# EXPLORING THE PERSPECTIVES OF PHYSICAL SCIENCE TEACHERS ON TECHNOLOGY UTILISATION: A CASE STUDY IN MAKHUTSWE CIRCUIT

by

**MOHALE THABISO MELVAR**

submitted in accordance with the requirements for

the degree of

**MASTER OF EDUCATION**

in the subject

**NATURAL SCIENCE EDUCATION**

at the

UNIVERSITY OF SOUTH AFRICA

**SUPERVISOR: Dr P Photo**

**FEBRUARY 2024**

## DECLARATION

Name: Mohale Thabiso Melvar

Student number: 64053202

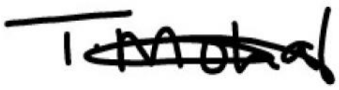
Degree: Master of Education (Natural Sciences)

**Exploring the perspectives of Physical Science teachers on technology utilization: A case study in Makhutswe circuit**

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

I further declare that I submitted the dissertation to originality-checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.



08/01/2024

_____ _____

SIGNATURE DATE

## DEDICATION

This composition is dedicated to my two younger sisters, Kabelo and Taelo Mohale. It is my fervent wish that this work serves as a wellspring of motivation, encouraging them not only to successfully attain their undergraduate degrees but to also pursue advanced academic accomplishments ambitiously, including Master's and Doctoral degrees.

## ACKNOWLEDGEMENTS

In developing this thesis, I would like to appreciate the efforts made by the following groups and individuals. Firstly, I would like to give thanks to the Almighty GOD for granting me this opportunity and courage to proceed successfully. I would like to thank my supervisor Dr P Photo with sincere gratitude for her invaluable assistance, recommendations and visions leading to the writing of this research master's thesis. My sincere gratitude also goes to the University of South Africa for allowing me to further my studies and the M&D bursary for the financial support which made the continuation of this work possible. Special thanks go to my family for always being by my side. It is due to their support and help that I managed to pursue this academic journey. I will always be thankful and appreciative to them.

## ABSTRACT

The use of technology in mainstream education has gained recognition around the world as an effective tool to improve teaching and learning across the educational curriculum system. This study aimed to explore the perspectives of Physical Science teachers on the use of technology in their classrooms in the Makhutswe circuit. To explore these perspectives the study examined teachers' knowledge about technology, the challenges they encountered when using technology, and the impact of the COVID-19 pandemic on their engagement with technology during and post-COVID-19 lockdown.

The study employed an interpretative research paradigm to interpret and understand physical science teachers' perspectives when using technology in their classrooms. A qualitative research approach was adopted in this study to better understand teachers' perspectives within their context. The study used a case study design as each teacher was treated as a unique case. Participants in this study were selected from the Makhutswe circuit population using a convenience sampling method because they were easy to access. Data was collected through semi-structured interviews, classroom observations, and document analysis from six Physical Science teachers out of ten in the Makhutswe circuit. To generate meaningful findings, each case was analyzed separately using thematic analysis.

The study findings revealed that most of the teachers had knowledge about technology use in their Physical Science classrooms. Some of them used technological tools such as laptops and projectors to conduct their lessons. However, some challenges prevented them from fully using it. Some of the barriers they mentioned were a lack of technological resources, teacher training, and adequate internet connectivity. Future research may focus on doing small-scale international comparative research on physical science teachers' perspectives on the use of technology in their classrooms. The study recommends that the Department of Basic Education make provision for technological tools, proper internet connectivity and effective teacher training for teachers, especially in rural schools. This would improve teaching and learning in rural areas.



**Keywords:** Technology; Physical Science; teaching and learning; COVID-19; rural areas

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## ABBREVIATIONS

DBE- Department of basic education

CAPS- Curriculum and Assessment Policy Statement

# CHAPTER 1

# INTRODUCTION

## 1.1. Background of the study

Globally, technology has been introduced into mainstream education as it is regarded as a convenient way to transform teaching and learning across the educational curriculum system (UNESCO, 2014). There is a possibility that technology will be used in classrooms to improve the traditional method of teaching and learning. According to Brem et al. (2021), technology can play a significant role in educational systems and human lives. This implies that students with access to technology in schools are more likely to share common innovative opportunities related to the current industrial revolution, thus enabling them to compete globally. Technology may facilitate effective communication, easy access, management, and distribution of information and knowledge in schools to help learners put their acquired skills and knowledge to work (Raja & Nagasubramani, 2018).

According to Saad and Sankaran (2020), there is a perception that the teaching profession in the 21st century requires some technological skills for teachers to adapt to and be proficient in. This would assist them in becoming comfortable with using modern computer skills and integrating technology into school subjects daily. Therefore, teachers must keep up with the millennial developments as they are technology orientated. Most developing countries are investing more funds in education to help with the introduction of technology into the educational system (Noor et al., 2020). Furthermore, teachers have an interest in using technology for teaching and learning in schools because they are convinced that it will improve classroom instruction as outlined by Chen (2022). However, in Physical Science classrooms, particularly in rural areas, some teachers show no interest (Li et al., 2019).

Studies have further shown that the use of technology can provide educational curricula with easy access to and processing of educational data (Prayudi et al., 2021). It also overcomes the boundaries of time and space while allowing people from different locations to have real-time interactions (Lutfiani & Meria, 2022). Moreover, technology can assist teachers with useful and timely feedback for both learners and teachers to keep on engaging in their learning environment. In addition, technology

provides learners with resources that allow them to interact and engage in experimental activities and scientific projects (Prayudi et al., 2021).

The significance of technology use has grown increasingly during COVID-19 national lockdown, where most of the schools especially in rural areas were shut down (United Nations Children's Fund, 2021). This unexpected shut down of schools had teachers and learners revising their teaching and learning strategies to meet their teaching and learning objectives (Adov & Mäeots, 2021). The COVID-19 pandemic triggered a sudden shift from face-to-face teaching to online teaching, which was not a merely temporary solution for the lockdown but a continuous part of the education system post-pandemic (Xie et al., 2020). The use of online teaching allowed learners to have access to instructional materials and other learning tools through the Internet and television programmes (Mahaye, 2020). The use of technology in this way has proven to be effective for the educational curricula (Mhlanga & Moloi, 2020).

In Physical Science classrooms, technologies help assist teachers to conduct teaching through videos or slides to illustrate some processes (Jumamuratov & Kaipbergenov, 2023). Furthermore, research studies conducted by Hillmayr et al. (2020) suggested that technology use has a positive impact on various learning outcomes such as the development of scientific reasoning and comprehensive understanding of science concepts. During the learning process, learners' interests will likely be stimulated by what they see and hear. Since technology is showing some good benefits in science classrooms, it becomes important for this study to explore Physical Science teachers' perspectives on the use of technology in their classrooms.

### 1.2. Problem statement

In a study conducted by Akram et al. (2022), it was indicated that most teachers perceive the value of the use of technology for themselves and their learners. They further highlight that in the context of technology-based lessons, learners participated more actively with each other than in a traditional setting (Akram et al., 2022). However, their findings showed that some teachers are still reluctant to integrate technology in their teaching of Physical Science, despite the improvements made in technology infrastructure and training programmes that are provided. Because teachers in a study conducted by Akram et al. (2022) were still reluctant to use technology for teaching; despite having the technological tools, this presented a gap to explore teachers' perspectives in the Makhutswe circuit on the use of technology in

their classrooms. Teachers' perspectives were explored in this study mainly to determine which other factors prevented teachers from using technology effectively in their Physical Science classrooms.

According to the research conducted by Khalo (2020), it shows that there are challenges faced by schools in rural areas when using technology in their science classrooms. The same findings were also found in the Akram et al. (2022) study. The main reason for these challenges was due to the lack of exposure to any form of professional development such as opportunities to attend training, workshops, or seminars regarding the use of technology in science classrooms (Akram et al., 2022; Khalo, 2020). Furthermore, Chen (2022) posits that the lack of appropriate software, lack of teachers' confidence and interest, support, and funds, lack of teachers' skills in the use of technology, infrastructure and electricity shortage are some of the contributory factors as to why schools in the rural areas face challenges when using technology for teaching and learning science. From the interviews conducted in the study by Akram et al. (2022), it emerged that most of these teachers felt their skills were insufficient for what was expected of them in terms of the use of technology for teaching science subjects. Considering what the previous studies have pointed out as factors preventing teachers from using technology for teaching, these factors remain speculations for teachers in the Makhutswe circuit, hence it is for this reason that the study sought to explore their viewpoints on using technology in their classrooms.

Additionally, due to the COVID-19 outbreak, South Africa went on a national lockdown on the 27$^{th}$ of March 2020, and this led to many schools being disrupted (Winter et al., 2021). Although some privileged schools managed to carry on with online lessons, the majority of the less privileged were forced to close without any form of teaching and learning provided to the learners (Khalo, 2020). Consequently, the inability of rural schools in South Africa to sustain teaching and learning during the pandemic highlights a critical gap in educational equity and access, warranting urgent attention in investigating technology use in rural areas.

### 1.3. Rationale of the study

The study findings and recommendations could enable the Department of Education to identify the challenges in terms of teachers' perceptions regarding the use of technology in schools. In Mercader and Gairín's (2020) study, it was discovered that

teachers who were participating in the study had access to different technologies such as laptops, iPads etc., however, they did not fully utilize them for teaching and learning purposes. Therefore, it was imperative to investigate teachers' perspectives on the use of technology in the Makhutswe circuit because they owned some of these technological tools that were used in the teaching and learning process.

It is important to note, however, that the traditional way of teaching in high schools and the disruption of the teaching process due to the COVID-19 national lockdown had the biggest impact on teachers' perspectives about advancing technology in schools (Maphosa, 2021). The researcher observed that the lockdown disrupted the school calendar and caused the rural schools in this area to fall behind with the curriculum. This sparked the researcher's interest in conducting the study. Furthermore, teachers reflected upon the importance of teacher training which they believed would intensify their teaching practices in making use of the technologies at their disposal (Mercader & Gairín., 2020). Moreover, once teacher training and other challenges are addressed, the use of technology in teaching and learning has the potential to improve. The present results contribute added value to prior studies on the same subject by evaluating the teachers' viewpoints regarding how technology is used.

