in the sense that without representations, it requires learners to form mental images for themselves in their mind of which other learners do not succeed. Koehler and Mishra's (2008) research has shown that educators are reluctant to use technology in their classrooms because they do not see its relevance. Are educators not seeing its relevance because it does not assist learners to perform better in the subject area or perhaps, they do not have the knowledge of when or how to use technology during lessons? According to Chow (2015), one thing that many schools lack is adequate training for teachers on ICT. If a teacher does not know how to use technological tools, they may waste a lot of time attempting to

troubleshoot the device, which can completely disengage the learners as they see a teacher who does not know what they are doing. Koehler and Mishra (2008, p.9) contend that the teacher's knowledge of technology, science and pedagogy comes with knowing where to use technology, what technology to use and how to use it for teaching. They further propose that "many technologies are part of science, not simply tools to do science" (Koehler & Mishra, 2008, p.196).

1.5 Rationale

In investigating Life Sciences teachers' willingness to use technology for instruction, the aim is to find out the perceptions that practising teachers have towards ICT and the reasons behind their attitudes. As suggested by Ertmer (2005), teachers' attitudes influence their perceptions and judgments, which in turn, affect their behaviour towards technology. The hope is that by gaining a better understanding of the attitude and level of competency of practising teachers towards technology for instruction, this study can enable the DoE to facilitate a better alignment between research, practice and attitudes and to provide training that will adequately train and prepare teachers for the use of ICT. According to Koehler and Mishra (2008), there are opportunities to teach with and about technologies that are integral to doing science in the 21st century.

1.6 Aims/objectives of the study

To establish the extent the practising teachers are willing to use technology in the classroom for the instruction of genetics

2. To establish the perception of practising teachers towards the use of technology for classroom instruction
3. To get an insight into how practising Life Sciences teachers perceive their competency in using ICT for teaching
4. To identify the challenges the Life Sciences teachers experience when teaching genetics using technology.

1.7 Research questions

The main question that guides my study is:

1. To what extent are practising teachers willing to use technology in the classroom for the instruction of genetics?

Research sub questions:

- What is the perception of practising teachers towards the use of technology for classroom instruction?
- How do practising Life Sciences teachers consider themselves competent in using ICT for teaching?
- According to the practising Life Sciences teachers, which challenges do they come across when teaching genetics using technology?

1.8 Concept clarification

The following concepts will help to add to the clarification and consistency of the study: ICT, genetics, willingness/preparedness, abstractness, perception/attitude and load shedding

- In this study, ICT (Integrated Communications Technology) refers to all communication technologies including the internet, wireless networks, cell phones, computers, software, middleware, video-conferencing, social networking and other media applications and services.
- Genetics is a branch of biology concerned with the study of genes, genetic variation and heredity in organisms. Genes are abstract concepts.
- Abstractness refers to something existing in thought or as an idea but not having a physical or concrete existence.
- Willingness is the quality or state of being willing, free choice or consent of the will and freedom from reluctance.

- Perception refers to a belief or opinion often held by people based on how things seem.
- Load shedding is an action to reduce the load on something especially the interruption of an electricity supply to avoid excessive load on the generating plant.

1.9 Research structure

Chapter 1 is the introduction, background of the study, research problem statement, purpose of the study, aims and objectives of the study, rationale, aims and objectives, research questions and concept clarification. The literature review is presented in Chapter 2, which established familiarity and understanding of current research in the field of ICT in education revolving around the theoretical framework. In chapter 3, there is an introduction, the research design and research methodology that has been employed in collecting data in this study. Also, it includes the research strategy, population and sample of this study, research instruments, data analysis, quality assurance, pilot study, research rigor and ethical considerations for this study. Chapter 4 covers the data analysis and findings. This was followed by Chapter 5 where the findings of the study were discussed. Chapter 6 covers the answers to the research questions guiding this study, recommendations, limitations of the study and my reflections on conducting and compiling this research report.

Chapter 2

2. LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant research on the uses and benefits of ICT in education. ICT includes computers, the internet and electronic delivery systems such as smart boards and projectors among others and is widely used in today's education field. Specifically, this chapter reviews education reform in the 21st century, the uses of ICT in different school settings, how ICT improves the quality of teaching and learning, teacher's perception of ICT and the challenges encountered in the use of ICT.

2.2 Digital age

Education reform is happening worldwide and one of the tenets of the reform is the introduction and integration of ICT in the education system for instructional purposes. Teachers play a crucial role in the adoption and implementation of new technologies in education. Teachers' perceptions are an important aspect that influences their adoption of ICT in teaching and learning since their educational beliefs are closely linked to their use of ICT for instruction (Chowdhury & Farhana, 2019; Zhu, 2010). However, change on the part of teachers may be met with resistance because they are unlike the present generation of children who are introduced to technology while they are still young, which results in them being much more technologically adept at an early age than previous generations. Some practising teachers were introduced to technology at their workplaces, hence this creates a discrepancy between the knowledge of teachers and learners where teachers are used to using older technological devices while learners are used to more cutting-edge technology (Chow, 2015).

According to Hickox (1997) as cited by Chow (2015, p.10), "The pressure on schools to teach the skills necessary to prepare learners for the future in this age of technology is growing" As such, Bloomstine (2001) proposes that changes are going to be made to keep pace with the global community. Many countries including South Africa are

recognising the paramount importance of ICT, as a result, special projects are being formulated and put in place to enhance the usage of information technology. D'Silva, Kumar and Rose (2008) contend that ICT has opened wide opportunities for educators to integrate technology-supported materials in the teaching-learning process. In the Gauteng province, there is a major push towards integrating computer technology into public schools because of the vast promises it offers such as cheap, accessible and instantaneous information. According to D'Silva, Kumar and Rose (2008), the internet has the availability of vast amounts of far up-to-date information in the teaching and learning of different subjects than textbooks. Thus, policymakers with the hope to improve the quality of learning are increasingly willing to make major investments into technological software, hardware and training.

For this study, policy makers refer to the stakeholders who are the decision-makers in education such as school principals, district and regional directors and national-level educational administrators. Also, unless stated otherwise, technology is used to include the computer system, internet, networks and communication devices and software.

Presently, ICT influences the way we live, communicate, socialise, educate and learn. This introduction of ICT in almost all sectors of our lives has created a new global economy that is powered by technology, fueled by information and driven by knowledge (US department of Labour, 1999 as cited by Chowdhury & Farhana, 2019). Koehler and Mishra (2008) state that the development of Technological Pedagogical Content Knowledge (TPCK) by teachers in this era is, therefore, critical to effective teaching with technology. This implies that teachers must engage with content, pedagogy and technology to develop knowledge of how technology can help learners learn specific Life Sciences content.

According to Angers and Machtmes (2005), the recent advancement in ICT innovations and usage is rapidly transforming work culture and teachers cannot escape the fact that today's classrooms must provide technology-supported learning. D'Silva, Kumar and Rose (2008) contend that being prepared to adopt and use technology and knowing how that technology can support learning must become integral skills each teacher should possess. However, it is worth noting that teacher's acceptance of ICT as an instructional

tool is an important factor to its success in education, hence there is a need to examine teacher preparedness in the use of technology in the teaching of genetics and factors affecting teacher's ICT use and its implications to teachers' professional development strategies. This study is supported by D'Silva, Kumar and Rose (2008) who propose that educational technology is not and will never be transformative on its own. Rather, it requires teachers who can integrate it into the curriculum and use it to improve the teaching and learning process.

2.3 The uses of ICT in different school settings

According to Niess (2008), back then, to be deemed a prepared teacher, you needed to know and understand the subject content you plan to teach; knowing the content at a particular level was adequate preparation for teaching that content at that level. A foundation phase teacher needed to be able to read, write and do basic calculations. At a secondary school level, a Life Sciences teacher needed a secondary school level Life Science understanding. However, that was yesterday. Today, beliefs about what preparation teachers need for teaching have significantly changed. It is still the case that teachers need to know the content they are to teach but they must also know how to teach and learning the concerned content; this knowledge about teaching and learning content is referred to as the pedagogy of teaching (Niess, 2008, p.223). As such, with the addition of integration of new technologies as tools for learning, the preparation of teachers must evolve towards preparing teachers to teach in ways that help them to guide their learners in learning with appropriate technologies.

According to Suryani (2010), face-to-face classroom interaction is getting replaced by online learning; the traditional chalkboard is getting replaced by interactive whiteboards and textbooks are getting replaced by on-line resources. Suryani (2010) further adds that ICT is providing a way for dynamic learning because by using the internet, learning is not limited to school hours and demography since e-learning allows learners to get information faster from anywhere and anytime. Due to this massive transformation in education, schools need new technological plans and designs. According to Kozma (2003), teachers in many countries are beginning to use ICT to help change classroom

teaching and learning by integrating ICT into the curriculum. Therefore, it is necessary to develop strategies for teachers to effectively use ICT to improve their teaching.

ICT is considered a powerful tool for educational change and reform. According to Kent & Faser (2004) the school is an important environment in which learners can participate in a wide range of computer activities for ICT can be applied successfully in instruction, learning and assessment. Fu (2013) contends that ICT tends to expand access to education because, with ICT, learning can occur anywhere and at any time. ICT provides both learners and their teachers with more educational affordances and possibilities because multiple resources are abundant on the internet and knowledge can be acquired through video clips, audio sounds and visual presentations to mention a few. Koc (2005) further suggests that using ICT enables teachers to communicate, share and work with their learners anywhere and anytime. For instance, with teleconferencing classrooms such as Zoom, all learners can gather simultaneously for a discussable topic.

2.4 ICT improves the quality of teaching and learning

Life Sciences as a subject is an imperative area of study and is emphasised in the curricula of secondary schools in South Africa. Life Sciences has both theory and practical components and is taught as a single subject and offered to those learners who intend to pursue courses such as nursing, medicine and other areas in the Natural Sciences field. The present century is being marked by the explosion of scientific knowledge, which has resulted in several educational innovations. The traditional content of Life Sciences has been replaced by modern discoveries in the fields of genetics (Senthamaraikannan, Senthilkumar and Sivapragasam, 2014). As such, according to research conducted by Senthamaraikannan, Senthilkumar and Sivapragasam (2014), many learners feel that Life Sciences is a tough subject especially because of the theory part. Garraway-Lashley (2014) suggests that the reasons would be due to the abstractness of certain aspects of Life Sciences and a lack of understanding of certain concepts and terminologies on the learner's part.

The problems associated with the abstractness and complex nature of genetics were studied in more detail by Boersma, Christine, Jan Waarl and Knippels (2010). Their findings show that the separation of inheritance, reproduction and meiosis in the curriculum accounts for the abstract nature of genetics, while the different levels of biological organisation contribute to its complex nature. Suryani (2010) further proposes that the deterioration in learner's achievement in Life Sciences can to some extent be contributed by the strategies of teaching Life Sciences when teachers adopt only the lecture method without any use of resources, which does not provide for a sequence of learning experiences. As such, in the search for more innovative instructional pedagogy, the use of computers and other forms of technology are being analysed for their impact on learners' academic performance (Garraway-Lashley, 2014).

Suryani (2010) proposes that ICT in education has benefits that not only profit the teacher but learners and the learning process as well. According to Suryani (2010), by using technology in their learning, learners can be active learners who will be aware of what information they need, why they need it and how they can get that information. He further states that by using ICT in their learning, learners will not be dependent on their teachers because they can explore information that is available on the internet. As such, learners become self-managed in their learning process. According Suryani (1992) "self-managed learning allows learners to be self-motivated and self-directed learners who can efficiently respond to the quick change of information".

According to Serhan (2009), ICT fosters autonomy by allowing educators to create their material, thus providing more control over the content than is possible in traditional classrooms. By using ICT, teachers' creativity can be optimised. They can discover new multimedia tools and create materials in the styles readily available to them so that they make their lessons more interesting to their learners. According to Watts-Taffe (2003), teachers can act as catalysts for the integration of technology in education through ICT. He suggests that if encouragement, equipment and the necessary technological support are available from schools, then, developing ICT classes will be easier for teachers. The main responsibilities of these teachers will be changing their subject format and arranging for computer laboratories through the technology assistants.

D'Silva, Kumar and Rose (2008) assert that despite the tremendous increase in the role of ICT in education, it is facing considerably high resistance. According to Childres and Rovai (2003), many teachers actively resist using ICT for instructional purposes even though many researchers clearly show that achievement and opportunities to learn would increase with the application of ICT. D'Silva, Kumar and Rose (2008) observe that although teachers are sent in batches for training to gain knowledge and skills in the usage of ICT and its equipment, teachers are not fully utilising these facilities in their teaching (Chong, Sharaf & Jacob, 2005). Instead, they returned from these training only to fall back onto their traditional mode of teaching. I believe that there is a need to examine factors affecting teachers' ICT use because it is a waste of resources equipping schools with computer software and hardware only to find that these resources are not being utilised.

2.5 Teacher's perception of ICT

Suryani (2010) contends that how teachers perceive ICT can determine how well and effective ICT is integrated into the classroom. Implementing ICT in the classroom is not an easy and simple matter; it comes with challenges, as such, certain teachers refuse to use ICT. Suryani (2010) suggests that there are various reasons why teachers refuse to use ICT and they include insufficient access to technological resources, low quality of hardware, technical problems and negative assumptions about the presence of ICT in the classroom. Suryani (2010) further adds that other teachers are afraid of learning new technology because they have the perception that learning something new (integrating ICT in the classroom) is complex and difficult. However, his study has shown us that with proper training and support, integrating ICT in education is easier to learn and operate.

According to Mumtaz (2000), there have been many studies that were implemented to identify factors that facilitate or prohibit ICT usage among teachers. It was found that based on the prominent models of ICT usage, there are several personal, behavioural and environmental factors that influence a teacher's use of technology. Personal and behavioral factors that have been identified frequently are attitude, perceived ease of use, usefulness and self-efficacy. In a study conducted by Chan and Singh (2014), it was found that the attitudes of teachers vary with their years of experience and level of knowledge

on ICT. On the other hand, the environmental factors of subjective norm and job relevance too may contribute to or inhibit teacher's performance in using computers. In light of other studies, my research will look at the extent to which practising Life Sciences teachers are willing to use technology for instruction.

According to Fu (2013), internal variables can partially explain the success of technology integration in the classroom. **Abbott and Faris (2000)** examined teachers' attitudes towards the use of ICT before and after a technology literacy course. Their results showed that positive attitudes towards ICT increased amongst the teachers after the course because of instructional approaches, meaningful assignments requiring ICT and supportive instructors. Thus, Fu (2013) contends that teacher education programmes should teach teachers not only how to use hardware and software but also how to incorporate ICT into their teaching strategies and lessons.