Furthermore, this research had the ability to raise awareness about teachers' attitudes toward technology, fostering acceptance of the unavoidable integration of technology and prompting appropriate actions. This might further attract the interest of teachers to integrate technology in schools and inspire other schools to implement the technological method of teaching as well. Moreover, the study provided the Department of Education with information that is important for decision-making concerning the adoption of technology in South African schools and overcoming the challenges posed by the COVID-19 pandemic in the 2020 academic year.

### 1.4. The purpose of the study

The purpose of this study was to explore the physical science teachers' perspectives on the use of technology in their classrooms and the challenges they encountered pre- and post-COVID-19 pandemic. This study was valuable because it could bring an understanding of how teachers perceive the use of technology in the classrooms. The teachers brought forward their perspectives based on the availability of technological tools, proper training, and stable internet connection to a mention few. Having this knowledge, the Department of Education might be able to cater to each school with

the technological tools that would suit their needs and as a result, the teaching and learning processes might improve. Furthermore, mapping out the impact of the COVID-19 pandemic on teaching and learning in this study, might have the potential to influence teacher's perspectives and other education stakeholders in a positive way such that they become interested in using technology in their classrooms.

## 1.5. Research questions

The subsequent research questions which guided this study**:**

### 1.5.1. Main research question:

What are the physical science teachers' perspectives on the use of technology in their classrooms and the challenges they encountered pre- and post-COVID-19 pandemic?

### 1.5.2. Sub-questions

- What do Physical Science teachers understand as technology use in their classrooms?
- What are the teachers' views on the use of technology in their Physical Science classroom?
- What are the challenges if any, do teachers face when using technology in their Physical Science classroom?
- How did the COVID-19 global pandemic impact the use of technology in Physical Science classrooms?

### 1.5.3. Aim and objectives of the study

This study aimed to explore Physical Science teachers' perspectives on the use of technology in some schools in the Makhutswe circuit. To achieve this aim, the objectives for this study were as follows:

- To find out what Physical Science teachers understands as technology use in their classrooms.
- To explore teachers' views on the use of technology in their Physical Science classrooms.
- To investigate if Physical Science teachers have any challenges when using technology in their classroom.
- To find out the effects of the COVID-19 pandemic on the use of technology in Physical Science classrooms.

## 1.6. Definitions of concepts

The following definitions are provided according to how they have been used in this study:

- **Technology**- refers to hardware and software which is used in a classroom to support teaching and learning such as laptops, projectors as well as internet connectivity (Raja & Nagasubramani, 2018).
- **COVID-19 pandemic**- The coronavirus disease 2019 (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus that mainly affects the respiratory system and presents as interstitial pneumonia and acute respiratory distress syndrome (Ciotti et al., 2020).
- **Traditional setting**- It is mostly a teacher-driven method of teaching where the teacher moderates and regulates the flow of information and knowledge (Kalanda & De Villiers, 2013).

## 1.7. Delimitations of the study

This research focused on teacher perceptions only, no data was collected from principals, parents, or other community representatives. Although this study focused on Physical Science teachers' perceptions of the use of technology, the same analysis was useful in determining teachers' perceptions of other subjects of interest. Since the study focused on some schools in the Makhutswe circuit, the results were not a generalised case to other circuits as challenges may differ. Furthermore, the study considered only six teachers who were teaching Physical Science in Grade 12 at the Makhutswe circuit, Limpopo province. The goal was to get a comprehensive teachers' point of view on the use of technology.

## 1.8. Research structure

This section provides an outline of all the chapters in this study and how they are organised:

**Chapter 1 Introduction**

This chapter presents the background of the study, problem statement, rationale, research questions, definition of concepts, delimitations of the study, research structure and chapter summary.

**Chapter 2 Literature Review**

This chapter provides a review of existing literature regarding the perceptions of Physical Science teachers on the use of technology in their classrooms to support the new findings. The conceptual framework that guides the study is provided in this section.

**Chapter 3 Research Methodology**

This chapter contains the research paradigm which guides the study, the research approach, research design, sampling methods and data collection tools. It also motivates their selection and subsequent use in this study.

**Chapter 4 Results**

This chapter presents data obtained from six Physical Science teachers in some schools in the Makhutswe circuit and provides an analysis based on these results.

**Chapter 5 Summary, conclusions, and recommendations.**

This chapter provides the answers to the research questions, summaries and conclusions based on the findings, as well as provides recommendations for the study**.**

## 1.9. Chapter Summary

This chapter presented the context and background within which the research was conducted, the rationale of the study, and the delimitations of the study. This section also highlighted what the next four chapters consist of. The next chapter presents the literature review and the conceptual framework that guided this study.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1. Introduction

The previous chapter provided the background, the focus of the study as well as the aim and objectives of the study. This chapter reviews the history of the use of technology for teaching and how it has impacted teachers' perspectives with time. It further studies the challenges that teachers experience and their perspectives when using technology for teaching Physical Science. The importance of technology in education, the impact that COVID-19 had on the use of technology for teaching, and the use of technology post-COVID-19 were further discussed in this chapter. Finally, the conceptual framework which guided the study was explained.

## 2.2. Definition of technology

At a simplistic level, technology refers to hardware and software used in a classroom to support teaching and learning such as laptops, projectors as well as internet connectivity (Clark-Wilson et al., 2020; Raja & Nagasubramani, 2018). However, with the increasing modern technology and connectivity, it means that the classroom context becomes increasingly important as one makes sense of technology in education (Clark-Wilson et al., 2020). Technology in education makes it easier for teachers to generate learning materials for learners to learn and collaborate, and as a result education improves (Haleem et al., 2022).

Technology as used in education can be defined as ethical practices of facilitating teaching and learning in order to improve the performance of the subject through the creation, use and management of appropriate technological processes and resources (Huang, 2019). From this perspective, technology could be understood as the use of old and modern technologies to improve the teaching and learning experiences in a variety of instructional settings such as formal and informal learning. Furthermore, educational technology could be viewed as a systematic and holistic approach to teaching and learning processes through the use of technological tools and materials (Tugun et al., 2020). In this approach, the teacher facilitates the teaching and learning processes by choosing the appropriate technological tools and methods to achieve the teaching and learning objectives. Moreover, the use of technology in education effectively transforms the teaching and learning processes (Singh, 2021). Technology

in this study was adopted as the use of technological tools to facilitate the teaching and learning process (Huang, 2019). Adopting the use of technology in this way was mainly to obtain Physical Science teachers' perspectives when using technology in their classrooms.

### 2.3. The History of the Use of Technology in Education

During the past 100 years, education was delivered through contact lessons in a classroom environment where chalkboards were mainly used for teaching (Bozkurt, 2019). The learners learned and acquired knowledge through what is referred to as a teacher-centred strategy. In this teaching strategy, the teacher is the main source of knowledge who presents information to the learners who would passively receive the information that is presented (Al-Balushi et al., 2020). Meanwhile, learners copied the notes during the class session and had to study outside the classroom in a specific manner or a group. According to Al-Balushi et al. (2020), this learning strategy was not collaborative, and it was burdensome for the learners.

During the 1940s-1980s, the use of technology to support education was accompanied by masterclasses through audio-visual media (Huang, 2019). During this time, instructional videos and television became the main channel for public school education. Often classrooms equipped with this media were used (Al-Balushi et al., 2020). Generally, television (TV) is an educational medium. Television has always been used as an instructional tool through a wide variety of educational programs offered by several channels that have aired (Gever, 2021). Considering this evidence, TV can be used for educational purposes as well as teaching a wide range of subject matter. Based on the researcher's observations, this technological tool has also been used in South Africa for a variety of educational lessons which are broadcast on radio stations, SABC 1 and mindset learning channels. Another example of audio-visual technology that followed was the computer-aided instruction (CAI). CAI refers to an "interactive instructional procedure that includes examining, showing content in a conversational mode, arranging to show forms, and bringing through educational content" (Suson & Ermac, 2020, p.48). Using the CAI such as videos and power presentations, the computer undertakes a significant task in assisting the teacher to achieve teaching responsibilities. This technique is a new way of teaching and has been perceived by many to help learners to become energetic and ready to learn more (Suson & Ermac, 2020). Furthermore, this technological tool helps learners to learn by

perception rather than by memorising as opposed to teachers-centred strategy. Moreover, it helps to close the gap between classical and modern perspectives in education (Suson & Ermac, 2020).

Another development in the late 1990s was the internet explosion which had a huge role in educational technology. Users used computer-to-computer interactions and computer-facilitated communications such as chatrooms and e-mails (Jelly et al., 2021). In the 21st century, technology use in education has been a motive behind the digital conversion of education, as education officials generally believe that technology can improve education (Wyant & Baek, 2019). The recent technology which is facilitated by the internet is called e-learning. It is the latest addition which comprises the past computer-driven technologies (Maatuk et al., 2022). Despite these trends in education, technology is broadly still not effectively used in Physical Science education (Oliveira et al., 2019).

### 2.4. The importance of technology in Education

According to Wyant and Baek (2019), technology use in education is a motive behind the digital convention in the 21st century. In addition, research conducted by Raja and Nagasubramani (2018) emphasizes that the 21st century is indeed viewed as an era of technology that plays a vital role in various aspects of our lives, including the aspect of education. Research revealed that learners nowadays prefer to use technological tools for learning because it increases their level of interactivity (Onyema et al., 2019). Moreover, it can also help learners to comprehend and cling to concepts in a better way. Other than being efficient, the knowledge transfer on the other hand turns out to be effortless and convenient (Szymkowiak et al., 2021). What this means is that technology being part of our lives nowadays tends to help our minds become versed or able to work faster. The reliance on the use of up-to-date technological tools makes the educational journey much smoother and more convenient (Al-Maroof et al., 2023). The use of these technological tools is inevitable these days in schools, colleges, and universities.

As briefly pointed out in the above paragraph, the introduction of technologies in schools is to help learners comprehend and cling to concepts in a better way. This integral role is further supported by Ojo and Adu (2018) who affirmed that technology indeed assists learners to have a full comprehension of the learning content covered in the curriculum. As opposed to routine learning, technology encourages active

engagement as learners choose when and what to learn (Ilgaz, 2019). When the material is recorded, they can revisit it whenever there is a need and master the contents of the recorded lessons on their own (Ojo & Adu, 2018). Furthermore, in a paper written by Ojo and Adu (2018), all the participants regardless of whether they were slow or fast learners were awarded the opportunity to catch up with the content they might have missed during the session.

Another important factor that technology has in the context of education is the ability to increase access to education, reduce costs, and improve its significance and excellence (Raja & Nagasubramani, 2018). For instance, online classes have been indicated as potentially transformative in higher education, thus increasing access for disadvantaged students (Goodman et al., 2019). This paper written by Goodman et al. (2019) further depicts that the number of online bachelor's degrees awarded increased from 4000 to 75000 between 2002-2012, which is equivalent to a 5% increase.

The introduction of online degree programs has addressed the geographical limitations as there is no need to be physically present in the classroom (Sadeghi, 2019). Most universities including South African universities have introduced online degree courses for students to access from all over the world. Besides the geographical limitations, online classes or programs can provide adult learners with an opportunity to upskill without being worried about their age factor and provide them with the opportunity to earn new qualifications (Sadeghi, 2019).

Nowadays, distance learning and online education have become the most substantial parts of the education system. Raja and Nagasubramani (2018) further argue that technology through online or distance learning promotes collaborative and cooperative learning i.e., regardless of the distance between the participants. It allows learners and teachers to work with each other from different cultures or groups and enhances their communication skills (Raja & Nagasubramani, 2018). Other important attributes discussed are:

- *Creative learning*: technology promotes creativity in one's thinking to produce a tangible product through the manipulation of existing information.
- *Integrative learning*: technology promotes an integrative approach to teaching and learning, where theory and practice cannot be separated when compared to a traditional classroom where the emphasis is on one aspect.

- *Evaluative learning*: the use of technology for learning that allows learners to learn on their own as sustained by the constructivist theories of learning other than remote learning and memorization.

Lately, there have been factors which indicate that using technologies in science subjects might have a positive impact on learners' creative thinking (Abdulrahaman et al., 2020). Abdulrahaman et al. (2020) specify that Physical Science technologies are used to conduct teaching through videos or slides to demonstrate some processes. This use of technology has a positive impact as it improves learners' thinking. In addition, the prospective learners' interest in the subject matter becomes stimulated when they visualise and/or hear during a learning process. When schools have internet access but lack science equipment or laboratories to conduct Physical Science practicals, technology can be used to offer virtual Chemistry and physics labs (Bugarso et al., 2021). This enables learners to have a similar experience to those in schools with better facilities. Basically, through technology learners who are historically disadvantaged can also be afforded the opportunities to grow, acquire equity and possess high-quality learning materials, expertise, personalised learning, and tools for future education (Lambert, 2020).

### 2.5. The challenges experienced by teachers when using technology in their classrooms.

Using technology in education has never been an easy process. Several key challenges have been identified in the literature relating to the use of technological tools in classrooms. The challenges became more significant because of the COVID-19 pandemic (Haleem et al., 2022). Therefore, it is important to be well-prepared and equipped in terms of knowledge, skills, and resources needed for technology use (Hakim, 2020). This section discusses some of these challenges and the perceptions teachers have about them. These include limited or lack of technological resources, lack of teacher training to use these technological tools, irregular network connection, and lack of technical support. Each one of these challenges is discussed below. Teacher perceptions of the challenges experienced when using technology are also discussed.

- **Limited or lack of technological resources**

According to Khalo (2020), the main challenge preventing teachers from implementing technology in their classrooms is the lack of access to technological resources. In the

teaching space, a lack of resources might be a deterrent to effective technology implementation (Rapanta et al., 2021). This was evident in a study conducted by Lestiyanawati (2020) where 30.3% of the teachers could not access technological tools. As a result, they resorted to the traditional way of teaching. In addition, limited technological resources are viewed as one of the negatively associated elements obstructing the use of technology in some classrooms (Karunaratne et al., 2018). Karunaratne et al. (2018) further argue that a lack of technological tools can potentially be an obstruction to the type of education learners acquire which would subsequently affect their performance. In a contrasting scenario, where there was an availability of technological tools such as computers at schools, research conducted by Hodgson and Khumalo (2016) at KwaZulu-Natal contended that technology had a positive influence on the way learners learn.

- **Lack of teacher training to use technological tools**

Modern technologies demand that teachers be properly trained to learn how to use these technologies in their classrooms (Raja & Nagasubramani, 2018). In some schools in South Africa, some teachers cannot operate technological tools because they were not trained as teachers some decades ago when various technological tools were not common (Dube, 2020). In addition, many of these teachers did not have access to technologies such as personal computers and the internet during their upbringing, unlike most of the new teachers today who were raised in an environment saturated with technological tools (Dube, 2020). Considering these scenarios, it can be pointed out that the effectiveness of any educational curriculum application is directly associated with the capabilities of a teacher. Otherwise, if teachers' training in the use of technological tools to support teaching and learning is not accessible, it will lead to an inadequacy in curriculum execution (Hebebci et al., 2020).

The study conducted by Du Plessis and Mestry (2019) also emphasized that much of the resolution to this challenge lies in the supply of sufficient numbers of properly trained teachers, especially in South African rural areas. Hence, teachers must receive effective professional development on new technologies. Otherwise, they will not be able to use it to attain its full potential because of inadequate technology training (Johnson et al., 2016). Furthermore, Johnson et al. (2016) highlight that if teachers feel that their skills are not enough when using technology, they may have low

confidence, use less technology, and be doubtful to explore new possibilities that employ technology when preparing their classes.

If schools could forecast which teachers might more enthusiastically withstand accepting technology for teaching, they could offer their teachers relevant support training before implementing technology for teaching which will certainly assist them in achieving better results and cultivating their efficacy (Corry & Stella, 2018). Lin and Zheng (2015) further indicated that teachers who moved from traditional teaching to teaching using technological tools desired more professional development in using technology for teaching.

- **Irregular internet connectivity**

Irregular internet connectivity or no internet and power supply are also common challenges that are experienced by most schools in the African continent including South Africa (Krönke, 2020). It is a fact that the advent of modern technology and the internet have caused new challenges to those who want to use technology in their classrooms, but the main challenge facing most African countries is the erratic power supply (Okebukola et al., 2020). The technological devices that teachers and learners use need a power supply. A stable internet is also required for online education. Both factors remain a challenge that will unfavourably affect the quality of teaching Physical Science by either using technology or through virtual classrooms (Pandey et al., 2021). Furthermore, Okebukola et al. (2020) highlighted that in Morocco, the main challenge affecting online Chemistry lessons for high school is irregular internet connections. In addition, in Senegal, learners struggle with poor network coverage and costly data bundles (Okebukola et al., 2020). These challenges remain the same in South African schools (Khan, 2020).

- **The lack of technical support**

The lack of technical support in the school structure has a huge influence on the teachers' use of technological resources in their classrooms. Technical support refers to the services provided by the service provider to the users of certain technological tools (Chisango et al., 2020). With limited or no technical support, even the most talented Physical Science teachers will have minimal success in using technology for teaching. This factor is a hurdle to the successful integration of technology in teaching, it also discourages teachers from adopting new technologies and integrating them into their classrooms (Chisango et al., 2020). This technical support should not only be

limited to the teachers' use of technological resources in the classroom. It is also important for teachers to receive proper training, time for planning and collaboration and the necessary resources which they would use to enhance the use of these technological tools for teaching and learning.

In conclusion, South Africa's mission to use technology in teaching and learning that is contained in the National Development Plan 2030 will only remain a dream if these contextual realities are not dealt with timeously (Padayachee, 2017). These challenges are liable to lessen the teachers' enthusiasm and desire to use technology in teaching and learning, which could result in holding back the realization of the Department of Basic Education's (DBE) technology-integration aims nationwide (Padayachee, 2017).

### 2.5.1 Teachers' perceptions of the challenges experienced when using technology in their classrooms.

The level of perception that teachers have, has to do with the level of integration of technology in their teaching (Chisango et al., 2020). Therefore, technology self-efficacy becomes a useful indicator of the effectiveness of teacher education programs. In support of this argument, the Taiwan Ministry of Education also supports that self-efficacy can serve as a basis for the development of effective training practices and programs that will lead to a successful implementation of educational technology through computer applications in the classroom (McMahon, 2021).

Technology self-efficacy is defined as a judgement of one's ability to use technology (McMahon, 2021). McMahon (2021) alluded to Bandura's theory that, individuals with high self-efficacy levels enjoyed using technology and experienced less-related anxiety. Meaning that individuals differ in areas in which they try to develop their efficacy, and in the way they nurture it even within the assumed pursuit. For instance, another Physical Science teacher may have a high sense of purpose in teaching the subject face-to-face in the classroom setting but have a low sense of purpose when delivering the lesson using technology for teaching or online education.

Teachers with low technology self-efficacy perceive technology as less useful and unsatisfactory (Emre, 2019). They would rather resort to traditional methods of teaching than try to use technology, which causes fear and anxiety in them (Dhawan, 2020). Teachers who perceive technology as convenient and effective readily adopt and use it in their classrooms. Dhawan (2020) argued that teachers showed that

having to replace the traditional way of teaching with technology-based teaching removes the sociality pedagogy which they perceive as important in their work. However, online learning is convenient and allows teachers to communicate with learners anytime and anywhere (Purwanto, 2020). Accessing teaching resources by using technology is easy and possible for teachers. The use of technology can address some of the challenges that schools in developing countries face such as shortage of textbooks and teaching aids.

In a study conducted by Chisango et al. (2020), it was revealed that in some schools, teachers were not using technology due to their sceptical views on technology, which has caused them to resist change and fail to adapt to the technological way of teaching. Teachers from disadvantaged schools further indicated that although they have received training on how to use technology in their classrooms, the learners were not trained. As a result, it becomes challenging to use technology in the classroom. Teachers' sceptical attitudes are mainly because technology in schools is introduced by individuals such as politicians and school governing boards who are not familiar with the classroom realities (Chisango et al., 2020).

Other studies further argue that even though teachers seem to accept that technology has value in schools, it needs to be integrated into education curricula. However, they continue to encounter difficulties during the process of adopting these technologies into classrooms. Only a few teachers are using technological tools for teaching and learning tools, this is because the challenges overshadow the benefits (Ghavifekr et al., 2016).