Suryani (2010) suggests that implementing ICT in education is not a matter of bringing the most modern technology to the schools for teachers to use but should be supported by good coordination and management system on the ICT application. Otherwise, teachers will be trapped in the 'cosmetic use' of ICT. Cosmetic use of ICT happens when teachers feel that they are pressed to use technology in their teaching even though they do not see the benefits of using ICT for instruction (Suryani, 2010, p.110). Law, Wong and Yuen (2003) suggest that the successful implementation of ICT depends on how teachers can be empowered and influenced to use the software/hardware. Those who can empower and influence them according to Law, Wong and Yuen (2003) are the school leaders (principals and school management teams). Law, Wong and Yuen (2003) suggest that school leaders are expected not only to support the implementation of ICT but also to lead their followers in accepting and learning to integrate ICT in the classroom.

According to Suryani (2010), one of the central technological issues in implementing ICT in the classroom by educators is the conventional assumption that technology will replace their role in class. Suryani (2010) contends that teachers are worried that their role in the classroom will be less significant because with ICT learners can browse all the information they need from the internet. Nonetheless, **Newhouse (2002)** states that technology will not replace the teacher's role. According to **Newhouse (2002)** just like a school will always

be a formal place for teaching and learning, teachers will always play a central role in the teaching and learning process. This is because teachers will always have the authority to direct what their learners should learn by using teaching instruction and creating a conducive learning environment.

2.6 Barriers and challenges encountered in the use of ICT

According to Suryani (2010), there is a belief by developing countries that the most essential prerequisite of building prosperous nations is technological access, skills and management. This is because it is assumed that what makes developed countries thrive is because they have good technological access, skills and management. Suryani (2010) suggests that in reality, developing countries face difficulties in integrating ICT into our classrooms. In some respects, we share similar challenges but, in some aspects, we have different challenges. Those difficulties may range from teachers' willingness and readiness to use ICT to school support and finance.

Although ICT has advantages, barriers and challenges associated with its use still exist. These barriers include insufficient time to master new software or integrate ICT into lessons, limited knowledge and experience of ICT in the teaching context, a lack of specific technological knowledge and how to combine it with the existing pedagogical content knowledge, lack of in-service training on the use of ICT, technical problems that arise in the classroom, a lack of appropriate subject content and instructional programme, a lack of fitting hardware and software materials, a lack of motivation and uncertainty about the possible benefits of using ICT in the classroom and how integrating ICT in lessons will improve student learning. According to Fu (2013), one possible explanation for such barriers and challenges is a lack of models for how to use technology to facilitate learning and limitations related to contextual factors.

The government is purchasing and installing the latest and greatest pieces of technology in schools. However, with insufficient training and understanding, these pieces of technology quickly become discarded and their potential is wasted. Therefore, by understanding the beliefs and attitudes of the technologically inclined teachers, the

government and schools at large may be better equipped to make decisions about using technology.

According to Fu (2013), several external and internal factors influence ICT integration outcomes. The most common external factors that influence the effectiveness of technology integration in schools include a lack of access to computer software, insufficient time for course planning and inadequate technical and administrative support (Chen, 2008). Internal factors include understanding of ICT use, beliefs that may conflict with the application of ICT, attitudes towards technology integration, perceptions including intention or motivation to use ICT, self-confidence and knowledge of ICT, technology skills and readiness to use ICT. A study conducted in Singapore shows that insufficient understanding of the scope of an ICT resource leads to inappropriate or superficial uses in the curriculum.

A study conducted in the United States shows that teachers are generally given only an hour per teaching subject in professional development. This amount of time is not enough to allow the teacher to be proficient in new technologies. One-stop shop professional development focuses on training teachers to operate computers and software packages instead of how to integrate technology in the classroom (Knapp, 1996). This type of training is not appropriate for meeting teacher's pedagogical needs. This type of training has yielded uninterested teachers and a lack of teachers integrating technology in the classroom. These professional developments need to train teachers how to fully utilise the power of the new technology and build their confidence and the necessary skills to enable them to use the computer for instruction.

It is undeniable that ICT has become a potent production tool and offers exciting approaches to teaching and learning and if used in a proper manner and extensively, ICT can bring progress that could improve education radically. The moment teachers see the light that ICT has benefits such as making lessons more interesting, easier to teach and exciting, they would perceive its usefulness and relevance. However, Jhurree (2005) suggests that it is not advisable to change current classroom practices of teachers abruptly without giving them enough time to get used to the presence of technology as an instructional aid. Teachers need to change their mind-sets from being ICT-illiterate to

one who is a competent and comfortable user of ICT. If they think of ICT positively and take necessary measures to ensure that they are increasing their levels of competency, whatever problems they might have can diminish and eventually be eliminated.

2.7 Theoretical framework

Realising that technological knowledge is an integrated aspect of teacher knowledge, Mishra and Koehler (2006, 2008) draw on Shulman's (1986, 1987) pedagogical content knowledge (PCK) to create a framework that includes the specialised, applied and situated knowledge that helps us to understand how different aspects of knowledge (may) interact and become integrated. This is about how technological knowledge, pedagogical knowledge (PK) and content knowledge (CK) can be integrated. They call this framework of knowledge TPACK (or TPCK).

The TPCK model has been developed from Shulman's (1986) model on Pedagogical Content Knowledge by introducing 'technological knowledge' which is the knowledge about the technology and how to use it as an explicit component. They argue that for teachers to be effective, they not only need to know about the subject matter and about how to teach but they need to understand appropriate pedagogies for that particular subject content.

According to Mishra and Koehler (2006), TPCK is the intersection of teachers' knowledge of pedagogy, (curriculum) content and technology. In this sense, TPCK is a complex form of knowledge shaped by a large number of contextual factors such as school organisation, curricula, students' socioeconomic backgrounds and technology may be in constant flux or cause rapid development. They argue that this TPCK framework can enable a more theoretical robust way of designing, implementing, analysing and evaluating the use of ICTs in education.

In the framework of TPCK, PCK, technological content knowledge (TCK) and technological pedagogical knowledge (TPK) have central positions. In essence, they accept the main concepts and develop them into their TPCK framework. They refer to aspects of teaching that Shulman identified as important to PCK and argue that newer technologies potentially play a critical role concerning these aspects. According to

Mishra and Koehler (2006, p. 1027), PCK is about “the representation and formulation of concepts, pedagogical techniques, knowledge of what makes concepts difficult or easy to learn, knowledge of students’ prior knowledge and theories of epistemology.” This includes knowledge of teaching strategies and their implications for learning as well as knowledge about what the learner brings to the learning situation. Their development of Shulman’s model introduces four ‘new’ knowledge: Technology knowledge (TK), TCK, TPK and TPCK.

Mishra and Koehler (2008) defined TCK as the knowledge about the relationship between a subject and technology. Teachers need to know not just the subject matter they teach but also how the subject matter can be changed by the applications of technology (Mishra and Koehler, 2006). They regard TCK as an understanding of how technology and content influence and constrain one another. This includes the understanding of how subject matter can be changed by the application of technology and what kind of technologies can be used to facilitate the learning of the subject matter. TK is stated as the skills and knowledge to use computer hardware and software.

TPK can be regarded as “an understanding of how teaching and learning changes when particular technologies are used” (Mishra and Koehler, 2008, p. 9). This implies knowledge about pedagogical constraints and the potential of technological tools when used in different ways and situations in a specific subject or disciplinary context. Where one needs to understand and consider the pedagogic appropriateness of the technology as well as being aware of how the technology might impact the desired pedagogy. Essentially, TPCK is a bringing together of TCK, TPK and PCK.

TPCK represents a class of knowledge that is central to teachers’ work with technology. This knowledge would not typically be held by technologically proficient, subject matter experts or by a technologist who knows little of the subject or pedagogy or by teachers who know little of that subject or about technology (Mishra and Koehler, 2006).

This **TPCK framework** is relevant to my study because as Mishra and Koehler (2006) argued, this framework allows one to design resources, methods, structures and

desired outcomes especially where ICTs are integral to the course. When a teacher is good at teaching genetics and in the use of ICT, then, it means that there will be an interaction between TCK, TPK and PCK implying that the whole theoretical framework is fulfilled and the teaching and learning of genetics can be enhanced.

Chapter 3

3. RESEARCH METHODS

3.1 Introduction

In this chapter, I discussed the research method and research design. I used a qualitative approach and a multiple case study design since I conducted the study at four high schools in Gauteng, East Rand. In this Chapter, I also explained the instruments and data collection techniques I used. Furthermore, I briefly discussed the data analysis I used together with the quality assurance measures I took into consideration to ensure the trustworthiness and credibility of the data I collected. The last part of the chapter outlined the ethical considerations I followed in conducting the study.

3.2 Research Design

A qualitative method was used to carry out this research. This chapter highlights the method of data collection that was used including the research instrument and research participants.

3.3 Research Methodology

The research framework led me to methodologically design a qualitative approach according to research objectives to compile the whole picture. Qualitative research is the method of observation to gather non-numerical data and is concerned with understanding the participant's perspectives and thinking and in doing so, provides insights into the problem (Bhendari, 2020). Qualitative data was collected using the interview method. The qualitative data from the teacher interviews were then analysed, coded and classified (Cohen, Manion and Morrison, 2000).

Qualitative research is defined as the naturalistic and interpretative approach concerned with exploring phenomena from the interior and taking the perspectives and accounts of research participants as a starting point (Ritchie, Lewis, Nicholls & Ormston, 2013, p. 3). Anderson (2010), looked at the disadvantages of qualitative research and concluded that

it is usually criticised as biased, small scale, anecdotal and/or lacking rigour. However, the same author agrees that when it is carried out properly, it is unbiased, in-depth, valid, reliable, credible and rigorous. Also, Anderson (2010) argued that there are advantages in qualitative research. One of the advantages is that qualitative data is usually collected from a few cases of individuals so findings cannot be generalised to a larger population. However, the findings are transferable to another setting. This applies to this study because the data was collected from only four participants selected for the study.

3.4 Research strategy: A case study

This study employed a case study of four grade 12 practising Life Sciences teachers. Creswell (2012) refers to a case study as “an in-depth exploration of a bounded system (e.g., activity, event or individuals) based on extensive data collection” (p. 465). A case study is one of the numerous ways of carrying out research studies because it seeks to understand human beings in a social context by interpreting their actions as a single group, community or event (McMillan & Schumacher, 2014). A case study is viewed as a useful tool for the beginning, exploratory stage of a research project and also as a basis for the development of the ‘more structured’ tools that are necessary for surveys and experiments (Rowley, 2002). This was a crucial tool to use in this study as it gave me as the researcher the opportunity of focusing on an in-depth qualitative exploration. A disadvantage of this approach as identified by Denscombe (2008) is that a case study produces soft data because of its lack of strictness since it concentrates on qualitative and interpretative measures rather than quantitative ones which are measurable.

3.5 Population and sample

In this study, purposive sampling was used. I needed teachers who teach grade 12 Life Sciences and who use ICT for their teaching. The target population was four teachers working under the Ekurhuleni South District. I selected teachers in this particular district because it was convenient and near to my geographical proximity. The study took place at four secondary schools in East rand in Gauteng province. The duration of data collection was two weeks, in the first week interviews were conducted with the different participants individually and on different days then the following week classroom

observations took place. Interview responses from teacher participants were recorded then transcribed after the interviews. Classroom observations were not recorded at all, as a researcher I relied on what I was observing at that time and it was easier because I already had a set of questions I wanted to answer from what was being observed. One of the schools selected is a full ICT school, which was provided with ICT equipment by the Gauteng Province Member of the Executive Council (MEC) for education Panyaza Lesufi when the project on smart classes was implemented. The other three schools are not full ICT schools meaning that certain classrooms in these schools still use the traditional blackboard while other classes have smart and electronic whiteboards. The reason for choosing these schools is because they already have ICT equipment that they are supposed to be utilising. The study was purposive; thus, the participants were experienced grade 12 Life Sciences teachers.

3.6 Research instrument

Various research tools were used to obtain a comprehensive description of the perceptions that the teachers had towards the use of ICT in teaching. The tools were open-ended and developed especially for this study. By open-ended, I meant that the tools allowed the formulation of any answer rather than a selection from a set of possible answers. The research instruments I used for this study were semi-structured interviews with teachers and classroom observations. Creswell (2009) suggests that multiple instrumentation is a valuable technique that increases the validity and reliability of a study and ensures the triangulation of the data. According to McNamara (1999), an interview is a verbal conversation between two people to collect relevant information for the research. Interviews are particularly useful for getting the story behind a participant's experiences. The interview was used mainly to provide data on teacher's perceptions about the value and level of integration of ICT for instruction along with the barriers they are confronted with in their practice with ICT and their general teaching philosophy. The peripheral purpose of the interview was to obtain information about the beliefs of teachers towards ICT from their perspective. The shortcoming of the interviews was that of social desirability, where participants answered questions according to the desired response. At times, they would want to impress me as the interviewer instead of being truthful in

their responses. Following a brief analysis of the interview data, classroom observations were used to study practices in teaching and learning situations. A classroom observation is the purposeful examination of teaching and learning events through the systematic processes of data collection and analysis (Bailey, 2001). The purpose of classroom observations was to obtain data on the same teachers' practice with ICT. Moreover, it offered me the opportunity to identify any convergent and divergent points among teachers' responses in the interview phase and their actual practice (Patton, 2002).

3.7 Data analysis

Data analysis approach for this study was inductive since it was associated with the qualitative aspect of the research which was guided by the research questions. An inductive approach to data analysis enabled me as the researcher to analyse documents in areas in which only limited knowledge exists. Inductive analysis is a qualitative method of data analysis that researchers use to develop theory and identify themes by studying documents, data recordings and other printed and verbal materials. As the name implies, the inductive analysis relies on inductive reasoning in which themes emerge from the raw data through repeated examination and comparison. As I analysed data from the interviews and classroom observation, I detected common themes and patterns in the data which were important for triangulation. Triangulation allows for the validation of data through cross verification and testing of the consistency of the findings obtained to eliminate measurement, procedural and sampling biases (Kennedy, 2009). Triangulation attempts to enrich a study by explaining different aspects of the issue and in so doing map out the complexity of the participants' responses so that the researcher can assess the causes influencing the results produced (Kennedy, 2009).