### 2.6. The Impact of COVID-19 on the Use of Technology for Teaching and Learning

The South African government took a decision that resulted in many of the schools being closed due to the start of COVID-19 in March 2020 (Valverde-Berrocoso et al., 2021). According to the United Nations Children's Fund (2021), an average of 95 instruction days globally were not used for teaching and learning as schools were closed during that time which represented approximately half the time intended for classroom instruction. The face-to-face or classroom teaching and learning was disrupted by this decision to mitigate the spread of the COVID-19 virus. This unexpected closure of schools required that teachers to revise their ways of teaching

to achieve their pedagogical goals (Adov & Mäeots, 2021). This section discusses the impact that COVID-19 had on teacher's use of technology in their classrooms.

During the COVID-19 era, teachers had to move from teaching face-to-face to teaching online using technological tools wherein they had to design lessons, homework, assignments, and assessments suitable for online teaching and learning (Winter et al., 2021). The transformation from face-to-face to online or remote teaching was easier for some teachers than the others (Adov & Mäeots, 2021). Several teachers reported having little or no training in the use of technology to engage in online teaching and learning, however, they were confronted with a need for a sudden change in their teaching practices (Winter et al.,2021). The teachers had to engage in what is referred to as Emergency Remote Teaching (ERT). This is an online teaching that served as a response to the COVID-19 pandemic crisis (Barbour et al., 2020; Hodges et al.,2020). Winter et al. (2021) argue that not only teachers were affected by this radical shift in teaching, but learners also were affected. The move to ERT resulted in learning loss for learners due to stress, lack of motivation, and less time spent on learning (Winter et al.,2021). Hasudungan and Ningsih (2021) further argued that learners from disadvantaged backgrounds would experience more learning loss because of no access to technological tools and the internet.

The study conducted by Courtney et al. (2022) revealed a critical issue that gained even more significance during the COVID-19 pandemic. Many teachers could not afford the necessary technology or monthly high-speed internet bills. This financial hardship impacted not just teachers but also parents who were unable to provide essential materials for their children to participate fully in the remote learning programme (Mabeya, 2020). As a result, learners, particularly those from lower socioeconomic backgrounds had unequal access to online resources during the pandemic. The quick move to online instruction made these tools critical, while the excessive expenses of quickly establishing proper technological infrastructure, combined with a shortage of experienced technology assistance, created a huge burden on the education budget (Chomunorwa et al., 2023).

In the South African framework, the divide between those who have access to technological tools and those who do not have access appeared to be the main reason for limiting the probabilities of the use of technology during COVID-19 (Vargo et al., 2021). This divide remained a major concern throughout the COVID-19 period. Not

only was this gap one of the major disadvantages of the use of educational technology in the South African framework but it was also a worldwide problem, especially in developing countries (Vargo et al., 2021).

Another issue cited by teachers during the COVID-19 era was an increase in cheating or academic dishonesty, as well as a rising inability of students to concentrate because of a greater reliance on technological tools. Learners frequently struggled to focus during online classes, and they were easily distracted by video games and other home-related distractions that differed from the classroom environment (Courtney et al., 2022). Furthermore, the constant availability of online resources provided new distractions, making it difficult for teachers to maintain their concentration while navigating the online teaching environment. This problem has been exacerbated by technological advances such as graphical calculators and high-tech watches which have become popular tools for cheating during tests (Ghory & Ghafory, 2021).

Some teachers found difficulties when employing technological tools to provide feedback on students' assignments. Meinck et al. (2022) stated that various researchers had raised this issue. The change to remote teaching required teachers to become proficient in using technologies such as Zoom, Google Meet, Microsoft Teams, etc., which were unfamiliar to many of them (Feder, 2020). This shift was especially difficult because it coincided with the already stressful conditions of the COVID-19 pandemic. Teachers had to not only become familiar with these new technologies but also handle the additional demands and uncertainties brought about by the outbreak, emphasising the importance of adaptability and resilience in the education sector during these times.

### 2.7. Physical Science Curriculum and the Use of Technology

Physical Science in South Africa is offered as a combination of Physics and Chemistry at the Further Education and Training (FET) levels (Mpungose, 2021). Innovations that enhance economic development are deeply rooted in the application of Physics, making effective teaching of Physical Science crucial for meeting South Africa's technological needs (Ogegbo et al., 2019). Since 1994, South Africa has undergone several curriculum changes aimed at addressing past inequalities and transforming the country into a globally competitive state (Doh Nubia & Blignaut, 2023). The latest of these reforms is the Curriculum Assessment Policy Statement (CAPS), formulated

in 2011. Each subject taught in South African schools has its own specific CAPS document, including one for Physical Science.

The Physical Science CAPS curriculum aims to promote knowledge and skills in scientific inquiry and problem-solving; the development and implementation of scientific and technological knowledge; and an understanding of the nature of science and its relationships to technology, society, and the environment (DBE, 2011, p. 8) This goal emphasises how the curriculum supports the use of technology in the classroom. However, as with any curriculum reform, implementation-related issues may arise that hinder the curriculum's ability to reach its intended goals (Doh Nubia & Blignaut, 2023).

Govender (2018) explored teachers' perspectives on the CAPS curriculum implementation, revealing that teachers felt they lacked sufficient professional development programs, guidance, and monitoring to help them implement the necessary changes. Ojo and Mathabathe (2021) further investigated the challenges associated with the CAPS curriculum and found a persistent implementation gap between well-resourced and under-resourced schools. This gap highlights a significant challenge in achieving the curriculum's aims and goals.

Recent studies continue to emphasize these issues. Mpungose (2020) examined the integration of digital technologies in teaching Physical Science and found that although technology is pivotal in enhancing learning, teachers often lack adequate training and resources to effectively integrate these technologies. Similarly, a study by Khalo (2020) highlighted that rural schools, in particular, face substantial barriers such as inadequate infrastructure, limited access to digital tools, and insufficient training for teachers.

### 2.8. The Use of Technology for Teaching and Learning Post-COVID-19 era

The COVID-19 pandemic triggered a sudden shift towards an increased reliance on technology for education, fast-tracking its integration into almost every aspect of our lives. Online learning is not merely a temporary solution; it has become a substantial and continuing part of post-pandemic education. It is not just a passing trend but an important component of the new educational landscape in the post-COVID-19 era (Xie et al., 2020). Traditional Physical Science classes are no longer the exclusive venues for teaching and learning.

For example, the South African government has devised strategies for curriculum recovery during and after the COVID-19 phase through the Department of Basic Education. Learners had and still have access to instructional materials and other learning tools via the internet, as well as through radio and television programmes (Mahaye, 2020). The Department of Basic Education has worked hard to reduce the impact of the COVID-19 pandemic on education. One example is the establishment of the COVID-19 Learner Support radio programme in conjunction with the South African Broadcasting Corporation (SABC). The government further allocated a channel for three months on open-view platforms for learners (Mhlanga & Moloi, 2020).

A study conducted by Duma et al. (2021) emphasized the importance of providing technological tools or resources to rural schools. However, merely providing these tools is not enough. These technological resources can become obstacles to learning if the learners are not familiar with the use of these tools for accessing or generating learning materials online. This was especially apparent during the COVID-19 pandemic when online education began to emerge as a solution to the interruption of traditional in-person learning. Before the pandemic, internet-based education mostly served those who were unable to attend traditional classroom settings. Nonetheless, as online education improved to promote continuous learning, its reach grew to include a bigger audience inside the greater educational system.

For instance, we have witnessed the emergence of new online high schools and an increasing number of enrolments in the already existing online high schools in South Africa. For example, the University of Cape Town (UCT) recognised the need for innovative educational solutions during the COVID-19 pandemic and expanded its offerings to include UCT Online High School. This online secondary school was founded in response to the pandemic which made traditional in-person schooling problematic. This initiative not only addressed immediate educational requirements during the pandemic, but it also positioned UCT to continue providing flexible and accessible online education beyond the pandemic.

Another example is Teneo Online School, which was founded before COVID-19 and has witnessed a considerable increase in enrolment during the pandemic. The school enrolment began with 85 students in 2018, the enrolment increased to 5,400 in 2020 and 8,620 in 2021. The online school now has approximately 9,000 students enrolled for 2022 and is planning for 13,000 students (Daily Mavericks, 2022).

## 2.9. Conceptual Framework

The conceptual framework that guided this study was based on the Unified Theory of Acceptance and Use of Technology (UTAUT) Model. The UTAUT model was developed by Venkatesh et al. in 2003 and is based on the concepts from existing theories that were tested (Perienen, 2020; Venkatesh et al., 2003). As the importance of technology in education continues to grow, it becomes essential to review teachers' perspectives regarding its application in the teaching of Physical Science in the classroom, as suggested by Venkatesh et al. 2003. The UTAUT framework, which served as the foundation for this study, has a major impact on the conditions under which teachers can successfully integrate technological tools into their teaching approaches.

The UTAUT conceptual framework is relevant in exploring Physical Science teachers' perspectives on the use of technology because it provides a comprehensive structure for understanding how individuals accept and use technology in their work or educational settings. This paradigm can be used to explore teachers' perspectives on technology in several ways. For example, understanding technology acceptance. The UTAUT key factors that influence technology acceptance, include performance expectancy (perceived benefits), effort expectancy (ease of use), social influence (influence from colleagues or peers), and facilitating conditions (external support and infrastructure) (Venkatesh et al., 2003; Wijaya et al., 2022). However, among the four key factors, this study only examined the effects that performance expectancy, effort expectancy, and facilitating conditions factors had on teachers' perspectives regarding the use of technology. Therefore, this approach assisted this study in discovering some of the factors that either contribute or limit teachers' willingness to integrate technology into their teaching methods in the setting of Physical Science education.

The UTAUT framework further emphasizes the significance of external support as well as resources (facilitating conditions) (Wijaya et al., 2022). This can include elements such as the availability of technology infrastructure in schools, access to training and professional development, and support from educational institutions. Understanding how these factors affect teachers might provide insight into some challenges they may experience when integrating technology. To make sense of the relationship between these factors and how are they related to each other. Consider the UTAUT framework model presented in Figure 2.1.

Figure 2.1 below illustrates the UTAUT framework model, highlighting four main core elements of exogenous variables: Performance expectancy, effort expectancy, social influence, and facilitating conditions. Meanwhile, there are only two endogenous variables, namely: Intention to use technology and use behaviour (Attuquayefio & Addo, 2014). The UTAUT framework model was adopted in this study as it was found to be appropriate because of its four core elements. The study used this framework to investigate the effect or significance level of the "exogenous variables" (PE, EE & SI) and "endogenous variables" (BI & FC) on teacher's perspectives concerning technology use.