3.8 Quality assurance

According to Chowdhury (2015), quality in qualitative research cannot be addressed by a single method, however, it may be judged through various perspectives such as trustworthiness and crystallisation. Chowdhury (2015) further states that in qualitative research, researchers often use 'credibility', 'reliability', 'transferability' and 'confirmability' as the criteria of 'trustworthiness'. The quality of research necessitates 'truth value',

'consistency' and 'neutrality'. These issues, Chowdhury (2015) suggests, are indicators of the trustworthiness of research. Elo, Kaariainen, Kanste, Kati, Kyngas and Polkki (2014) contend that the aim of trustworthiness in a qualitative investigation is to support the argument that the inquiry's findings are worth paying attention to.

Credibility is the first aspect of trustworthiness, according to Chowdhury (2015). This is because it essentially asks the researcher to link the research findings with reality to demonstrate the truth of the research study findings. According to Shanton (2004), credibility is the accuracy of research findings where investigators attempt to demonstrate a true picture of the phenomenon under scrutiny being represented. **In this particular study credibility was involved in establishing that the results of the study are believable. As such credibility depended more on the richness of the information gathered rather than the amount of data gathered.** Korstjens and Moser (2018) propose that strategies to ensure credibility are prolonged engagement, triangulation and member checking. Prolonged engagement means investing sufficient time during an interview to become familiar with the setting and context, to build trust and get rich data (Korstjens and Moser, 2018). Triangulation aims to enhance the process of qualitative research by using multiple approaches. Member checking is feeding back data, interpretations and conclusions to members of those groups from whom the data were originally obtained (Korstjens and Moser, 2018). This strengthens the data because the researcher and participants look at data with different eyes. **In this study triangulation was guaranteed by using multiple sources of data and member checking by allowing the teacher participants to read the transcriptions to be sure that I did not misquote them.**

Korstjens and Moser (2018) add that to be credible, research needs to have reliability and validity. Further, they state that reliability is the extent to which the results of the study are consistent over time. **Findings of the study show that results were consistent over time because interview responses of teacher participants are supported by classroom observations.** An accurate representation of the total sample under study is referred to as reliable if the results of the study can be reproduced under a similar methodology. On the other hand, validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are.

According to Chowdhury (2015), transferability is the second aspect of trustworthiness and refers to the degree to which the research can be transferred to other contexts; this section, Chowdhury (2015) argues, is defined by readers of the research. This is done when the reader notes the specific details of the research situation and methods and compares them to a similar situation that they are more familiar with. If the specifics are comparable, then, the original research would be deemed more credible.

Dependability is the third aspect of trustworthiness. Chowdhury (2015) contends that dependability ensures that the study findings are consistent and can be repeated. This is measured by the standard in which the research is conducted, analysed and presented.

The last aspect of trustworthiness is confirmability. Confirmability questions how the research findings are supported by the data collected. It is the degree to which the findings of the study can be confirmed by other researchers. This is a process done to establish whether the researcher has been biased during the study. **The findings of this study are supported by literature, according to Koc (2005) using ICT enables teachers to communicate, share and work with their learners anywhere and anytime, T-1 commented during the interview that she shares slides with her learners via WhatsApp while T-3 mentioned that during lockdown he used to carry out his lessons via Zoom, so although him and his learners were not in the same place at the same time yet lessons were carried out.** Korstjens and Moser (2018) suggest that confirmability concerns the aspect of neutrality since interpretation should not be based on your preferences and viewpoints but needs to be grounded in the data. It establishes that data and interpretations of the findings are not figments of the researcher's imagination but derived from the data.

3.9 Pilot Study

A pilot study is referred to as a feasibility study that comprises 'small-scale' versions of the planned study and trial runs of planned methods to answer a methodological question(s) and guide the development of the research plan (Prescott & Soeken, 1989, p.60). According to Kim (2010) a pilot-study is conducted to prepare for the main study and is intended to ensure that methods or ideas would work in practice. The pilot study is intentional and planned from the beginning of a proposed project and before the actual

investigation. Kim (2010) suggests that the principal benefit of conducting a pilot study is that it provides researchers with an opportunity to make adjustments and revisions in the main study. According to Kim (2010), a pilot exercise can be useful to novice researchers as it can be used to self-evaluate one's readiness and help researchers assess and prepare their interview and observation techniques. I did pilot study in the school where I practice, and my colleagues assisted me by pointing out the interview questions which were not clear or ambiguous and I corrected them before interviewing the actual participants.

3.10 Research Rigor

In this study, rigor was determined by examining the quality of the research. From the research instruments, the participants' answers were analysed qualitatively. The explanations given by the participants during the interview gave an insight into teacher's beliefs and attitudes towards the use of ICT for instruction. **Apart from me, another researcher was asked to qualitatively analyse the data to see whether we get the same results or not.**

3.11 Ethical considerations

Regarding research ethics, Pillay (2014) states that there are three objectives which include:

- To protect the human participants.
- To ensure that research is conducted in a way that serves the interests of individuals, groups and/or the society as a whole.
- To examine specific research activities and projects for their ethical trustworthiness, management of risk, protection of confidentiality and informed consent.

In this study, as part of my ethics application, I applied for ethical clearance considering my moral and responsible behaviour towards participants and in compliance with the Wits School of Education ethics requirements. I sent letters to the Gauteng Department of Education (GDE) and to the principals of the schools I conducted my research at asking

them for permission to conduct the study with the educators at those institutions. Since I was working with humans in this study, I asked each educator for permission to participate in the study and for me to use their information. I also asked permission from the grade 12 learners who are in classes that are taught by these educators for permission to record their lessons for my classroom observations. Consent was obtained from their parents as some of them were minors. To ensure the confidentiality of the participants' information, access to the information from the interview, classroom observations and other data is restricted to the researcher (me) and my supervisor and will be disposed of via shredding once the study has been completed. Participants' responses have not been discussed by other parties outside of myself as the researcher and my supervisor.

To ensure anonymity, the research participants' identities were only put on the consent forms and not used in the data analysis and discussion of the findings write-up of the research. So, research will not link individual responses with participants' identities. Pseudonyms names were used for each teacher and school. Raw data collected from the interview and classroom observations are stored in a locked cabinet in my supervisor's office at the Wits School of Education. Other data is stored on my personal computer as well as my supervisor's personal computer both of which are password protected. Five years after the completion of the research project, the raw research data will be destroyed using a paper shredder. The only risk the study might have posed to the participants was that classroom observations would inconvenience educators. However, arrangements were made so that observations took place at a time and venue of the participants' convenience.

Chapter 4

4. DATA ANALYSIS

4.1 Introduction

This chapter provides an insight into the research findings. Qualitative data analysis was used. Interviews and classroom observations were used to collect data; four participants who were within the ages 25- 50 years category were part of the study. Inductive analysis was used to analyse the data, this is a qualitative method of data analysis that researchers use to develop theory and identify themes by studying documents, data recordings and other printed and verbal materials Trochim (2006). As the name implies, the inductive analysis relies on inductive reasoning in which themes emerge from the raw data through repeated examination and comparison. In this study in making use of the inductive approach to research, I analysed data from the interviews and classroom observation and then detected common themes and patterns in the data which were important for triangulation. The two males and two females were all teaching grade 12 learners. Participants had to teach Life Sciences as a subject for them to be part of this study. I transcribed all interviews and classroom observations and checked the transcripts by moving back and forth between the recordings and transcripts. Below is information representing participants' responses from the interviews and data from classroom observations. These classroom observations lessons were based on genetics and inheritance. This section illustrates ways in which four teachers transformed and enhanced the teaching and learning process using available ICT and their willingness to do so.

4.2 Biographical information

Anna was a 48-year-old female teaching in a public township school (School A) with moderate ICT. By moderate ICT, it meant that the school has the basic ICT equipment as indicated in the table below. The teacher had limited experience in teaching subject matter with technology. She started using technology for teaching when it was introduced in schools by the Gauteng Department of Education in

2016. The school had a data projector which is kept in the school's strong room and only utilised by teachers on appointment. From the observations, I noticed that the classroom had a smartboard with no internet access, an electronic whiteboard, the teacher's laptop, and the learners' cell phones.

Teacher/ school	School/ teacher ICT resources	Learner resources
Anna in a public township school (School A)	*Data projector (needs to be pre-booked) *Smartboard with no internet access *Whiteboard *Laptop	*Learner's cell phones (70% of learners)

Table 4.1: Summary of Anna's information

Mcusi 25-year-old female teaching in a public township school (School B) with enough ICT as indicated in the table below. ICT equipment at this school was enough to support quality teaching and learning. From the observations, I noticed that her classroom had a smartboard with internet access, a data projector, the teacher's laptop and the learners' smartphones which were also connected to the school's internet.

Teacher/ school	Teacher/ school ICT resources	Learner resources
Mcusi in a public township school (School B)	*Data projector *Smartboard with internet access *Laptop	*Learner's cell phones (75% of learners)

Table 4.2: Summary of Mcusi's information

James was a 47-year-old male teaching in a public former model C school (School C) rich in ICT. The school had a variety of ICT equipment. Learners had tablets which are compulsory since the school does not use hardcopy textbooks. From the observations, I noticed that his classroom was equipped with a 3D projector, smartboard, teacher's laptop, an electronic whiteboard, visualiser, interactive TV, tablets for learners and the internet.

Teacher/ school	Teacher/ school ICT resources	Learner resources
James is in a public former model C school (School C)	<ul style="list-style-type: none"> *3D Projector *Smartboard with internet access *Electronic whiteboard *Laptop *Visualiser 	<ul style="list-style-type: none"> *Learner's tablets (compulsory for all learners) *Learner's cell phones

Table 4.3: Summary of teacher Jame's information

Thato was a 28-year-old male teaching in a public township school (School D) with limited ICT. It was limited in the sense that there was no variety of ICT equipment and what they had was not enough to be utilised by all teachers at the school. From the observations, I noticed that in his classroom, there was no smartboard or electronic whiteboard. Instead, the classroom had the old traditional greenboard used for writing using chalk.

Teacher/ school	Teacher/ school ICT resources	Learner resources
Thato is in a public township school (School D)	*Teacher's personal laptop	*Learner's cellphones (60% of learners)

Table 4.4: Summary of Thato's information

School	Teacher code	Gender	Age	Highest qualification	Subject specialization	No of years teaching	No of years teaching Life sciences	No of years teaching with ICT
A	1	Female	48	Bachelor of science honours	Life sciences	12 years	12 years	3 years
B	2	Female	25	Bachelor of science honours	Life sciences	4 years	4 years	4 years
C	3	Male	47	Bachelor of education	Life sciences	20 years	20 years	5 years
D	4	Male	28	Bachelor of science honours	Life sciences	8 years	6 years	3 years

Table 4.5: Summary of teachers' biographical information

4.3 Classroom observation analysis and findings

I observed the four Grade 12 teachers teaching the topic of genetics and inheritance.

4.3.1 Teacher Anna School A

The ICT equipment I observed in her classroom includes a smartboard, laptop, smart phones and a white electronic smartboard (used for writing). During the lesson, the smartboard was the only ICT equipment utilised for the lesson by the teacher. No ICT tools were utilised by learners. Learners wrote in their exercise books and were only allowed to use their smartphones at the end of the period to receive the slides from the teacher. ICT was used by the teacher to maintain learner engagement in the sense that during the lesson when the teacher was explaining concepts, she included visuals as part of her PowerPoint presentation. From the lesson, I observed that the teacher occasionally asked learners' questions based on what they saw on the pictures displayed on the smartboard before she explained to the learners what she had initially wanted to explain. Towards the end of the lesson, there was load shedding, so the teacher had to improvise by using her laptop to teach. However, learners were unable to see anything from her laptop, thus had to listen attentively to her when teaching. After the lesson, the teacher made the slides available to the learners through their WhatsApp group.

4.3.2 Teacher Mcusi School B

The ICT equipment I observed in her classroom includes a smartboard, data projector, laptop, smartphones. During the lesson, the smartboard was the only ICT equipment utilised for the lesson by the teacher. No ICT tools were utilised by learners. Learners wrote in their exercise books. During my observations, I did not see any obstacles the teacher faced when using ICT. On that particular day, there was no load shedding in that area and she also managed to use her smartboard to the best of her ability. The use of ICT made the lesson quite interesting because the teacher showed learners a video to explain genetic lineage. I think the video

allowed learners to understand the content better. In her classroom, many learners found Life Sciences interesting because throughout the lesson, they were fully attentive, asking questions and making comments that showed that they knew and were interested in the content being taught.

4.3.3 Teacher James School C

The ICT equipment I observed in his classroom includes a laptop, interactive TV, visualiser, 3D projector, 3D glasses, smartboard, tablets and smartphones. During the lesson, the smartboard connected to the laptop through an HDMI cable was the ICT equipment utilised for the lesson by the teacher. He could not use everything at the same time. For instance, when he decided to use the smartboard, then, he did not use the data projector because they almost do more or less the same thing. He added that the choice of equipment utilised for a particular lesson is largely informed by the topic to be taught. The ICT tools being utilised by learners during the lesson were their tablets and smartphones. The only obstacle I noted during my observation was that the network was quite slow when he wanted to access the internet to search for some information. The use of ICT worked well for his lesson. Learners were attentive as they were watching a video. The video explained how cloning as an artificial process creates a genetically identical copy of an organism or biological material. The selection of ICT tools by James depended on relevance and suitability to curriculum requirements and learners' interests.

4.3.4 Teacher Thato School D

The ICT equipment I observed in his classroom is his laptop and smartphones (his and learners). There was no ICT equipment being utilised for the lesson by the teacher. The teacher only used the chalkboard and chalk. He stated that he only used his laptop for administrative purposes like typing question papers and capturing learner's marks. No ICT tools were being utilised by learners during the lesson. Although some learners in his classroom had smartphones, they were not permitted to use them in the classroom or during school hours.

When observing Anna, Mcusi and James teach genetics, it was evident that teachers are using ICT effectively to support attainment. These teachers used ICT to enhance their teaching practices. From the classroom observations, I was able to see that these teachers are employing various strategies to guide, facilitate and support appropriate learning activities. The whole-class use of a smartboard for Powerpoint presentation was the most popular way of presenting lessons used by teacher participants in the study because it helped learners visualise difficult genetics concepts and processes. However, Anna and Mcusi only focused on the presentation aspects unlike James who did not disregard the use of simulations and modelling.