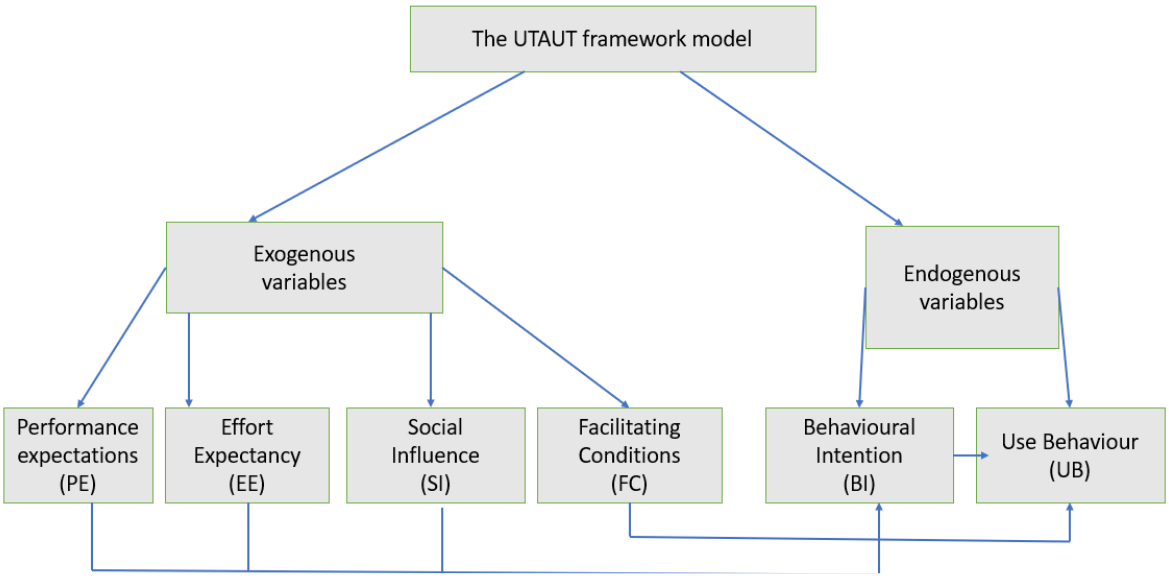



***Figure 2.1*** The UTAUT framework model (adopted from Venkatesh et al., 2003)

Each of the elements of the exogenous and endogenous variables in the UTAUT framework model above can be explained in detail as follows:

### 2.9.1. Performance Expectancy (PE)

Performance expectancy (PE) refers to "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Abbad, 2021, p. 7211). In this study, this factor describes the extent to which the teacher believes that using technology will help achieve the teaching and learning objectives. Five main concepts refer to performance expectancy, namely, "perceived usefulness, outcome expectancy, relative advantage, extrinsic motivation, and job fit" (Venkatesh et al., 2003, p. 447).

### 2.9.2. Effort Expectancy (EE)

Effort expectancy (EE) is a measure of ease that is linked to the use of the system (Abbad, 2021). This factor describes how simple it is for the teacher to use technology for teaching, looking at the availability and complexity of the technological tools. There are three constructs according to Venkatesh et al., (2003) from previous standing models that best explain the notion of effort expectancy, namely, “ease of use, complexity, and perceived ease of use”. This factor is the main determinant of whether the teacher uses technology or not.

### 2.9.3. Social Influence (SI)

Social influence (SI) refers to “the level at which the user sees the importance of using the system through others” (Abbad, 2021, p. 7211). It describes the level at which the teacher sees the benefit of using technology through others, it can be through family, friends or colleagues and he/she uses it as a result. It also includes the expectations and views of certain individuals such as peers, co-workers, friends, and superiors. One’s conduct depends on how they think others will reflect on them after they have seen them using technology.

### 2.9.4. Facilitating Conditions (FC)

Facilitating condition is a measure or the extent to which an individual believes that a particular working environment supports the use of technology (Wijaya et al., 2022). In this study, this factor describes the level at which the teacher can make a judgement on the availability of technological resources and support, to enable him/her to use technology for teaching. In the study by Venkatesh et al. (2003), this factor is embodied by three distinct constructs, namely, perceived behavioural control, facilitating conditions and compatibility.

### 2.9.5. Behavioural Intention (BI)

The model highlights that behavioural intention (BI) is a suitable proxy to observe and predict a user’s behaviour toward a specific technology or system. It is defined as an individual’s willingness to accept and use technology in the future. It is the most influential factor that affects the use behaviour directly (Yee & Abdullah, 2021). Moreover, according to the study conducted by Attuquayefio (2019), BI is more predictive of use behaviour when people have had experience with the technology.

### 2.9.6. Use Behaviour (UB)

Use behaviour (UB) in the UTAUT paradigm refers to the degree to which users use technology for teaching and learning. Figure 2.1 shows that there is a direct link between facilitating conditions and use behaviour. Teachers' behaviour can be seen; however, intentions represent the motivation and the perspective behind one's actions. Individual teachers have different perspectives about the functionality of the facilities they use. This includes the provision of ongoing training and development, user support and access to technology which are pointed out as major factors in the behavioural use of technology in the classroom.

## 2.10. Chapter Summary

This chapter presented a literature review on the use of technology in the teaching and learning of Physical Science as well as the teachers' perspectives in this regard. Reviews on the history of the use of technology in education, the importance of technology in Education, the challenges of the use of technology in the classroom, teacher's perspectives, and the impact of COVID-19 on teaching and learning and teachers' perspectives were also discussed. The use of technology post-COVID-19 was also discussed. The discussion of the conceptual framework which guided the study was also provided in this chapter. The next chapter presents the methodology of this study.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1. Introduction

The previous chapter presented a literature review relating to teachers' perspectives on the use of technology. To explore these perspectives, the following was discussed in the above chapter: The history of technology use for teaching, the importance of technology use in the classrooms, and the challenges teachers face when using technology for teaching. The conceptual framework underpinning this study was also discussed. The following chapter aims to present the methodological elements of this study. These include the research paradigm, the research approach, the research design, sampling methods, data collection tools as well as data analysis. Table 3.1 below outlines the summary of the research methodology.

**Table 3.1. Summary of the research methodology**

| Components | Categories |
|---|---|
| **Research questions of the study** | ***The Main research question:***<br>What are the physical science teachers' perspectives on the use of technology in their classrooms and the challenges they encountered pre- and post-COVID-19 pandemic?<br>***Sub-questions:***<br>1. What do Physical Science teachers understand as technology use in their classrooms?<br>2. What are the teachers' views on the use of technology in their Physical Science classroom?<br>3. What are the challenges if any, do teachers face when using technology in their Physical Science classroom?<br>4. How did the COVID-19 global pandemic impact the use of technology in a Physical Science classroom? |
| **Research paradigm** | Interpretivist paradigm |
| **Research approach** | Qualitative approach |
| **Research design** | Case study |
| **Sampling methods** | Convenience sampling |
| **Data collection tools** | Semi-structured interviews; Observations; Document analysis |
| **Data analysis** | Thematic analysis |

## 3.2. The Research Paradigm

Research paradigms are foundational beliefs or worldviews that guide research action or development (Kumatongo & Muzata, 2021). They serve as a guideline for researchers to choose the methodology and research methods that will guide a study. In every research study, a researcher must indicate which research paradigm will be used and why it is suitable for that study (Kankam, 2019).

In this study, an interpretive paradigm was adopted. The interpretive paradigm refers to understanding the human experience in their own world (Kumatongo & Muzata, 2021). This approach tries to get into the participant's situation to understand and interpret what they think or mean concerning their context. All the efforts are made to try and understand the viewpoints of the participants rather than the viewpoints of a researcher (Alharahsheh & Pius, 2020). A researcher tries to comprehend the perspectives of the participants and how they understand the world around them (Kankam, 2019).

This paradigm was selected for this study because it is suitable for a qualitative research approach. The interpretative research paradigm appreciates people's personal and interpersonal views as they interact with the world around them (Pervin & Mokhtar, 2022). Therefore, the researcher was able to interpret and understand Physical Science teachers' perspectives on the use of technology in their classrooms. Furthermore, the researcher was able to see what knowledge they have regarding the use of technology, and what challenges if any that they encountered when using technology. Moreover, the researcher was able to discover the effects of the COVID-19 pandemic on the use of technology in Physical Science classrooms by investigating participants' views.

## 3.3. Research Approach

The study adopted a qualitative research approach. A qualitative research approach is an investigation that aims to have a better understanding of a social phenomenon (Ahmad et al., 2019). It is a method of inquiry that aims to understand the central phenomenon by studying participants in their context (Renjith et al., 2021). Hence, the researcher organised classroom observations with the Physical Science teachers to observe if they use technology when teaching Physical Science. Furthermore, the

researcher was able to get possible explanations of the phenomenon under investigation.

Tomaszewski et al. (2020) stated that a qualitative research approach is an approach that allows interactions between a researcher and the participants. Therefore, the researcher was in close proximity to the participants as they are known to be the source of information, therefore, the researcher was able to answer the research questions through their responses.

A qualitative research approach is a suitable approach to investigate human experience through how and why questions (Kyngäs, 2020). Its core interest is on the "how" questions and depends on the experience of people. Hence, one of the study's aims was to explore how "Physical Science teachers" view the use of technology in their classrooms. Furthermore, Ahmad et al. (2019) posit that a qualitative research approach is a method of observation that is used to collect non-numerical data. Henceforth, data in this study was collected through interviews and classroom observations.

A qualitative research approach in this study was further preferred for these subsequent reasons:

- It allowed the researcher to acquire a better understanding and gather data on how Physical Science teachers perceive the use of technology in their classrooms.
- To understand how participants conduct their lessons.

### 3.4. Research Design

A research design is a design that creates a relationship between the research questions and the result of a study (Sileyew, 2019). A research design ensures that the elements of research correlate to fit a study. It is used to properly plan the research methods (Pandey & Pandey, 2021). Asenahabi (2019) states that a research design is a basic plan for a piece of research that includes the conceptual framework that guides a study, the research questions, data collection tools, and procedures used for data collection and analysis. Therefore, a proper plan was executed by the researcher to communicate how the study would be carried out. Hence, the study adopted a case study design.