As shown in the pie chart attached below, all four teachers have laptops. Some of these laptops are their laptops and others are the ones that they received at their respective schools. They used these laptops for administrative purposes and for preparing lessons. The other 3 teachers had smartboards in their classrooms except for Thato who did not have one in his classroom. Mcusi and James are the only two teachers that had a data projector in their classrooms while James was the only one out of the four teachers who was part of the study and had a visualiser and interactive television in his classroom. Most learners in the classrooms of these four teachers had smartphones. At Jame's school, all learners must have a tablet as they do not use hardcopy textbooks.

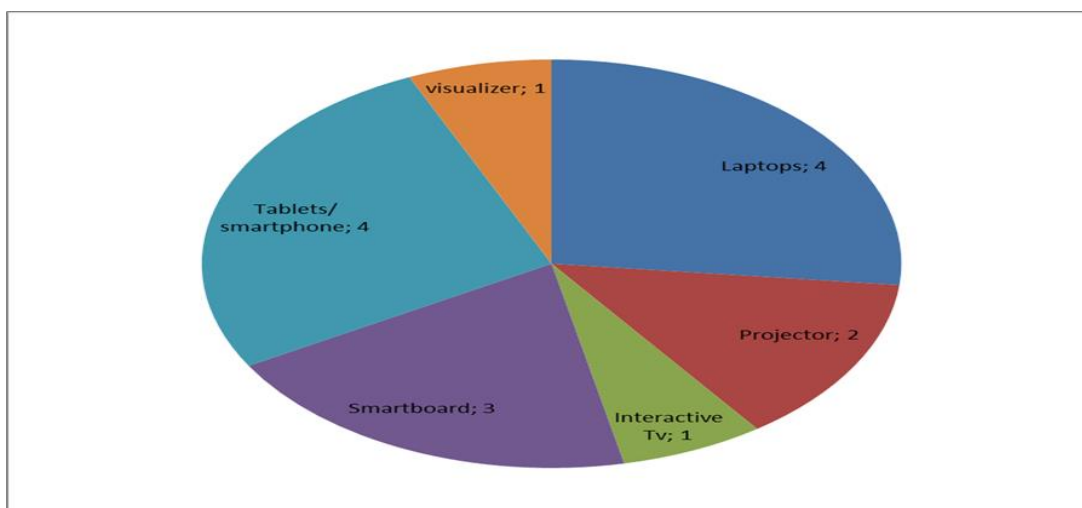


Figure 4.1: Pie chart representing the teachers' equipments

4.4 Interview analysis and findings

I also interviewed the four Grade 12 Life Sciences teachers at the time and venue which was convenient to them without disrupting their lessons. I classified the data into main themes which were divided into sub-themes and categories according to the emerging patterns.

4.4.1 Emergent themes, sub-themes and categories

Theme 1: Knowledge of ICT
<i>Sub-theme 1.1:</i> Explanation of what ICT is Category: Able to correctly explain what ICT is
<i>Sub-theme 1.2:</i> Able to state what the acronym ICT stands for Category: Able to denote what ICT stands for Category: Not able to denote what ICT stands for
Theme 2: ICT tools in the classroom
<i>Sub-theme 2.1:</i> ICT tools being utilized by both the teacher and learners Category: Educator tools Category: Learner tools
<i>Sub-theme 2.2:</i> Types of hardware and software communication tools Category: Hardware communication tools Category: Software communication tools Category: Knowing what hardware and software communication tools are Category: Not knowing what hardware/ software communication tools are Category: Purpose for using these ICT tools
Theme 3: Teacher attitudes and perceptions towards ICT
<i>Sub-theme 3.1:</i> Attitude towards ICT

<p>Category: Positive attitude</p> <p><i>Sub-theme 3.2: Perception towards ICT</i></p> <p>Category: Positive perception</p>
<p>Theme 4: Frequency of ICT integration</p>
<p><i>Sub-theme 4.1: Frequency of using ICT tools in the classroom</i></p> <p>Category: Often</p> <p>Category: Not often</p>
<p>Theme 5: Effect of ICT integration in Genetics instruction</p>
<p><i>Sub-theme 5.1: Impact of using ICT to teach genetics</i></p> <p>Category: Visual enhancement aids learning</p> <p>Category: Simplifies abstract Life sciences concepts</p> <p>Category: Save time (content is explained in a short space of time)</p> <p><i>Sub-theme 5.2: Influence of ICT on learner achievement</i></p> <p>Category: Positive (with ICT use learner marks have improved)</p> <p>Category: Negative (it is a distraction to learners that are not disciplined)</p>
<p>Theme 6: Challenges faced when using ICT for Instruction</p>
<p><i>Sub-theme 6: Obstacles teachers face with ICT</i></p> <p>Category: Load shedding</p> <p>Category: Inadequate training</p> <p>Category: Slow internet</p> <p>Category: Expensiveness of data</p>

The coding levels for interview data

4.4.2 Knowledge of ICT

To find out how much teachers knew about ICT, I asked the teachers the following question, “What do you understand by ICT?” in the interview. All four teachers had an

idea of what ICT is because, from their explanations, they were able to state that ICT referred to technological tools that can be used to support lesson delivery. However, only two teachers, Mcusi and James were able to correctly state what the acronym ICT stands for. Anna said ICT is the Integrated Curriculum Technology while Thato did not even attempt to say what it stands for. Seeing that ICT has been integrated into our schools, one would assume that all participants would at least be able to denote what ICT stands for.

According to Niess (2005), teachers' understanding of ICT is an important aspect of the development of TPCK. To find out if teachers consider themselves knowledgeable when it comes to ICT, I asked the question, "Do you consider yourself knowledgeable when it comes to ICT? Explain in detail why you consider yourself knowledgeable or not knowledgeable". Only James considered himself completely knowledgeable and competent when it comes to ICT. He explained that not only does he use ICT for consumption as in the classroom only, but he goes beyond that by including his creativity element where he creates videos and quizzes for the learners to use. I think that access to a variety of digital learning resources can motivate teachers to integrate ICT in their teaching and hopefully promote a more creative pedagogical use of these resources like what James does. The other three teachers (Anna, Mcusi and Thato) considered themselves average when it comes to ICT use and knowledge and the main reason being that they were able to use ICT tools like smartboards to show a PowerPoint presentation, play a video and write but there were certain things that they could not do on their own using a smartboard. Anna said:

"I can say it is not really that I am knowledgeable when it comes to ICT because there are so many things in ICT. When it comes to teaching, I am only focusing on curriculum delivery; whatever I am giving the learners using ICT, I am focusing on curriculum and some of the lessons are PowerPoint. They are already there. I am not planning them. Remember that the Department of Education is providing us with prepared lessons. For me, it is just to add where I think there is a lack of content and knowledge. So for me, my ICT knowledge is moderate, thus, I do not

go into detail. Some of the things on the smartboard I cannot use because I am not competent enough but can show learners the perfect videos”.

Anna and Mcusi reported that they had received minimal training on using smartboards when they were implemented and also stated that at their schools, there were no ICT technicians who are based on the school premises. Their ICT technicians were based at the district and they not only service one school but had to also train and assist teachers from other schools as well. Although Thato did not have access to a smartboard in his classroom, he considered himself average when it came to the knowledge of ICT because when he did his teaching practice, he made use of a smartboard for teaching his learners. Anna and Mcusi cited that they had received minimal training on using smartboards when they were implemented and they also stated that at their schools there were no ICT technicians who are based in the school premises, their ICT technicians were based at the district and they not only service one school but had to also train and assist teachers from other schools as well. Although Thato did not have access to a smartboard in his classroom, he considered himself average when it came to knowledge of ICT because when he did his teaching practical's he made use of a smartboard for teaching his learners.

4.4.2 ICT tools in the classroom

To find out what ICT tools teachers had in their classrooms, I asked the question, “Which ICT equipment do you have in your classroom? Do you utilise all the equipment you have mentioned? If not, explain with reasons”. Three teachers (Anna, Mcusi and James) stated that they had ICT tools like smartboards, laptops and smartphones which they utilised almost every time they deliver their lessons. Mcusi and James went on to add that they also had overhead projectors in their classrooms which they utilised when they were not using the smartboard. From James's response, you could tell that the school he taught in was a full ICT one because he mentioned that they even had an interactive TV, a visualiser, 3D projector and glass. His learners used tablets instead of traditional hardcopy textbooks. The only ICT tool that Thato had was a laptop that he did not use for lessons but only used for recording marks and typing the learner's test.

To find out the types of hardware and software communication that teachers used and the purpose for usage, I asked the question, “What types of hardware and software communication do you use and for what purpose?” This question was inadequately answered by all the participant teachers. Anna simply said:

“I have a laptop that I use for typing notes and capturing marks, a smartboard and a smartphone”.

She did not state whether the laptop is software or hardware.

James explained:

“This year has changed a lot of things and many things came in. I use a laptop. I use an interactive double board TV, which enables me to gather extensive feedback from learners by listening to their explanations; thus, I can gain an insight into their understanding and progress. There is also an interactive table at the back which is run on Edu-board basis, so, it is a projector and a sensor that works with a pen then the front board works with touch. The laptop that I am currently using is a Lenovo idea pad which is nice because it is a touch screen and you can write on the screen with a pen; it is a new experience that I have been using for the past 3/ 4 weeks. We recently started using google classroom. We also have our school system called NLMS. Also, we do Zoom lessons”.

Thato had this to say:

“WhatsApp group with learners, I used to send them previous question papers for revision. However, a small percentage of learners does not have cell phones”.

The reason I am saying this question was inadequately answered by participants is that some participants in their responses did not group their ICT tools into software tools and hardware tools although they did attempt to say what the tools are used for. Only Mcusi did that. She stated her software tools to say that it included Microsoft words used for typing notes and creating activities, PowerPoint presentation for preparing slides that are used for teaching and excel that is used

for recording marks on a spreadsheet that has learner's names but was honest enough to say that she did not have a clue of what was meant by hardware tools.

4.4.3 Teachers' attitudes and perceptions towards the use of ICT for instruction

To find out the attitude that teachers had towards ICT, I asked the question, "What is your attitude towards ICT especially for instruction? What informs that attitude whether negative or positive?". I needed to find out the attitude that teachers had towards ICT because according to De Villiers, Fraser and Kawai (2016), an attitude refers to a person's disposition and plays a major role in organising and directing their behaviour. Understanding their attitude whether negative or positive would make us have an understanding of their approach towards ICT.

All four teachers had a positive attitude towards ICT use which was informed by the fact that ICT assists in time management in the sense that learners do not need to copy notes into their books but can access the notes via USB from the teacher. Anna explains:

"My attitude is positive towards ICT but the only thing is that I still need more training because there are certain things that I struggle to do using a smartboard, for instance, I struggle to draw a graph or a diagram using the smartboard features".

The participants also believed that ICT enhances learner performance as it keeps them interested in the lesson especially if visuals are being used.

What informs Mcusi's attitude is that she believed that ICT could improve the quality of teaching and learning in schools and so help raise standards.

"Luckily, for me as a young teacher, I can relate more with ICT because I am part of the generation that uses ICT for most of the stuff. My attitude towards ICT is positive because it improves instruction and makes learning in the classroom easy and accessible to learners and keeps them drawn to the lesson. It has the potential to improve performance in the classroom. With the current situation in our country as we are faced with COVID-19, the way we normally do things especially in education has to change because we are not able to be in contact with our learners

but because of the presence of ICT, we can reach them so that teaching and learning continues”

Thato stated the following:

“Although I do not have ICT tools in my classroom, I saw at University how ICT use is beneficial, and I also hear from my friends who teach in other schools how ICT integration makes life easier”.

According to James, those teachers that had a negative attitude towards ICT use must be challenged to reconsider their subject matter content and the impact of ICT on the development of that subject itself as well on teaching and learning that subject. He argued that seemingly teachers have a negative attitude towards ICT because they consider it a tool to do science rather than a tool embodying science.

All teacher participants had a positive attitude towards the use of ICT for instructional purposes and those who were using ICT at that time (Anna, Mcusi and James) strongly agreed that they will continue to use it for teaching and learning. This finding suggested that teachers were willing to teach genetics using ICT.

It was necessary to know about the general perspectives on ICT in education to understand how it could be applied in the classroom. To find out what the participant's perspectives were about ICT in education, I asked the question, “What is your perspective on ICT in education?”. All four teachers had a positive view of ICT in education. They all believed that it enhanced the lesson because the use of visuals like pictures and videos catered even for visual learners and made lesson delivery faster compared to using a traditional chalkboard where you have to write things on the board then wait for learners to copy what you have on the board into their books. Thato further on went on to comment that although he saw ICT in education as a great initiative, he believed that South Africa still had a long way to go. His comment was informed by the fact that at the school that he was teaching, there were limited resources for ICT which were being utilised by a few teachers. Although he would like to teach using ICT, he was currently not able to do so because of limited resources at his school. One would assume that he would have been given first preference when the school was allocating smart classes to educators since

he was teaching grade 12s but that was not the case. When asked what might have caused that he said at his workplace, teachers had a sense of ownership over classes. He further added that he was disappointed in the limited availability of ICT tools at his school because, if for instance there was a data projector, he would utilise it for his lessons.

The teacher's own pedagogical beliefs and values play an important part in shaping ICT-mediated learning opportunities. Teachers were willing to use ICT because, with ICT, they could keep and retrieve information records, carry out assessments of learning with ease and speed and even communicate with parents.

4.4.4 Frequency of ICT integration

According to Bulut and Delen (2011), educators in many countries are beginning to use ICT to change classroom teaching and learning. To find out if my participants were also using ICT for change, I asked the question, "How often do you use ICT tools for classroom instruction? What informs the decision to use ICT for instruction on those particular days?" Three out of the four teachers interviewed used ICT equipment every day for their lessons. They stated that when they planned their lessons, they planned in such a way that ICT tools have to be utilised. Thato did not use ICT equipment in his lessons simply because he did not have ICT resources. Bulut and Delen (2011) suggest that due to improvements in technology, ICT equipment has become cheaper and more sophisticated. However, they further state that despite the increase in the number of ICT equipment, it is not everyone who has the same access to these technologies. This was the case with Thato who from his other responses had stated that if he had an opportunity, he would use ICT for instruction because he has heard from other teachers and also noticed during his teacher training how beneficial ICT was.

4.4.5 Effect of ICT integration in Genetics instruction

To find out the impact ICT had on specific content knowledge and how that related to different teaching practices, I asked the question, "What impact has the use of ICT had

on specific content knowledge (genetics) and how does this relate to different teaching practices?” From the responses, it seemed that ICT had a positive impact on the teaching of certain abstract topics like genetics because participants had stated that as a teacher, it allowed you to use visuals like pictures and videos to show learners what is not readily available for them to see. Mcusi stated:

“Basically, genetics is not an easy topic to teach so when you are speaking about genes, genetic information and DNA, it is very difficult for learners to comprehend because it is not something that they can see with your eye so the use of ICT allows us to have videos that can be watched by learners, to sum up everything. Videos show how genes are transferred and they work in a visual form so that learners can understand concepts like genes because they are not easy to teach”.