A case study research design is an “approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources” (Baxter & Jack, 2008, p. 545). This ensures that there is no one perception. Therefore, a variety of perceptions which allow for different parts of the phenomenon to be revealed and understood would stand out. According to Hancock et al. (2021), a case study investigates participant’s experiences carefully without being bound by space and time. The researcher found a case study design relevant to this study because it allowed the researcher to have in-depth knowledge of the phenomenon being investigated.

Research shows that a case study approach allows for the in-depth investigation of human interactions, uniqueness, and the dynamic nature of the context (Tomaszewski et al., 2020). The researcher interacted with participants to get detailed information from them as they are known to be a source of information and to further obtain data from interviews and observations to answer the research questions of the study.

Additionally, a case study research design was suitable for this study because every teacher who was selected to participate was considered a case. Based on participants' views regarding technology use in their classrooms, the researcher studied their cases within their natural context, avoiding theoretical assumptions that the researcher might make. Conclusions were drawn from the data collected from each case.

### 3.5. Research context

This section outlined the research setting of the study, the sampling process, and the criteria used for selecting the participants. Each of the cases was discussed in this section.

#### 3.5.1. Research setting

The setting of this study was in Limpopo Province. The Limpopo Province is one of the nine provinces of South Africa. The capital city of Limpopo is Polokwane. Limpopo lies in the northern part of South Africa. On its southern edge, from east to west, it shares borders with Mpumalanga, Gauteng, and Northwest Province. The province has five districts namely: Mopani, Vhembe, Capricorn, Waterberg, and Sekhukhune district. District refers to an area of a country characterised by a particular feature or activity (Saparov et al., 2021). The Mopani district has 1 159 185 people in the

population, and the most spoken language of this population is Northern Sotho (community survey 2016). Learners from the district come from rural areas. The Mopani district is divided into two, Mopani East and Mopani West. This district consists of schools and circuits. The Mopani West district consists of 13 circuits, which the Makhutswe circuit lies where there are 10 high schools. Figure 3.1 below shows the map of the Limpopo province where the study was conducted.

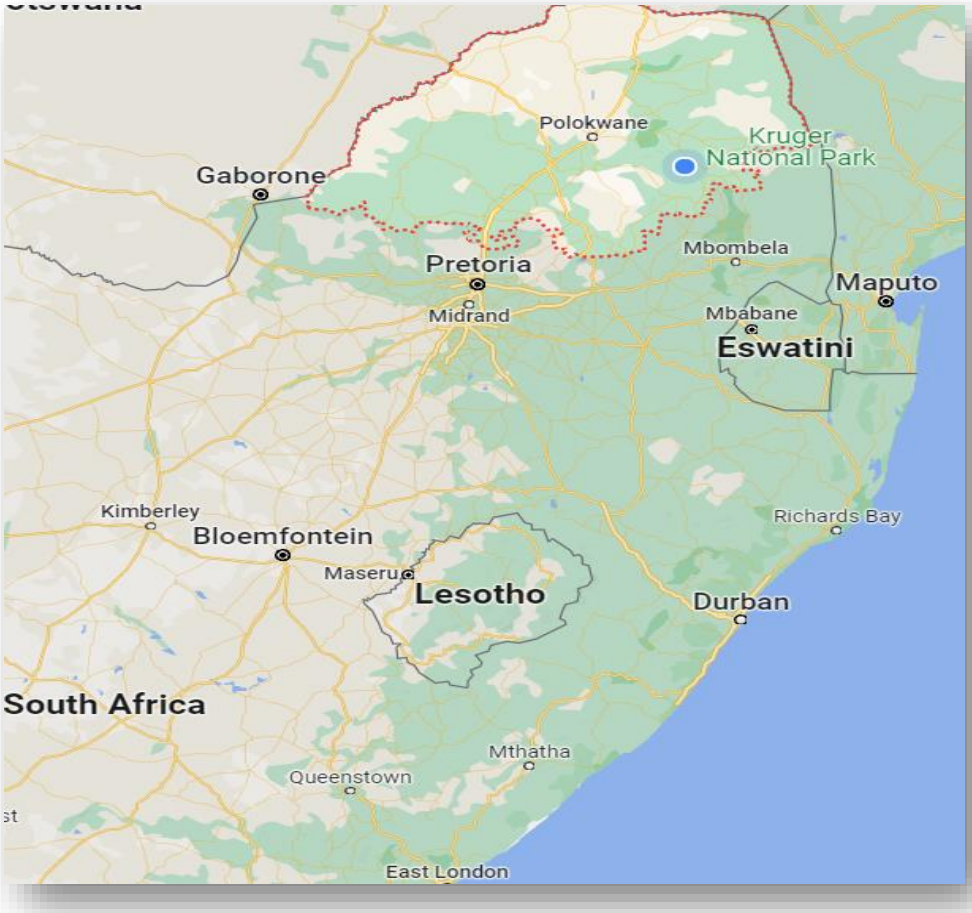



***Figure 3.1*:** Map showing the Limpopo Province (Polokwane) where the study was conducted.

The researcher conducted this study in the Makhutswe circuit of Mopani West district because it is where the researcher is based. The researcher was motivated by the shutting down of schools due to COVID-19 pandemic national lockdown. From the researcher's observation, this lockdown distracted the school calendar and left schools in this rural area lagging with the curriculum. This has raised the interest of the

researcher to carry out this study. Data was collected in the Mopani West district from six high schools in the Makhutswe circuit.

### 3.5.2. Sampling Process

Convenience sampling was adopted in this study. Convenience sampling refers to the "selection of the most accessible subjects, it is the least costly to a researcher, in terms of time, effort and money" (Marshall, 1996, p. 523). Obilor (2023) defines convenience sampling as a non-random sampling method where the target members of the population are selected because they meet certain criteria. The criteria such as easy accessibility, geographical proximity, availability at a given time, or willingness to participate in a study are considered when carrying out convenience sampling. Convenience samples can be regarded as 'accidental samples' because the participants are selected as they happened to be located near where data is collected by a researcher (Lombardini, 2019).

This sampling technique was adopted mainly because the participants were easy to contact, as they come from the same circuit as the researcher. Participants were teachers who were teaching Physical Science subjects at the high school level. The study generated data from schools in the Makhutswe circuit in the Mopani West District. Six teachers from different schools in the Makhutswe circuit were selected as participants.

The sampling process was done based on the following proposed criteria:

- All participants must be teaching Physical Science in high schools, particularly in the Makhutswe circuit.
- The participants must have a Physical Science teaching qualification.
- The participants must be willing to participate in the study.

The researcher included six participants according to the proposed criteria. The real names of participants and schools were not stated in this study, instead pseudonyms were used. The following are the pseudonyms of the participants and their schools.

- John from Dinaledi High School
- Katlego from Remmogo High School
- Tebatso from Reatlegile High School

- Thabo from Hope High School.
- Lebo from Faith High School
- Peter from Grace High School

### 3.5.3. Cases

To explore Physical Science teachers' perspectives on the use of technology in the Makhutswe circuit, the study focused on six high schools. Each school had one participant and was considered as a case. The cases are discussed in detail below:

***Case 1: John from Dinaledi High School***

Dinaledi High School is in an anonymous village in Limpopo province. Dinaledi High School offers Grades 8 to 12; it uses Sepedi as its home language. Most of the learners in this school reside where the school is located. Dinaledi High School is not well-resourced in terms of teaching aids and facilities. The school has an enrolment of 745 learners and does not have science and computer laboratories. The school consists of several Grade 12 classes with one class having 52 learners doing Physical Science. In the school, Physical Science is allocated four hours per week, and the period for Physical Science is divided into 30 minutes short and 60 minutes long. English is used as a medium of instruction for teaching and learning. John is a black male teacher and has 20 years of experience in teaching. He has been teaching Physical Science for 20 years. He teaches Physical Science in Grade 12 and other Grades. He holds a diploma in teaching, specializing in Physical Science and natural sciences. He went further to obtain an advanced Certificate in Teaching (ACE Certificate) and a Bachelor of Honours in Education Management and Leadership.

***Case 2: Katlego from Remmogo High School***

Remmogo High School is situated in the village. The school is not well-resourced and lacks proper infrastructure, they are using mobile classes for all Grades. Most of the learners in the school reside in the same village where the school is located. Remmogo High School uses Sepedi as its home language. The school has an enrolment of 328 learners. Twelve of these learners are doing Physical Science in Grade 12. There are no science and computer laboratories in the school. Katlego is a male teacher and holds a Bachelor of Science Honours degree and a Postgraduate Certificate in Education specializing in Physical Science. Katlego has 9 years of experience in

teaching Physical Science subjects. He also teaches Grade 12 Life Orientation and Grade 10 Mathematical Literacy.

***Case 3: Tebatso from Reatlegile High School***

Reatlegile High School is in a village. It uses Sepedi as its home language. The school is one of the big schools in the Makhutswe circuit with an enrolment of 1254 learners. The classes start from Grade 8 to Grade 12. The school is not well-resourced and lacks proper facilities for teaching and learning. There are no science and computer laboratories. Physical Science is allocated four hours a week, with shorter periods lasting for 30 minutes and long periods lasting for 1 hour. The learners are taught in English as a medium of instruction. 39 learners are doing Physical Science in Grade 12. Tebatso is a black male teacher and holds a Bachelor of Education specializing in Physical Science and Life Sciences. He teaches Grades 8 and 9 Natural sciences, and Grade 11 and 12 Physical Sciences. He has 3 years of teaching experience.

***Case 4: Thabo from Hope High School***

Hope High School is in a village. It offers classes from Grades 8 to 12. Sepedi is used as a home language and most of the learners in this school reside where the school is located. The school has 956 registered learners. Fifty of these learners are doing Physical Science in Grade 12. Hope High School is not well-resourced in terms of teaching facilities and there are no computer and science laboratories. Physical Science is allocated four hours per week, with periods lasting from 30 to 60 minutes on duration. Thabo is a male teacher who teaches Physical Science in Grade 12 and other lower Grades. Thabo has four years of experience in teaching Physical Science. He holds a degree in Bachelor of Science and a post-graduate certificate in education, specializing in Physical Science.