According to James, ICT visualisations can make the invisible visible. James went on to state that using videos can save time because they explain the content in a short space of time. However, he also stated that videos need to be scrutinised since most of them are produced in other countries, thus language and terminology might differ. At times, some videos that are uploaded on platforms like YouTube might have been produced and uploaded by novices, therefore, you must be selective because some of their content might not necessarily be correct. These teacher responses provided an example of consideration of learners’ understandings, thinking and learning with ICT. They have justified how a lesson taught with ICT is beneficial and how without the use of ICT the lesson might lead to misconceptions.

The way ICT is used in the classroom is influenced by the teacher’s knowledge about their subject and how ICT is related to it. Anna, Mcusi and James were willing to use ICT to teach the topic of genetics and were able to use their subject expertise to select appropriate ICT resources which helped them meet the specific learning objectives. The use of ICT equipment allowed teacher participants to bring events of far distance in time and space into the classroom for lesson discussion (Maundu, Midigo and Mwanda, 2017).

To find out the teachers’ opinion on the influence of ICT use on learner achievement, I asked the following question, “In your own opinion, do you think the use of ICT for

teaching and learning influences learner achievement? Provide reasons for your opinions.” Anna, Mcusi and James stated that from their experience that ICT influences learner achievement. They indicated that they had noticed that since they started using ICT for teaching and learning, their learners’ marks were improving. For Anna, that was because using ICT allowed her as a teacher to make use of visuals, so, her learners were able to see things that they would not normally see. For example, with visuals when teaching about the three types of dominance in monohybrid crosses, she was able to show her learners the pink flower to represent incomplete dominance and show them a flower that has an equal distribution of red and white patches when she was teaching about co-dominance. She also added that using visuals was better than using a drawing from the textbook because visuals are colored and their images are clearer. While Anna’s background with technology in teaching her subject was limited, she believed that her learners were able to understand the content better with ICT integration, as a result, she consistently taught using ICT. In her view, ICT is easy to use once you know how to use it. James stated that:

“The use of ICT for teaching and learning can influence learner achievement positively or negatively depending on the learner. It gets the visual learners to also be involved not just the auditory learners. It can be a big distraction though for many learners which is a huge problem. When it is a distraction, then, it does not promote learner achievement because they get busy with other things instead of using ICT for learning. If learners are disciplined, then, ICT can have a positive impact”.

4.4.6 Challenges faced using ICT for Instruction

To find out what obstacles’ teachers came across when using ICT, I asked the question, “Which obstacles and challenges do you face with using ICT for instruction?” It was deemed important to explore these challenges as they may have a direct impact on how instruction takes place and the attitudes of the teachers towards the use of ICT. Load shedding has been cited by three out of the four educators as being an obstacle in using ICT. Mcusi said:

“For me, the main obstacle I have is load shedding. When there is load shedding, it is not easy to access these gadgets, thus, it becomes tricky because you find that I had planned a lesson when I was going to use PowerPoint Presentation slides and I had intended for learners to watch a video. Then, all of a sudden, there is load shedding, so now, I have to teach using the traditional method which becomes inconvenient. Sometimes even technical problems also arise, for instance, you might think that you had saved something, but you did not. However, that one can be overcome by double-checking when you are saving the work and saving in different folders”.

Thato said:

“I do not use it but my colleagues complain about load shedding almost every day from 8:00 am to 10:00 am which makes it to be difficult for them to prepare for their lesson using ICT”.

The participants explained that if you had planned to use PowerPoint slides that had visuals like pictures, videos and animations, then, when there is load shedding, you cannot access them anymore. So, that becomes a problem because you must change your approach to teaching and use the traditional method of teaching where you must use the chalkboard. Now a huge problem arises when you have to draw diagrams and if drawing is not your strong point, you might end up drawing inaccurate diagrams. During the classroom observations, it was evident that load shedding is indeed an obstacle. When I was observing Anna’s lesson, in the middle of the lesson, the power went off and the lesson was disturbed. Thus, the teacher ended up having to teach from her laptop because the school did not have a back-up generator. That was a disadvantage because learners could no longer see the diagrams, she had prepared for them to see rather they had to listen attentively and try to visualise the diagrams.

The main challenge that teachers cited was the issue of load shedding as being the biggest obstacle. They also added inadequate training as being an obstacle because it resulted in teachers not being confident enough in using ICT tools. Thato said that these might be because:

“Some have started teaching in the early '90s, so they are not familiar with the technology. They do not use the smartboard to its full capacity due to the minimal training they received”.

James stated that the main challenge for him was that the internet was slow and data were very expensive in South Africa. During the lockdown period, he conducted his lessons via Zoom but could not reach all learners since others did not have money to buy data.

4.5 Summary of chapter

The main research question for this study, “To what extent are practising teachers willing to use technology in the classroom for the instruction of genetics?” aimed to explore the perception of practising teachers towards the use of technology for classroom instruction especially in teaching the topic of genetics. Second, it meant to find out if teachers considered themselves competent in using ICT for teaching and last, determine challenges that they came across when teaching genetics using technology. From the investigation, I found out that teachers had a positive attitude towards ICT use in the classroom. According to **Gressard and Loyd (1985)** teachers’ attitudes towards ICT are a key factor in the successful implementation of ICT in education. Teacher participants in this study believed that ICT use helps learners to understand and retain the concepts taught better. They highlighted that for them with ICT, teaching becomes easy, effective and convenient. This is supported by Ratheeswari (2018) who contends that the role of technology in education is to aid teaching and be a tool to enhance the entire learning process.

The study revealed that 3 teachers (Anna, Mcusi and Thato) did not consider themselves competent when it comes to ICT use. Although they were flexible in using ICT in their teaching of different concepts, they felt limited because there were certain ICT features that they could not use. James who was in his late forties considered himself competent when it came to ICT use. What was intriguing about this was that one would have assumed that young teachers are the ones who would consider themselves competent when it comes to ICT use as opposed to an older teacher. Then, this finding helps to

dispel the myth that younger teachers are more competent when it comes to ICT as opposed to older teachers.

Although the use of ICT has made the process of teaching and learning more effective and enjoyable, it comes with challenges. Load shedding was cited by three teachers (Anna, Mcusi and Thato) as being a huge disturbance to lessons that were meant to be carried out using ICT. Load shedding is something that is still on-going, as such, in education, we need to come up with ways of how we can carry out lessons with ICT use without having to worry about load shedding. James cited slow internet and the price of data as the main challenge for him. This is a disadvantage for learners who have to miss lessons conducted online (zoom, Microsoft teams) because they cannot afford data.

Chapter 5

DISCUSSIONS

5.1 Introduction

This study aimed to investigate East Rand practising teachers' willingness in teaching genetics using ICT. A qualitative method was used to carry out this research focusing on teacher's perspectives and classroom practices where teacher participants were interviewed, and classroom observations also took place. Qualitative research is the method of observation to gather non-numerical data and is concerned with understanding the participant's perspectives and thinking. In doing so, it provides insights into the problem. Data from the interview and lesson observations were triangulated. Triangulation in this study allowed for the validation of data through cross verification and attempted to enrich the study by explaining different aspects of the issue and in so doing mapped out the complexity of the participants' responses to assess the causes influencing the results produced (Kennedy, 2009). To ensure credibility, during the interviews, participants were encouraged to support their statements with examples so that there was prolonged engagement. For the study to be trustworthy, all transcripts of the interviews were sent to the participants for feedback. In addition, halfway through the study period, a virtual meeting was held with those who had participated in the interview, enabling them to correct the interpretation and challenge what they perceived to be wrong interpretations. For transferability in this study, I provided a context in which the research was carried out, its setting, sample, and sample size under the section of data analysis. Piloting assisted me as a researcher to enhance the credibility of my qualitative study. It provided an opportunity to resolve issues that may have otherwise hindered the main project. Through piloting, I was able to focus on and expand my research topic and was also able to gain a clear conceptualisation of the focus of the topic. I did a pilot study because I had hoped that any other practical issues and difficulties could be discovered to see if they could be resolved before the main project began. After obtaining approval from the Wits ethics committee and the Department of Education, I recruited two of my colleagues who taught Life Sciences for the piloting exercise. I informed my colleagues

that their participation would be in a pilot study intended to guide a main body of research. The methods of data collection used in this pilot were in-depth interviewing and classroom observation. Interviews were conducted at the time, which was convenient for the participants and was recorded on a tape recorder. At the end of each interview, a member check was made as part of the necessary process for establishing credibility.

5.2 Interview and observation findings combined

When asked during the interview what participants understood by ICT, their responses during the interview showed that all participants had an idea of what ICT is because, from their explanations, they were able to state that ICT referred to technological tools that can be used to support lesson delivery. However, only two participants were able to correctly denote that ICT stands for Information and Communications Technology. Findings by Leach and Moon (2000) show that some teachers only superficially accept technology into their work. However, could it be that the two teachers who could not correctly state what the acronym ICT stands for are part of the group Leach and Moon (2000) were referring to? When observing the two teachers who could not state what the acronym ICT stands for, I found out that although James did not know what ICT stands for, he was knowledgeable in using ICT and enjoyed using ICT for the teaching and learning process, which means that James is not part of the group that Leach and Moon (2000) referred to when they said other teachers superficially accepted technology in their work. For Thato, it was hard to tell because he did not utilise any ICT equipment during his lessons due to a lack of resources.

During the interview when participants were asked if they considered themselves knowledgeable when it comes to ICT, only one participant (James) out of the four participants considered himself knowledgeable and competent. According to Bhattacharjee and Deb (2016), a competent teacher has several skills and techniques for providing successful teaching. During classroom observations, James seemed to know his way around the ICT tools in his classroom as he presented his lesson confidently using the smartboard that was connected to his laptop while his learners were working

on their tablets. I believe James is indeed knowledgeable and competent in using ICT because he was successful in using ICT equipment to make the teaching and learning process easy and interesting. During the interviews, the other three participants stated that they did not consider themselves competent in using ICT. When asked to elaborate on why they did not consider themselves competent, their main reason as they put it is that they were able to use ICT tools like smart boards to make notes, show a PowerPoint presentation and play a video but there were certain things that they could not do on their own using a smartboard like drawing diagrams. Abbott, Beauchamp, Blakeley, Cox, Rhodes and Webb (2004) suggest that without teachers' skilled pedagogical application of educational technology, technology in itself cannot provide innovative school practice and educational change. During classroom observations, the two teachers (Anna and Mcusi) who were using a smartboard for their lessons only used it for a PowerPoint presentation. They did not use the smartboard to draw diagrams or even use other features that come with a smartboard to enhance the lesson and this observation supports what they had stated during the interview. This makes the findings by Niess (2008) to be valid. She previously stated that with the addition of ICT as tools for learning, the preparation of teachers must evolve towards preparing teachers to be able to use ICT equipment in various ways. The three teachers in my study have stated that they are not competent in using ICT because they were not able to use ICT in various ways. They were limited to using ICT for PowerPoint presentations and showing pictures and videos because those were the only things they could do on their own. These findings also endorse Fullan (1992) who contend that "educators' vision of the potential for educational change with new educational technologies underestimate how difficult it is for teachers to implement the changes that will be required in their practices and skills".

When asked during the interview which ICT equipment teachers had in their classrooms and if they utilised all the equipment in their classrooms, three teachers (Anna, Mcusi and James) stated that they had ICT tools like smartboards, laptops and smartphones which they utilised almost every time they delivered their lessons. Teachers Mcusi and James went on to add that they also had overhead data projectors in their classrooms which they utilised when they were not using the smartboard. The only ICT tool that Thato had was a laptop that he did not use for lessons but only for recording marks and typing the

learners' tests. Interestingly, the Gauteng Department of Education is advocating for the integration of ICT in education because it is believed that ICT offers exciting approaches to teaching and learning. If used properly and extensively, it could bring progress that could improve education radically, yet we have Thato, a grade 12 Life Sciences teacher teaching in a classroom that lacks ICT equipment. This lack of ICT equipment becomes a dilemma for such teachers because even though they are willing and passionate to use ICT tools in their teaching, they do not have adequate equipment to implement the ICT integration. A study conducted by Suryani (2010) suggests that although it is believed that technology can bring education from the dark age to the light age, a lack of ICT equipment causes problems because although teachers are willing to use ICT, without that equipment, they have no choice but to continue with the traditional method of teaching.

Technological developments like data projectors, computers and 3D visualisation tools have been identified by Ratheeswari (2018) as great sources for teachers to help learners grasp a concept easily. When participants were asked during the interview what types of hardware and software communications tools they used and for what purpose, responses from participants showed that participants did not have a good understanding of the terms software and hardware communications tools. Although they were able to state that they used laptops and data projectors, they did not know whether a laptop is a software or a hardware tool. However, Mcusi knew what was meant by software tool because from her response, she stated that software tools included Microsoft words used for typing notes and creating activities, PowerPoint presentation for preparing slides that are used for teaching and excel that is used for recording marks on a spread sheet that has learners' names but was honest enough to say that she did not have a clue of what was meant by hardware tools. This finding could lead one to assume that developmental workshops that teachers attended when ICT was being introduced in schools did not properly cover aspects such as software and hardware communication tools.

Teacher's attitudes are filters that guide them during instructional and curricular decision-making, as such, attitude affects how teachers implement innovations (Levin & Wadmany, 2006). During the interview, participants were asked what their attitude was towards ICT

especially for instruction. All teacher participants had a positive attitude towards the use of ICT for instructional purposes and those who were using ICT (Anna, Mcusi and James) strongly agreed that they will continue to use ICT for teaching and learning. This finding suggests that teachers are willing to teach genetics using ICT. Their attitude was informed by the fact that ICT assists in time management. According to Suryani (2010), one of the reasons why teachers have a negative attitude and are reluctant to use ICT for teaching is because they have the assumption that ICT will replace their roles in the classroom. The findings of my study show that teachers have a positive attitude towards ICT because these teachers understand that ICT is not replacing them. Rather, with the use of ICT, they will not be the only source of all knowledge anymore but will be supervising their learners' during the learning process. The participants have a positive attitude because they believed that ICT enhances learner performance as it keeps them interested in the lesson especially if visuals are being used as that improves the quality of teaching and learning in schools and so help raise standards. This researcher is of the view that teachers tend to adopt new classroom practices if the new practices are consistent with their beliefs.