***Case 5: Lebo from Faith High School***

Faith High School is situated in a village. The school has an enrolment of 460 learners. It offers classes from Grades 8-12 with science and general stream. 34 learners are doing Physical Science in Grade 12. Faith High School is not well-resourced in terms of teaching and learning facilities. There are no computer and science laboratories in the school. Physical Science is allocated four hours per week, with periods lasting from 30 to 60 minutes on duration. Lebo is a female teacher who teaches Physical Science

in Grade 12 and other lower Grades. Lebo has seven years of experience in teaching Physical Science. She holds a degree in Bachelor of Science and a post-graduate certificate in education, specializing in Physical Science.

***Case 6: Peter from Grace High School***

Grace High School is in the village. The school is not well-resourced and lacks proper infrastructure. Most of the learners in the school reside in the same village where the school is located. Grace High School uses Sepedi as its home language. The school has 370 registered learners. Physical Science is allocated four hours per week. Each period lasts for 30 to 60 minutes on duration. There are no science and computer laboratories in the school. Peter is a male teacher and holds a secondary teacher's Diploma. Peter has 18 years of teaching Physical Science subject.

### 3.6. Data Collection

To find out how Physical Science teachers viewed the use of technology in their classrooms, the data was gathered using these techniques: Interviews, classroom observations, and document analysis.

#### 3.6.1. Interviews

According to DeJonckheere and Vaughn (2019), an interview is a shared conversation between the interviewer and the interviewee. The interviewer learns about the ideas, beliefs, views, opinions, and behaviours of the interviewee through a set of questions to collect data. Through qualitative interviews, the researcher would obtain in-depth knowledge and social reality (Döringer, 2021). Furthermore, qualitative interview's main goal is to understand the world from the participant's point of view and if they are used correctly, they can provide valuable information. Conducting face-to-face interviews is advantageous in this study because it gives the researcher a good chance to gain a profound understanding as well as build up a faster, yet efficient and smooth assessment process while enabling a thorough data collection process (Saarijärvi & Bratt, 2021).

The goal of the interview in this study was to ask the Physical Science teachers how they perceive the use of technology in their Physical Science classrooms. Furthermore, the researcher sought to find out the knowledge the participants have

regarding the use of technology in the teaching of Physical Science. Moreover, to explore the challenges they encountered if any when using technology in their classrooms, and how COVID-19 global pandemic impacted the use of technology in their classrooms.

This study interviewed all the participants. Therefore, six face-to-face interviews were conducted. The interview lasted for 20-35 minutes. The COVID-19 protocols were observed during the interview process. The interviews were semi-structured and consisted of questions that helped to answer the research questions. Each teacher was interviewed once before they were observed in their school setting for convenience. Before the interview began, the researcher explained to the participants the purpose of the interviews and asked for their permission to record them.

### 3.6.2. Observation

Observation is a systematic process of recording occurrences, and behavioural patterns of participants or objects without necessarily questioning or communicating with them (Harvey, 2021). An observation was used to enable a researcher to understand the phenomenon being observed at a deeper level. The researcher used this technique to understand how Physical Science teachers use technology in their classrooms and what challenges they come across when they teach their lessons using the technology at their disposal.

The research questions and literature review were used to generate the observation schedule. Six lessons that were presented by the teachers were observed. The observation was done once per teacher. The researcher observed what type of technological tools or devices teachers made use of during lessons as well as how time-efficient and compatible they were with these tools. An observation template was formulated and subsequently employed for the purpose of conducting observations.

### 3.6.3. Document Analysis

Document Analysis is a systematic process for reviewing and evaluating documents for both printed and electronic materials (Morgan, 2022). The process of analysing data requires the researcher to examine the data and elicit meaning, understanding and develop knowledge (Armstrong, 2020). The researcher used this type of technique

to find, select, make sense of and synthesise data contained in the documents being analysed.

In this study, the researcher collected the lesson plans used during lesson presentations. The lesson plans were used to check which technological tools were used. The researcher requested these documents at the end of each lesson from all the participants.

**Table 3.2 Indicates which data collection tool answered which research question.**

| Data collection tool | Research question |
|---|---|
| **Interviews** | • What do Physical Science teachers understand as technology use in their classrooms?<br>• What are the teachers' views on the use of technology in their Physical Science classrooms? |
| **Observations** | • What are the challenges, if any, do teachers face when using technology in their Physical Science classroom?<br>• How did COVID-19 global pandemic impact the use of technology in a Physical Science classroom? |
| **Document analysis** | • What do Physical Science teachers understand as technology use in their classrooms? |

### 3.7. Data Analysis

Thematic analysis was used in this study. Thematic analysis is a systematic process of identifying, organizing, and deriving patterns of meaning (themes) from a dataset (Humble & Mozelius, 2022). The data from the interviews and observations were coded to generate themes for analysis purposes. Themes were used to create subthemes to help in giving meaning and understanding of data. The researcher used this type of analysis because it offers great flexibility when it comes to (a) the type of research questions it can address from personal accounts and understandings to broader social context; (b) the type of data and documents examined; (c) the volume of data analysed; (d) the choice of conceptual framework applied; and (e) the ability to analyse data with an inductive approach (Kiger & Varpio, 2020).

#### 3.7.1. Interview, Observation, and Document Analysis

A six-stage process of thematic analysis outlined by Kiger and Varpio (2020) was adopted to guide the interview analysis. The stages below were followed:

*Stage 1 – Getting familiar with the data.*

The researcher started by transcribing the audio recordings from the interviews and by reading the information coming from the observation schedule and lesson plans. The researcher read the entire dataset to be familiar with it while taking notes of what might be relevant to the research questions.

*Stage 2 - Generating codes.*

The researcher generated codes from the dataset after reading it thoroughly. The researcher labelled the features from the dataset dataset that are potentially relevant to the research questions.

*Stage 3 - Searching for themes.*

The researcher searched for the themes by studying coded data to classify the resemblance and the extent of the codes. Furthermore, the researcher grouped the codes that appeared to share some common features to reflect and define a clear and meaningful pattern of data. Through this process, the researcher created themes and sub-themes from the dataset.

*Stage 4 - Reviewing potential themes.*

The researcher reviewed the developing themes relative to the coded data and the whole dataset. If there were codes that were not working with the data, the researcher removed or moved them under other themes.

*Stage 5 - Defining and naming themes.*

The researcher selected extracts from the dataset and analysed them to set out the story of each theme.

*Stage 6 – Report writing.*

The researcher wrote a report to give a persuasive story about the data built on the researcher's analysis.

### 3.8. Credibility and Trustworthiness

Lincoln and Guba (1985) argue that trustworthiness in a study is determined by ensuring credibility. Credibility seeks to confirm whether a study tests what is being proposed. This study followed Guba's criteria for trustworthiness as described below:

- “Credibility” –refers to the confidence in the truth of the study (Stahl & King, 2020). It poses questions such as was the study conducted using standard procedures of qualitative research? Some of the techniques to establish credibility include prolonged engagement with participants and persistent observations. The copies of the collected data should be kept as evidence to examine several times. The researcher followed all the standard procedures of qualitative research. A sample was selected from a population of the Makhutswe circuit, where data was collected. The data was collected and analysed in the form of semi-structured interviews, classroom observation and document analysis. The interview transcript, observation templates and lesson plans were kept for future referrals.
- “Transferability” –describes whether the findings apply to other settings or other individuals (Stahl & King, 2020). To ensure transferability, research shows that a thorough description of the phenomenon under the study must be given to allow the readers to understand it properly so that they can do a proper comparison if a similar phenomenon occurs (Shenton, 2004). In this study, the researcher started by describing the participants and their school contexts where the perspectives of Physical Science teachers on technology use in the classroom were explored.
- “Dependability”- it requires an outside individual to review and examine the research process and data analysis to evaluate the consistency of the findings so that they can be repeated (Stahl & King, 2020). The researcher gave her supervisor field notes and interpretations to read and react to them.
- “Confirmability” - explanation to permit the integrity of research results to be scrutinized (Stahl & King, 2020). To verify confirmability in this study, data from the semi-structured interviews was compared with data from the classroom observation.

### 3.9. Ethical Consideration

Ethical considerations are important in all research studies. This should be “undertaken within an ethic of respect for people, respect for knowledge, respect for democratic values, and respect for the quality of educational research” (Makhubele, 2016, p. 30). Therefore, the following was taken into consideration in this study: Research setting, informed consent, risk of harm, anonymity, and confidentiality.

*Research setting*

The setting of this study was in Limpopo province, Mopani West District. The study was conducted in the Makhutswe circuit because it is where the researcher is situated. The researcher requested permission to conduct the study by filling out an ethics form from the University of South Africa, CEDU Research Ethics Committee. The researcher proceeded and wrote letters to the Department of Education, circuit manager and school principals to further ask for permission. As soon as permission was granted, the researcher held meetings with the Physical Science teachers to explain to them the aim of the study and plan possible dates for data collection.

*Informed Consent*

Data about teachers' perceptions were collected through interviews and observations. The consent parties were enlightened about what they would be questioned about, how the data would be used for the intended research purpose, and what (if any) consequences there could be. In addition, all the participants were made aware that they have the right to withdraw from the study at any stage of the research process, including being aware of their rights to read or have access to their information.

*Risk of Harm, Anonymity, and Confidentiality*

The teachers' identities and the schools within the Makhutswe circuit were kept confidential and anonymous. To ensure the participants' confidentiality, pseudonyms were used instead of their real names. To further ensure confidentiality, the participants were told to avoid self-identifying statements and information such as mentioning their names in the data collection process. This was an imperative step in ensuring no risk to all the teachers and schools that were participating in this dissertation.

## 3.10. Chapter Summary

This chapter outlined the research methods that were used to explore the teachers' perceptions of the use of technology in their Physical Science classrooms in the Makhutswe circuit. The data collection methods included classroom observations, interviews, and document analysis. It further outlined a six-stage process of thematic analysis that was adopted to guide the interviews, observations, and document analysis. Lastly, an ethical consideration was considered to ensure smooth collaborative work such as mutual respect and fairness to all the parties that were involved.

# CHAPTER 4

# DATA PRESENTATION AND DISCUSSION

## 4.1. Introduction

The previous chapter described the research design and methodology used to collect data for this research. This chapter presents and discusses the data collected from semi-structured interviews, classroom observations, and data analysis. Six teachers participated in the data collection process. The teachers were exposed to the same interview questions and observation process but in different settings. This was done to explore how they perceive the use of technology in their Physical Science classrooms. The data was collected and analysed to answer the following research questions:

**Main research question:**

What are the physical science teachers' perspectives on the use of technology in their classrooms and the challenges they encountered pre- and post-COVID-19 pandemic?