According to Chowdhury and Farhana (2019), teachers' perspectives are an important aspect that influence their adoption of ICT in teaching and learning since their beliefs are closely linked to their use of ICT for instruction. Chamblee and Slough (2000) further state that teacher's view of technology can present a major barrier to the use of technology in the classroom. When participants were asked during the interview about their perspectives of ICT in education, all four teachers had a positive view about ICT in education. They all believed that it enhanced the lesson since the use of visuals like pictures and videos caters even for visual learners and make lesson delivery to be faster compared to using traditional chalkboard where you had to write things on the board, then, wait for learners to copy what you had on the board into their books. The teachers all stated that they used ICT to support their teaching in ways that they thought appropriate. Thato further went on to comment that although he saw ICT in education as a great initiative, he believed that South Africa still had a long way to go. His comment was informed by the fact that at the school that he was teaching, there were limited resources for ICT which were being utilised by a few teachers. Although he would like to

teach using ICT, he was currently not doing so because of limited resources at his school. One would assume that he would have been given first preference when the school was allocating smart classes to educators since he was teaching grade 12s but that was not the case. When asked what might have caused that he said at his workplace, teachers had a sense of ownership over assets and classes. He further added that he was disappointed in the limited availability of ICT tools at his school because, for instance, there was a data projector, he would utilise in his lessons. According to Mishra and Koehler (2006) TPCK is a complex form of knowledge shaped by a large number of contextual factors such as school organisation, curricula, students' socioeconomic backgrounds and technology. This study has shown that this is true, especially in the case of Thato who was willing to teach using ICT however due to contextual factors in the school organisation and lack of technology he did not teach with technology. This teacher's frustration is shared by many other teachers who are also willing to integrate ICT in their lessons but the limited availability of ICT equipment in their schools discourages them. This was also claimed by Suryani (2010) who state that some of these teachers are not taking ICT training seriously anymore since they know that no matter how good they are in training, they will not be able to implement it in their schools due to insufficient ICT facilities.

During the interview, the teachers were asked how often they used ICT tools for classroom instruction and what informed the decision to use ICT for instruction on those particular days. Three out of the four teachers (Anna, Mcusi and James) stated that they used ICT equipment every day for their lessons. During classroom observations, all three teachers integrated ICT into their lessons. Thato was the only teacher who taught using the chalkboard and chalk during his lesson because his classroom did not have ICT resources.

The researcher asked the teachers about the impact the use of ICT had on specific content knowledge (genetics) and how that related to different teaching practices. From the participants' responses, it seemed that ICT had a positive impact on the teaching of certain abstract topics like genetics because the participants stated that ICT allowed them to use visuals like pictures and videos to show learners what was not readily available for

them to see. The use of ICT equipment allowed teacher participants to bring events of far distance in time and space into the classroom for lesson discussion (Maundu, Midigo & Mwanda, 2017).

When teachers were asked if they believed that the use of ICT for teaching and learning can influence learners' achievement, Anna, Mcusi and James stated that they initially thought ICT does not influence learner achievement. However, since they started using ICT for teaching and learning, their learners' marks were improving. Mishra and Koehler (2006) regard TCK as an understanding of how technology and content influence and constrain one another. This includes the understanding of how subject matter can be changed by the application of technology and what kind of technologies can be used to facilitate the learning of the subject matter. Anna and Mcusi mentioned during interviews that for them technology has enabled Life Sciences as a subject to be understandable to their learners as such even their results have improved, that is because through the use of technology during lessons they were able to use visuals which made the content more accessible to learners. For Anna, using ICT allowed her as a teacher to make use of visuals, thus, learners were able to see things that they would not normally see if she was not using ICT equipment. She also added that using visuals was better than using a drawing from the textbook because visuals are coloured and their images are clearer. During classroom observations, Anna used the smartboard to show her learners' visuals when she was teaching about the three types of dominance in monohybrid crosses. She showed her learners the pink flower to represent incomplete dominance and a flower that had an equal distribution of red and white patches when she was teaching about co-dominance. While Anna's background with technology in teaching her subject was limited, she believed that her learners were able to understand the content better with ICT integration. As a result, she consistently taught using ICT. In her view, ICT is easy to use once you know how to manipulate it. Golombek (1998) suggests that beliefs largely determine how and why teachers adopt new teaching methods. This is true for this study because the beliefs that these teachers have are the reason why they integrate ICT into their lessons.

For this study, it was important to find out the challenges that teachers faced when using ICT equipment for teaching and learning as those challenges could have a direct impact on how instruction took place and the attitudes of the teachers towards the use of ICT. During the interview when teachers were asked what obstacles and challenges, they faced when using ICT for instruction, load shedding was cited by three out of the four educators (Anna, Mcusi and Thato) as being one of them. The participants explained that if an educator had planned to use PowerPoint slides that had visuals like pictures, videos and animations when there was load shedding, you could not access them anymore. That became a problem because one must change his/her approach to teaching and use the traditional method of teaching where you must use the chalkboard. By doing so, a huge problem arises when you have to draw diagrams especially when drawing is not your strong point, you might end up drawing inaccurate diagrams. During the classroom observations, it was evident that load shedding is an obstacle. When I was observing Anna's lesson, in the middle of the lesson, the power went off and the lesson was disturbed. Thus, the teacher ended up having to teach from her laptop because the school did not have a back-up generator. That was a disadvantage because learners were no longer seeing the diagrams, she had prepared for them to see. Rather, they had to listen attentively and try to visualise the diagrams. Those learners who could not successfully form mental images for themselves on an abstract concept like genes and chromosomes were greatly disadvantaged because of load shedding.

Teachers also cited inadequate training on the use of ICT equipment as being a hindrance because it results in teachers not being confident enough in using ICT tools. They contend that had they received proper and adequate training; they would be competent in using ICT equipment.

James stated that the main challenge for him was that data is very expensive in South Africa. During the lockdown period, he conducted his lessons via Zoom but could not reach all learners because others did not have money to buy data. So, despite learners having ICT tools like tablets and smartphones, these gadgets were sometimes not useful without internet access. The learners who could not afford to attend Zoom classes due to lack of funds to buy data were left behind while others continued with lessons.

A study conducted by Levin and Wadmany (2006) suggest that the challenges faced by teachers often limit their ability to provide instruction congruent with their beliefs. This is also the case in my study for the challenges that these teachers faced affected their ability to provide instruction which they believed could make the content more accessible and understandable to learners.

5.3 Chapter summary

This study explored the willingness of teachers to teach genetics in the context of a technology-based classroom. The study assumes that teachers' willingness and classroom practices are interrelated, thus, the study not only focused on teachers' responses but observations of classroom practice as well. For this investigation, classroom observations took place because I believed that teachers' actual practices cannot be predicted on a teacher's expressed belief about ICT in education. The study argued that it is possible to change teacher's classroom practices especially when they see the positive that comes with using ICT for instruction. Fortunately for this study, all four teachers had a positive attitude towards ICT, but the question remains if they always had a positive attitude towards ICT or their attitude changed from negative to positive once they started using ICT and realising its benefits. Findings of the study show that teachers have knowledge of what ICT is and although not all of them considered themselves competent enough when it comes to using ICT, proper structured developmental training on the use of ICT is what can assist these teachers to become competent and gain confidence in using ICT for teaching and learning. The study also revealed that teachers' attitudes and perceptions of the role of ICT for instruction are closely linked to how ICT is used for instruction.

Chapter 6

CONCLUSIONS

6.1 Introduction

Technology is an integral part of our everyday lives; thus, the Gauteng DoE has introduced ICT in the education system through setting up multimedia classrooms in several schools. There is a revolution underway in classrooms as schools adopt a new style of classrooms and pedagogy that is focused on mobile learning. However, several external and internal factors affect the proper implementation of ICT in classrooms. To succeed, the move to anytime, anywhere learning must be supported by a strong foundation in ICT and teachers' willingness to use ICT for instruction.

6.2 Addressing research questions

The results show that teachers in my study both male and female were willing to use ICT for teaching genetics. They believed that integrating instruction with ICT is the best way to improve the quality of teaching and learning. For these teachers, integrating ICT in teaching Life Sciences allowed the bringing of content closer to the learners. ICT has a positive impact on education, as such, teachers should take advantage of this in a good light so that they can achieve excellence.

The effective implementation of ICT programmes depends on the teachers' willingness and their positive attitude towards ICT. Despite increasing access to ICT in schools, teachers are usually portrayed as hesitant users. When teachers are not confident in the usage of ICT tools, they tend to have a lower perception of its value. Thus, the tools will not be used to their full capacity. The study reveals that practising teachers have a positive perception of the use of technology for classroom instruction. They believed that by using ICT tools like a smartboard or data projector to show learners videos or pictures of abstract content like genes, the learners could easily grasp the content.

My findings show that practising Life Sciences teachers did not consider themselves competent in using ICT for teaching. Teachers' competency on how to use ICT in the teaching and learning process has an important effect on either the use or non-use of ICT tools. A well-designed educator training programme is important in meeting the needs of teachers who want to learn how to use ICT effectively for teaching and learning. My study has shown that even with adequate ICT equipment access, effective professional development remains a reason that makes it difficult for teachers to be competent when it comes to ICT. Teachers have stated that they are not provided with a sufficient amount of professional development. Research conducted by Papanastasio, Vrasidas and Zemblyas (2003) indicates that simply providing teachers with professional development opportunities related to using technology does not translate into the integration of ICT in the classroom. Successful teacher use of ICT for instruction hinges on knowing how to manage ICT efficiently and over-coming barriers that come with integrating ICT in the classroom. Development workshops will help boost Life Sciences teachers' confidence in acquiring the necessary ICT skills so that they become competent. Teachers need intensive training in the use of ICT to facilitate its integration. They must be supported, and their needs must be met throughout the implementation process.

Teachers have a desire to integrate ICT into education. However, they face many obstacles. The study has shown that the challenges that practising Life Sciences teachers come across when teaching genetics using technology include load shedding, slow network and expensive data. Smart classrooms not only require ICT equipment but also a strong Wi-Fi signal that assures the teacher and the learners of anywhere anytime connectivity for a range of devices (Build the 21st Century Classroom, 2018). Slow networks and shortage of ICT equipment may cause teachers to feel discouraged and abandon the implementation of ICT into their practice. Unfortunately, these teachers sometimes faced challenges due to inadequate support in their schools. This is because, in some of their schools, there is no good coordination and management system of ICT applications. According to Suryani (2010), for successful ICT implementation in schools, there should be a clear job specialisation stating who will be responsible for assisting teachers, monitor the progress of ICT in schools and conduct training. By doing so, teachers do not become reluctant to use ICT because of not getting immediate help when

encountering a challenge in using ICT. The other challenge that this study revealed is that of access. Other schools do not have access to ICT facilities which is a cause for concern especially since this study and other studies have shown that ICT has the potential to change traditional classrooms into smart classrooms.

6.3 Conclusions and recommendations

The study concludes that not all schools are properly equipped with ICT equipment despite the positive attitude that teachers have towards the integration of ICT in teaching. Some schools were not well equipped with ICT facilities and there were several challenges that teachers came across. These challenges include load shedding, slow network, expensive data and a lack of access to ICT resources. While teachers in the study are willing to teach Life Sciences with ICT equipment, a majority of them is not highly competent in using ICT for instruction. Thus, the study makes the following recommendations:

6.3.1 Recommendations

- The Department of Education should formulate clear policies to guide the process of allocation of ICT equipment to schools. All core subjects need to be prioritised. If the school does not have enough ICT equipment then a rotational time-table should be drafted by the school which will give all teachers a fair chance to use ICT classrooms.
- Teachers need to work closely with the schools' ICT team to create a schedule for the use of ICT classrooms especially in schools where there are limited classrooms with ICT equipment like was the case for Thato.
- In-service and pre-service teachers should be trained to properly integrate ICT in their daily classroom practices.
- Continuous professional development workshops should be organised by the Department of Education for teachers to be competent in using ICT. In these course workshops, teachers need to be provided with proper and adequate information about the function, usage and benefits of ICT. Current situation is that workshops on ICT are once off which is not enough as such workshops must be on-going.

- When there is a need for teachers to attend developmental workshops on ICT integration, they should be allowed to go for these courses. It is recommended that teachers be constantly asked if they need to attend ICT courses and the feedback must be sent to districts for further action. If a teacher feels that he/ she is not competent enough and wishes to attend an ICT course, then, the teacher's wish must be granted. This will make teachers move towards the integration of ICT in the classroom and find it useful in no time.

Teachers who have already attended workshops and deem themselves as competent should be observed to see if the knowledge they have acquired is put to good use. Regardless of suggestions made, the integration of ICT for instruction very much still depends on the teachers themselves.

- In addition, there is a need for the Department of Education to start investing and providing schools with backup generators so that lessons are not disturbed due to load shedding.

Finally, free data or the internet need to be made accessible so that teachers and learners may be able to view pre-recorded video lessons and access learning materials such as past question papers from various reputable websites.

6.4 Limitations of the study

There were limitations to this study that the reader needs to take note of. The findings of this study should not be generalised to all Gauteng schools as the data were collected from four secondary schools in the Gauteng province in South Africa. The data were collected from only four teachers which is a small sample size. As such, it is difficult to generalise the findings to a broader population. These participants were selected because of ease of accessibility. Nonetheless, the study relies very heavily on the honesty of its respondents. As such, the findings are valid in terms of the opinions of the four teachers that participated in this study and provide us with factors that could influence Life Sciences teachers' willingness to use ICT to teach the topic of genetics.

The collection of data for this study got delayed due to lockdown so data collection had to be conducted after the restrictions were eased. However, due to Covid 19 restrictions, certain schools were a bit reluctant to allow visitors on their premises. Nevertheless, after several attempts in convincing the school's principals that I would observe all social distancing protocols, I was allowed to do my classroom observations.

6.5 Reflections

I have demonstrated my interpersonal and communication skills at various stages of doing the research report. My listening skills have proved to be highly valuable in terms of understanding vital information given by my supervisor and the panel I had presented my research proposal to. It increased the quality of my work because this advice was fully understood and implemented. My interpersonal skills played a positive role when I was preparing for the research proposal presentation. I asked my colleagues to be an audience when I was rehearsing my presentation so that they could provide me with their opinion regarding the quality of my presentation.

Answering the research questions in my research report was directly related to the quality of secondary data and the choice of methodology. As a result of comprehensive analysis, the most reliable sources of secondary data used in this research report included credible websites, published books, articles and journals. On the other hand, the choice of data collection for this study was guided by the reliability of the data analysis methods and their relevance to the research issues. It is fair to state that all of the research questions in my research report have been effectively addressed because the data used for this research report was obtained from reliable sources Also, a relevant methodology was used to conduct the study and the research findings have been critically discussed.

For the entire duration of this research report, I had chances of meeting my supervisor face to face and virtually. Through this, I obtained practical support regarding various aspects of the work during these meetings. Our first meeting was mainly dedicated to clarifying our expectations and discussions took place related to the issues of selection of the research approach and formulation of research questions and objectives. By the time I had a meeting with my supervisor for the second time, the introduction had been

completed and I received detailed feedback. Subsequent meetings were held about data analysis and presenting the findings. During the final meeting with my supervisor, the overall work had been scrutinised and a set of specific points were mentioned by my supervisor. Specifically, my supervisor raised a point that my discussions of research findings lacked depth. Then, after these points had been addressed, the final draft of the research report was completed. I found the advice given by my supervisor helpful in terms of increasing the quality of my research report and equipping me with knowledge of effectively conducting in the future. Moreover, my supervisor was not only highlighting the shortages that were associated with the project but also giving detailed explanations why these changes were important.

Conducting the research increased the level of my professional competency in several ways. My supervisor made it clear that it was important to critically analyse issues related to the research instead of just offering a description of the issues. She stressed many times that critical analysis and discussions are the main elements of the report and increase its value. For the same reason, I had to revise my research report several times until my supervisor was satisfied with the level of work I produced. Although such an approach to work seemed challenging and confusing during the research process, the skills of critical analysis that I have developed and applied in this research report will assist me in the future in my professional capacity. Completing the research report was similar to my duties as a teacher in terms of organising, planning and meeting deadlines. Moreover, my writing skills have also improved as a result of engaging in this research report. From this point of view, engaging in research was a very beneficial experience for me on both a personal and professional level. As a result of this research report, my research interest has been enhanced. It has increased the level of my motivation for studying, making bold plans for my future career. As such, I am planning to enrol for a PhD in ICT education.

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Appendices

APPENDIX 1

Research interview questions

1. What do you understand by ICT?
2. Do you consider yourself knowledgeable when it comes to ICT? Explain in detail why you consider yourself knowledgeable or not knowledgeable.
3. What is your perspective of ICT in education?
4. Which ICT equipment do you have in your classroom? Do you utilise all the equipment you have mentioned? If not, explain with reasons.
5. What is your attitude towards ICT especially for instruction? What informs that attitude whether negative or positive?
6. Which types of hardware, software and communications do you use and for what purpose?
7. How often do you use ICT tools for classroom instruction? What informs the decision to use ICT for instruction on those particular days?
8. What impact has the use of ICT had on specific content knowledge (genetics) and how does this relate to different teaching practices?
9. What obstacles and challenges do you face when using ICT for instruction?
10. In your own opinion, do you think the use of ICT for teaching and learning influences learner achievement? Provide reasons for your opinion.

APPENDIX 2

Interview transcript and how I analysed it

Interviewer: What do you understand by ICT?

Anna: It is the Integrated Curriculum Technology. It helps a lot when it is coming to teach because it minimises the writing on the chalkboard and you can even display pictures on the smartboard and therefore even the learners become active when listening to you they even check if the diagrams are relevant to the information you are teaching.

Mcusi: ICT is an acronym for Information and communications technology. ICT is the use of different technologies such as smartphones, smartboards, projectors, laptops and anything that is in line with technology that can be used to enhance teaching and learning. The use of technology to ensure that teaching is enhanced in the classroom.

James: ICT stands for information and communications technology. It is any technology that we can use that can relay a message to someone else or be able to process information in any way to make it easier for oneself. This normally is associated with computers, cell phones, the internet, the cloud and any technology that you use to display anything to somebody else with such as projectors, multimedia Tv and so forth.

Thato: It is the system in education that uses technology or integrates technology to support and optimize lesson delivery.

Comments: All four teachers have an idea of what ICT is because from their explanations they were able to state that ICT refers to technological tools that can be used to support lesson delivery. However, only two of these four teachers were able to correctly state what the acronym ICT stands for. Anna said ICT is the Integrated Curriculum Technology while Thato did not even attempt to say what it stands for.

Interviewer: Do you consider yourself knowledgeable when it comes to ICT? Explain in detail why you consider yourself knowledgeable or not knowledgeable.

Anna: I can say it is not really that I am knowledgeable when it comes to ICT because there are so many things in ICT. When it comes to teaching I am only focusing on curriculum delivery, whatever I am giving the learners using ICT I am focusing on curriculum and some of the lessons are PowerPoint, they are already there I am not planning them remember the Department of Education is providing with prepared lessons for me it is just to add where I think there is lack of content and knowledge. So for me my ICT knowledge is moderate because I do not go into detail, some of the things on the smartboard I cannot use them because I am not competent enough but when it comes to writing, show learners the videos that one is perfect.

Mcusi: I would think to a certain extent I am knowledgeable when it comes to ICT the reason, I say this is because I do understand that ICT speaks to the integration of ICT in the classroom. I as a teacher do integrate ICT in my lessons when I teach. I do see the value and the role of ICT.

But not real deep knowledgeable. But I would like to think that to a certain extent I am knowledgeable.

James: I consider myself knowledgeable in the use of ICT. We are using ICT in my classroom up to the creative level, which means that it is much more than consumption, we are creating videos, creating quizzes, I have also created an interactive table at the back of my class, that people can use to do blended learning with. I have achieved the third prize in the Gauteng teachers award, two years ago, where I came third in the use of ICT in the classroom.

Thato: I think I have basic knowledge, not an expert or very knowledgeable because I'm not using it and is limited to my school to only a few teachers. For me, the mode of teaching is still textbook, chalk, and chalkboard.

Comments: Only one teacher out of the four considers themselves knowledgeable and competent when it comes to ICT, he explains that he does not only use ICT for consumption but he goes beyond that by including his creativity element where he creates videos and quizzes for the learners to use. The other three teachers consider themselves average when it comes to ICT knowledge reason being that they can use ICT tools like smartboards to show a PowerPoint presentation, play a video and write but there are certain things that they cannot do on their own using a smartboard.

Interviewer: What is your perspective on ICT in education?

Anna: ICT is good in education because it makes the delivery of content to be faster compared to the traditional method where you had to write notes on the board and wait for learners to copy the notes into their books. In most cases, you can even share the information with the learners using their USB so that when they arrive at the home they can load the information onto their laptops and therefore they can continue with the work even during your absence as a teacher. It performs wonders for me because it minimises stress as it is very simple and straight forward I am not struggling, everything is there we are even able to share question papers with the learners sometimes you can even show questions on the smartboard then learners with the use of their smartphones and tablets they can respond and therefore the answers reflect on the smartboard and therefore when doing corrections, it is going to be simple because the learners have already sent their answers.

Mcusi: For me, the integration of ICT in education makes life easier because most of the learners that we are teaching are technology learners so basically, they relate more to visuals in the form of videos. My perspective of ICT in education is that it enhances the teaching and learning in the classroom and it keeps learners excited and drawn to the lesson for longer. It enhances what the teacher would be doing in the classroom. To a certain extent, it does improve the results and performance of the learners because when you are using different mediums in teaching you are bringing in different things for instance videos and pictures things that were not there before so that caters even for those learners that are visual so you are catering for the vast majority unlike just using one method of teaching.

James: ICT can be well used in education and it is the future. We must use it; we cannot let the whole world go ahead and use it while we do not use it. We need to get our learners ready for the future and how they would use ICT in the workplace, but we must be careful not to use ICT just to use ICT rather it must be constructively used in the classroom. We must use a form of blended learning where we use everything good from the old method of teaching and blend it with ICT in the classroom.

Thato: I think it is a great idea, as the world approaches the Fourth Industrial Revolution. The modes of doing things are changing, i.e., modes of transportation, communication. Hence the modes of education also need to change. However, I do not see it possible anytime soon in my country South Africa.

Comments: All four teachers have a positive view about ICT in education they believe that it enhances the lesson since the use of visuals like pictures and videos caters even for visual learners and make lesson delivery to be faster compared to using a traditional chalkboard where you have to write things on the board then wait for learners to copy what you have on the board into their books. Thato further on went to comment that although he sees ICT in education as a great initiative, South Africa still has a long way to go, his comment is informed by the fact that at the school that he is currently teaching there are limited resources for ICT which are being utilized by a few teachers.

Interviewer: Which ICT equipment do you have in your classroom?

Do you utilize all the equipment you have mentioned? If not explain with reasons.

Anna: I have a smartboard, a laptop which I can connect to the smartboard using an HDMI cable. I can even include the smartphone as ICT equipment.

Mcusi: In my classroom, I have smartphones (mine and the learners), a smartboard that I use regularly if not all the time, a laptop and a projector. I would like to think that I utilize all the ICT equipment even though it would not be at the same time because at times I use a smartboard so when I am using a smartboard I do not use a projector.

James: I use all the equipment in my classroom. There are some things in the past that we have not used because it was not practical. The ICT equipment that I have in my classroom includes an interactive Tv at the front, the learners are using tablets, I use a laptop, I also have an interactive table at the back of my classroom. I also have a visualiser that we use a lot, I use it to show things that we do on a microscope or when I do experiments I do it under that or on the whiteboard at the back with blended learning. I use everything in my class in terms of ICT what I had not used was for example at some point we had a 3D projector and 3D glasses, that is because of the administration of taking out the glasses and putting them back and the actual usefulness of showing a 3D video instead of a normal video it just wastes too much time which does not make sense so we stopped using that.

Thato: I do not have ICT equipment in my class except for a personal laptop, which is also used in typing the question papers, not for lessons. No, there is no smartboard or overhead projects to display for learners.

Comments: Three teachers stated that they have ICT tools like Smartboards, laptops and smartphones which they utilize almost every time they deliver their content. Mcusi and James went on to add that they also have overhead projectors in their classes which they utilize when they are not using the smartboard. From James's response, you can tell that the school he is in is a full ICT school because he mentions that they even have an interactive TV, a visualizer, 3D projector and glass, learners use tablets instead of traditional hardcopy textbook. The only ICT tool that Thato has is a personal laptop that he does not use for lessons but only uses for typing things like the test.

Interviewer: What is your attitude towards ICT especially for instruction?

(a). What informs that attitude, whether negative or positive?

Anna: My attitude is positive towards ICT the only thing is that I need more training because there are certain things I struggle to do using a smartboard for instance I struggle to draw a graph, even drawing a diagram using the smartboard features.

Mcusi: Luckily for me as a young teacher I can relate more with ICT because I am part of the generation that use ICT for most of the stuff, my attitude towards ICT is positive because ICT improves instruction and makes learning in the classroom easy and accessible to learners and keeps them drawn to the lesson. It has the potential to improve performance in the classroom. With the current situation in our country when we are faced with COVID-19 the way we normally do things especially in education had to change because we are not able to be in contact with our learners but because of the presence of ICT, we can reach learners so that teaching and learning continues.

James: I have a pretty positive attitude towards ICT in education but as people implementing ICT in education, we have to understand that it takes some time for other people to adapt to it, change is never easy. For every classroom it needs to be different, it needs to suit the classroom and need to suit the subject and also for some people it takes time, you also need champion teachers to drive it then the rest will follow, you should never force someone to use it from the start.

Thato: I think ICT is a good thing, and I could be happy to use it for lesson delivery. I have seen it at the tertiary level, how beneficial it is. I have also heard from my other friends who teach outside South Africa how it makes life easier for a teacher. Also, how it could improve in time management during the lesson and even learners' concentration.

Comments: All four teachers have a positive attitude towards ICT, their ICT is informed by the fact that ICT assists in time management in the sense that learners do not need to copy notes into their books but can access the notes via USB from you as a teacher. They also believe that ICT enhances learner performance as it keeps them interested in the lesson especially if visuals are being used. Thato comments that although he does not have ICT in his classroom, he saw at University how ICT is beneficial and also hears from his friends how ICT makes life easier.

Interviewer: What types of hardware, software and communications do you use and for what purpose?

Anna: I have a laptop that I use for typing notes and capturing marks, a smartboard and a smartphone.

Mcusi: Software refers to Microsoft Word for typing notes, creating activities and tests, PowerPoint for preparing slides that I use to teach in class. Excel for recording marks I normally have a spreadsheet with learners' names, and I use it to capture their marks then I keep it in a safe place. I am not sure what is meant by hardware so I will skip that one.

James: This year has changed a lot of things and many things came in, I use a laptop, I use an interactive TV double board TV, interactive table at the back which is run by edu-board basis so it is a projector and a sensor that works with a pen then the front board works with a touch, the laptop that I am currently using is a Lenovo idea pad which is nice because it is a touch screen and you can write on the screen with a pen, it is a new experience that I have been using for the past 3/ 4 weeks. We recently started using google classroom, we also have our school system called NLMS, we also do Zoom lessons.

Thato: WhatsApp group with learners, I used to send them previous question papers for revision. However, a small percentage of learners do not have cell phones.

Comments: This question was poorly answered by the teachers. They were simply supposed to group their ICT tools into software and hardware. Only Mcusi did that, she started her software tools but was honest enough to say that she does not have a clue of what is meant by hardware

Interviewer: How often do you use ICT tools for classroom instruction? What informs the decision to use ICT for instruction on those particular days?

Anna: When I am planning and preparing my lessons I make sure that the lesson has to be centred around the use of ICT, there is no single day where I can teach without using ICT, I am using it every day then if there is no electricity I struggle because I then have to use the chalkboard which delays me because whatever lesson I had prepared will be affected and delayed. With ICT, everything is smooth.

Mcusi: I use ICT all the time. My classes use ICT because I teach using slides, that is how I carry out my lessons. The use of ICT reaches a vast majority of learners so what informs my decision is the fact that we live in a digital world so learners relate more with technology some using technology in the classroom ensures that learners are drawn to the lesson which will also improve their performance.

James: Because you can use videos and animations because you can write on the board and save it for the next class, a video and animation has been edited which means that when a person does it they plan it properly then when they edit it they can edit it to 5 or 6 minutes to explain the content I would have explained in 40 minutes with a blackboard

Thato: I do not use it because of the lack of ICT equipment.

Comments: Three out of the four teachers interviewed use ICT equipment every day for their lessons, they state that when they plan their lessons, they plan in such a way that ICT tools have to be utilised. Thato does not use ICT equipment in his lessons simply because he does not have the resources, from the other responses he stated that if he had a chance he would use ICT equipment because he has heard from other teachers and also saw during his teacher training how beneficial ICT is.

Interviewer: What impact has the use of ICT had on specific content knowledge (genetics) and how does this relate to different teaching practices?

Anna: It is perfect especially because when we are talking about alleles that carry colour, in genetics we have different types dominance, remember we have co-dominance, incomplete dominance whereby in co-dominance we have two parents carrying different characteristics, phenotypically they are different but there is no allele that is dominating the other so when the offspring are born they are born with equal distribution of characteristics from both the mother and the father, so with ICT learners can be able to see that if the black bull is crossed with a white bull then the calf will be born with equal distribution of black and white so with ICT it is clear because whatever that I will be explaining they can see on the smartboard, for example with incomplete dominance you find that a plant that is producing red flowers and a plant that is producing white flowers when they are going to pollinate each other so we will check the offspring of those flowers and you may find that they will produce a third phenotype which is pink. Some learners especially mostly boys are not competent with colours so at least using a smartboard will help them see how colour pink looks like, they can see everything that is clear. With the help of ICT, I have improved my teaching together with the performance of learners.

Mcusi: Basically genetics is not an easy topic to teach so when you are speaking about genes, genetic information and DNA it is very difficult for learners to comprehend because it is not something that they can see with their naked eye so the use of ICT allows us to have videos that can be watched by learners, to sum up everything. Videos show how genes are transferred and they work in a visual form so that learners can understand concepts like genes because they are not easy to teach.

James: The resources are available so you can google at any stage when you do not know something, some videos explain the content in a shorter amount of time. The resources available have become so much more and more practical for example when you go to google all themes under genetics can be found. The only thing we need to consider is that the terminology we use in South African exams is not the terminology that they use in videos produced in America.

Thato: I think if I could get the opportunity of using ICT in my lesson, it could most useful, especially in the section of platonic solids where learners can easily see the faces, vertices and edges.

Comments: From the responses, it seems that ICT has a positive impact on the teaching of certain abstract topics like genetics because as a teacher you can use visuals like pictures and videos to show learners what is not readily available for them to see. James further went on to

state that using videos can save time because videos explain the content in a short space of time. However, he also stated that videos need to be carefully scrutinised because mostly are produced in other countries thus language and terminology might differ. At times because many videos are uploaded on platforms like YouTube you must be selective because other videos have been produced by novices so their content might not be necessarily correct.

Interviewer: What obstacles and challenges do you face with using ICT for instruction?

Anna: The only thing as I have mentioned before is electricity, when there is electricity, I do not have any obstacles everything runs smoothly.

Mcusi: For me, the main obstacle I have is load shedding. When there is load shedding it is not easy to access these gadgets thus it becomes tricky because you find that I had planned a lesson whereby I was going to use PowerPoint presentation slides and I had intended for learners to watch a video then all of a sudden there is load shedding so now I have to teach using the traditional method which would be inconvenient. Sometimes even technical problems also arise for instance if you thought that you had saved something, but you did not. That one can be overcome by double checking when you are saving the work and saving in different places.

James: The internet here in South Africa is still very slow and still too expensive.

Thato: I do not use it, but my colleagues used to complain about load shedding almost every day from 8:00 am to 10:00 am which makes it to be difficult for them to prepare for their lesson using ICT. Also, some have started teaching in the early '90s, so they are not familiar with the technology. They do not use the smartboard to its full capacity, due to the minimal training they received.

Comments: Load shedding has been cited by three out of the four educators has been an obstacle in using ICT. For instance, if as an educator you had planned to use PowerPoint slides that have visuals like pictures, videos and animations when there is load shedding you cannot access them anymore so that becomes a problem because you must change your approach to teaching and use the traditional method of teaching whereby you must use the chalkboard now a huge problem arises when you have to make diagrams and drawings and they end up making inaccurate diagrams

Interviewer: In your own opinion do you think the use of ICT for teaching and learning influences learner achievement? Provide reasons for your opinions.

Anna: Exactly, I have seen with my learners, in the olden days we used to talk about colours, talking about alleles talking about pregnancy whereby you are drawing things on the chalkboard so at times our drawings were not accurate especially if you had to draw a foetus inside the woman's uterus but with ICT they can see all the development of the foetus in the uterus and everything and they cannot forget so the results are improving with the use of ICT, if a teacher uses ICT for science then results are good and learners also become active in class.

Mcusi: I would definitely say it does because it gives you different modes of teaching because visual learners are catered for and most learners are kept longer in lessons. Things examples that can be used when explaining unlike relying on one textbook so with ICT you can access a variety of examples to use from Google when explaining.

James: The use of ICT for teaching and learning can influences learner achievement positively or negatively depending on the learner, it gets the visual learners to also be involved not just the auditory learners. It can be a big distraction for many learners which is a huge problem, it is a distraction then it does not promote learner achievement because they get busy with other things instead of using ICT for teaching. If learners are disciplined then ICT can have a positive impact we found that our marks improved when we started using ICT because we also make use of 5 minutes' tests that are electronically marked such as Sakai, Blackboard, Google classroom.

Thato: Yes. It can improve time management, and more time could be used in delivering the lesson instead of writing questions on the chalkboard.

Comments: Three teachers out of the four teachers stated that from their own experience, ICT does influence learner achievement, they have noticed that since they started using ICT for teaching and learning their learner marks are improving, that is because using ICT allows you as a teacher to make use of visuals so then basically learners can see things that they would not normally see for example with visuals they can see the development of the foetus when teaching about gestation. Using visuals is better than using a drawing from the textbook because visuals are coloured, and their images are clearer. Anna's experience provides an example of how without the use of technology misconceptions could arise during the lesson.

APPENDIX 3

Classroom observation schedule

School:
Class:
Date:
Time:
Lesson topic:
Teacher's name:
Observer:

1. ICT equipment available in the classroom
2. ICT equipment being utilised for the lesson by the teacher
3. ICT tools being utilised by learner
4. What obstacles does the teacher face with using ICT for instruction?
5. What influence does the use of ICT have on the lesson?

School: School A
Class: 12
Date: 22 June 2020
Time: 12:00
Lesson topic: Genetics and inheritance
Teacher's name: Anna
Observer: Mapaseka Khanye

1. *ICT equipment available in the classroom*

- Smartboard
- Laptop
- Smart phones
- White smartboard (electronic for writing)

2. *ICT equipment being utilised for the lesson by the teacher*

- Smartboard

3. *ICT tools being utilised by learners*

- None. Learners were writing inside their exercise books they were only allowed to use their smart phones at the end of the period to receive the slides from the teacher.

4. *What obstacles does the teacher face with using ICT for instruction?*

- There was load shedding, so the teacher had to use her laptop to teach but learners were not seeing anything they had to listen attentively to her when teaching. After the lesson the teacher made the slides available to the learners through the WhatsApp group.

5. *What influence does the use of ICT have on the lesson?*

- Due to load shedding the teacher could not utilise the smart board, she used her laptop but that did not have any influence on the lesson because she was the only one who was seeing what was on the screen.

Classroom observation schedule

School: School B
Class: 12
Date: 23 June 2020
Time: 10am
Lesson topic: Genetics and inheritance
Teacher's name: Mcusi
Observer: Mapaseka Khanye

1. ICT equipment available in the classroom

- Smart phones
- Smart board
- Laptop
- Projector

2. ICT equipment being utilised for the lesson by the teacher

- Smartboard

3. ICT tools being utilised by learners

- None. Learners were writing inside their exercise books

4. What obstacles does the teacher face with using ICT for instruction?

- No obstacles seen

5. What influence does the use of ICT have on the lesson?

- It made the lesson quite interesting because the teacher showed learners a video to explain genetic lineage. I think the video made learners to understand the content better.

School: School C
Class: 12
Date: 22 June 2020
Time: 9:30
Lesson topic: Genetics and inheritance (Cloning)
Teacher's name: James
Observer: Mapaseka Khanye

1. ICT equipment available in the classroom

- Interactive TV
- Laptop
- Visualiser
- 3D projector
- 3D glasses
- Smartboard
- Tablets?/ Smartphones

2. ICT equipment being utilised for the lesson by the teacher

- Smartboard
- Laptop with HDMI cable

3. ICT tools being utilised by learners

- Tablets

4. What obstacles does the teacher face with using ICT for instruction?

- Network was quite slow especially when he had to access the internet in order to google something.

5. What influence does the use of ICT have on the lesson?

- ICT made learners to be attentive as they were watching a video. The video was explaining how cloning as an artificial process creates a genetically identical copy of an organism or biological material.

Classroom observation schedule

School: School D
Class: 12
Date: 23 June 2020
Time: 13:30
Lesson topic: Genetics and inheritance
Teacher's name: Thato
Observer: Mapaseka Khanye

1. ICT equipment available in the classroom

- Teacher's personal laptop

2. ICT equipment being utilised for the lesson by the teacher

- None. The teacher only uses the chalkboard and chalk.

3. ICT tools being utilised by learners

- Not applicable

4. What obstacles does the teacher face with using ICT for instruction?

- Not applicable

5. What influence does the use of ICT have on the lesson?

- Not applicable

Appendix 4: Ethics approval

WITS SCHOOL OF EDUCATION



SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE

PROTOCOL NUMBER: 2019ECE049M

PROJECT TITLE

Investigating practising teacher's inclination in teaching genetics with the use of ICT.

INVESTIGATOR

MAPASEKA NTINTISENG KHANYE

SCHOOL/DEPARTMENT OF INVESTIGATOR

WITS SCHOOL OF EDUCATION

DATE CONSIDERED

09 March 2020

DECISION OF THE COMMITTEE

Approved unconditionally

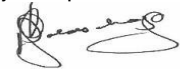
EXPIRY DATE

Date of submission of the project report

ISSUE DATE OF CERTIFICATE

12 February 2021

CHAIRPERSON


(Dr Paul Goldschagg)

cc: Supervisor: Dr Portia Kawai

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** emailed to the Ethics Office: Matsie.Mabeta@wits.ac.za .

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature

Date



GAUTENG PROVINCE

Department: Education
REPUBLIC OF SOUTH AFRICA

8/41411/2

GDE RESEARCH APPROVAL LETTER

Date:	18 February 2020
Validity of Research Approval:	04 February 2020 — 30 September 2020 2019/396
Name of Researcher:	KHANYE M N
Address of Researcher:	464 BUHLE PARK PHASE 5b GERMISTON, 1401
Telephone Number:	073 437 6321
Email address:	722164@students.wits.ac.za
Research Topic:	INVESTIGATING PRACTICING TEACHER'S WILLINGNESS TO TEACH GENETICS WITH THE USE OF ICT"
Type of qualification	MASTER OF EDUCATION
Number and type of schools:	Four Secondary Schools
Districtis/HO	Ekurhuleni South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

18/02/20
2-0 2 C

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Simmonds Street, Johannesburg, 2001

Tel: (011) 355 0488

Email: Faith.Tshabalala@gauteng.gov.za

Website: www.education.gpg.gov.za

1.Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.

Letter to principal

Dear: Principal

My name is Mapaseka Khanye. I am a student in the School of Education at the University of the Witwatersrand. I am doing research on doing research on “Investigating practising teacher’s willingness in teaching genetics with the use of ICT”. My research involves investigating the extent to which practicing Life Sciences teachers are willing to use technology for instruction. This research is motivated by my quest to find out the attitudes that practising teachers have towards the use of technology for classroom instruction, the challenges they face when teaching using technology and how using technology in teaching genetics can influence learner achievement. The research will include 4 participants, 2 males and 2 females who are teaching grade 12 Life Sciences. The teachers will be given consent forms they will need to read and sign before they can participate. For each school there will be one participant, in total 4 schools will be part of the study. The method to be used in conducting the research is a semi-structured interview and classroom observations. The research will be conducted in the first term. The interview will be conducted after school hours while the classroom observations will be conducted during school hours, dates will be agreed upon with the participants. The interviews will take 30- 45 minutes while the classroom observations will take 60 minutes maximum depending on the school time-table.

The reason why I have chosen your school is because it is a full ICT school that has ICT equipment in classrooms. Participants will be informed that this is voluntary, which means that they do not have to do it. Also, if they decide halfway through that they prefer to stop, it is completely their choice and will not affect them negatively in any way. I will also emphasise to them that there will be no prejudice in terms of their progress should they choose not to participate in the research.

I am inviting your school to participate in this research because this research will enlighten us as schools and the DoE (though on a small scale) on the challenges that teachers face when teaching using technology and how teaching genetics can influence learner achievement.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and the identity of the school will be kept confidential at all times and in all academic writing about the study. Your privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project. Data obtained through this research will be used for research report, conferences and journal articles.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE: M.Khanye

NAME: MAPASEKA KHANYE

ADDRESS: 464 BUHLE PARK PHASE 5b, GERMISTON 1401

EMAIL: 722164@students.wits.ac.za

TELEPHONE NUMBERS: 073 437 6321

Permission by Principal granted

YES/ NO

Signature of principal

Educator Consent Form

Please fill in the reply slip below if you agree to participate in my study called: "Investigating practising teacher's willingness in teaching genetics with the use of ICT"

My name is: _____

Permission to be interviewed I would like to be interviewed for this study.

YES/ NO

Permission to be audiotaped I agree to be audiotaped during the interview.

YES/NO

I know that I can stop the interview at any time and do not have to answer all the questions asked. **YES/NO**

Permission for classroom observation.

I agree to be observed when teaching grade 12 learners. **YES/NO**

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- All the data collected during this study will be destroyed within 3-5 years after the completion of my project.

Sign _____ Date _____

**LANGUAGE EDITING
CERTIFICATE**



ZANEZ EXPERT EDITING

**Registered with the South African Translators' Institutes (SATI)
Reference number 1000363**

SACE REGISTERED

28 March 2021

Report on Master Thesis: MAPASEKA KHANYE (722164)

Thesis title: Investigating practising teachers' willingness to teach genetics with the use of ICT

This serves to confirm that I edited substantively the above document including a Reference list. I returned the document to the author with some tracked changes intended to correct errors and clarify meaning. It was the authors' responsibility to attend to these changes.

Yours faithfully

Dr. K. Zano

Ph.D. in English

kufazano@gmail.com/kufazano@yahoo.com

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by Mapaseka Khanye

Submission date: 31-Mar-2021 12:25PM (UTC+0200)

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Word count: 26282

Character count: 135138

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ORIGINALITY REPORT

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Supervisor: Dr P Kawai

Signature: 