**Sub-questions**

- What do Physical Science teachers understand as technology use in their classrooms?
- What are the teachers' views on the use of technology in their Physical Science classroom?
- What are the challenges if any, do teachers face when using technology in their Physical Science classroom?
- How did the COVID-19 global pandemic impact the use of technology in Physical Science classrooms?

## 4.2. Themes Presentation

Through the interview responses, observations and document analysis, the researcher was able to generate codes which were potentially relevant to the research questions. Secondly, from the coded data the researcher searched for the themes by studying coded data to classify the resemblance and extend over the codes. Thirdly, the researcher grouped the codes that appeared to share some common features to reflect and define a clear and meaningful pattern of data. Through this process, the

researcher created themes and sub-themes from the dataset. Fourthly, the researcher selected extracts from the dataset and analysed them to set out the story of each theme. Lastly, the researcher wrote a report to give a persuasive story about the data built on the researcher's analysis. Table 4.1 below shows the themes and categories used in this study.

**Table 4.1. Data analysis plan (DAP)**

| Themes | Categories |
|---|---|
| Teachers' knowledge concerning the use of technology in their classrooms. | Teachers' understanding of technology use. |
| | Technological tools, skills, and qualifications. |
| Teachers' views on the use of technology | Teachers' willingness to use technology. |
| The challenges they encounter when using technology | Teachers' challenges to technology use |
| The impact of COVID-19 global pandemic on the use of technology. | Teachers' perspectives of the impacts of COVID-19 on the performance of Physical Science. |

The results from the semi-structured interviews, classroom observations and document analysis of the six Physical Science teachers, namely John, Katlego, Tebatso, Thabo, Lebo and Peter (pseudonym), who participated in the study are presented in sections 4.3 to 4.8. The results show teachers' knowledge concerning the use of technology, teachers' views on the use of technology, the challenges they encounter when using technology and the impact of COVID-19 on the use of technology. The data is presented per case in these sections, to allow the researcher to get in-depth knowledge of each theme in that specific context. Section 4.3 show data obtained from John in the form of interviews, classroom observation and document analysis, section 4.4 indicates data collected from Katlego, section 4.5 shows data from Tebatso, section 4.6 indicates data from Thabo, section 4.7 shows data from Lebo, whereas section 4.8 illustrates data from Peter. Section 4.9 presents the chapter summary. Categories from the DAP were used to present data for each case.

## 4.3. Case One: John

### 4.3.1 Teachers' Understanding of Technology use.

Technology use refers to the use of hardware and software applications such as laptops, projectors as well as internet connectivity in a classroom to support teaching and learning (Raja & Nagasubramani, 2018). Clark-Wilson et al., (2020) define technology use as the use of tangible hardware such as computers, smartphones, calculators etc. in combination with software or applications and connectivity in a classroom context.

John showed some understanding of what technology was during the interview. His understanding was based on the context of the classroom, this was evident in his response when he said:

> *John: "Using technology for teaching Physical Science involves the use of laptops and smartphones to conduct a lesson".*

His understanding was linked to what Clark-Wilson et al. (2020) defined as technology use. Apart from what John understood as technology use, he further pointed out that technology can overcome learners' learning barriers by providing an alternative way of learning in a case where schools lack the apparatus to conduct experiments. He pointed out that educational websites such as YouTube channels could help to carry out the experiments theoretically by watching them on the above-mentioned channels. Prayudi et al., 2021 emphasise that technology provides learners with resources that allow them to interact and engage in experimental activities and scientific projects. This is what John had to say:

> *Researcher: "What do you understand about technology use in the teaching of Physical Science"*?
>
> *John: "Yah, that will be using the technology we have, such as laptops and smartphones, to check or complete lessons that the learners may be working on. We occasionally have experiments or lessons that we are unable to carry out at the school level, but you might find that such activities or lessons can be accessed elsewhere online or on YouTube, and learners can benefit from viewing them or seeing how the experiment is carried out. They can be used in conventional education as well".*

The data revealed that John understood technology as gadgets such as laptops and smartphones that were used in the classroom to teach. He saw the use of these tools

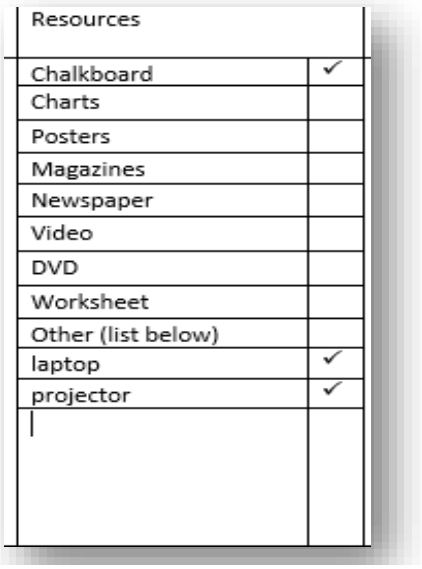
as an alternative way to close the gap in case the school lacked the apparatus to conduct the experiments. Furthermore, John believed that these tools could be used to access some educational websites such as YouTube channels. During his classroom observation, John demonstrated his understanding of technology by using a laptop to present his lesson. He seemed to be comfortable using it to teach, although he mentioned that he had not received any formal training.

### 4.3.2 Technological Tools, Skills, and Qualifications

The use of technological tools in schools plays an integral role in helping learners to have a full comprehension of the learning content covered in the curriculum (Ojo & Adu, 2018). John mentioned laptops, projectors, and WI-FI connectivity as the technological tools they have in their school. This is what he had to say:

> *John: "I would say we do have our laptops; we have projectors, and we are also connected to WI-FI."*

During the classroom observation, John entered the classroom with a laptop and a projector, indicating his intention to use the technological devices for the lesson. He took some time to set up and connect the tools, which slightly affected the time allocated for the class. Figure 4.1 below shows part of the lesson plan which indicates the resources John used during his lesson presentation.



| Resources | |
|---|---|
| Chalkboard | ✓ |
| Charts | |
| Posters | |
| Magazines | |
| Newspaper | |
| Video | |
| DVD | |
| Worksheet | |
| Other (list below) | |
| laptop | ✓ |
| projector | ✓ |
| | |

***Figure 4.1**:* Resources used by John during his lesson presentation.

The data collected from John during the interview indicated that he did not acquire any kind of skill or attend any formal training to be able to use the technological tools at his

disposal to advance the teaching of Physical Science. Instead, he mentioned that he had taught himself to use the technological tools at his disposal. He further highlighted that he had no technology-related qualifications. This is what he had to say:

> *John: "I just have a self-taught skill. It is not about having gone to a specific training or what, it is just that we learn as we go along. I just taught myself".*

Despite the initial setup delay during the classroom observation, John managed to cover the content within a relatively short period. The use of technology seemed to have a positive impact on teaching and learning efficiency, allowing John to present the material more effectively compared to traditional methods. However, teachers need proper training for them to acquire the necessary skills to be able to use technological tools effectively in their classrooms (Valverde-Berrocoso et al., 2021).

Drawing from John's response, the researcher could comprehend that he was able to use these technological tools but to a certain extent as he mentioned to have taught himself. This was not in line with what Valverde-Berrocoso et al. (2021) mentioned as proper training. Proper training according to Valverde-Berrocoso et al. (2021) goes beyond the development of basic computer skills to use technological tools in an interpretative and creative way to advance in the teaching.

### 4.3.3 Teachers' Willingness to Use Technology.

John stated his willingness to employ technology in the classroom. He believed that technology simplified the teaching of Physical Science. John further stated that technology enhanced understanding by introducing a more visible form of learning than traditional theory-based instruction. He claimed that Physical Science was a practical subject, therefore, learners should participate in all various learning styles. This was evident during the classroom observation whereby John used a laptop and a projector to conduct the lesson. The use of these technological tools enabled him to project visual content, which according to him, enhanced learners' understanding, and engagement. John further highlighted that learners were excited to see the lesson being projected, and the visual aspect made it easier for him to convey the content effectively. This is supported by Khalo (2020) who said learners have a better chance to understand the teaching processes if they are exposed to different teaching methodologies such as watching video tutorials. John commented as follows:

*John: "Technology can play a crucial role in the teaching of Physical Science because Physical Science is not only a theoretical subject but also practical, therefore learners need to see what they learn. The use of videos and anything relating to technology can help in educating the learners and have a good impact".*

The data collected from John showed that he was willing to use technology for teaching Physical Science. This was evident during his classroom observations where he used some of these technological devices to conduct the lesson. The use of technology seemed to help John to present the lesson conveniently and effectively. The data further highlighted the impact of technology not only on learning but also on the performance of the subject in general. This is supported by a study conducted by Iglesias-Pradas et al. (2021), where it was discovered that the performance of the subject seemed to improve when different technologies were used for teaching.

### 4.3.4 Teachers' Challenges to Technology Use

John pointed out lack the of technological tools for learners as a challenge. He indicated that while he had access to technological tools such as a laptop and projector, the learners did not possess some of these tools during classroom presentations. He pointed out that they relied on traditional resources such as textbooks and classwork books, as their learning materials. In a study conducted by Winter et al. (2021), it was stated that if the teachers and learners do not have the necessary technological tools, then teaching using technology is impossible. It was further highlighted that if learners lacked these technological tools, teachers would also be affected in a way that limits the type of activities they give to learners.

John further mentioned lack the of proper connectivity as one of the barriers that prevented the teachers and the learners from using these technological tools. This was supported by Van Roy (2012), when he mentioned lack the of proper internet connectivity as one of the challenges experienced especially in rural areas. John commented as follows:

*John: "If we could be able to have these gadgets to learners, we could have learners having cell phones and proper connectivity, then we can be able to introduce technology gradually to teaching of these learners".*

Based on the data collected from John on this theme, it was shown that there were challenges associated with using technology for teaching. The main challenges stated by John were the lack of technological tools especially for learners and the lack of proper connectivity. During the interviews, John stated that, if all these challenges could be addressed then using technology for teaching Physical Science would be possible and consequently benefit the learners.

### 4.3.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

In March 2020, schools in South Africa were closed due to the COVID-19 pandemic, as a result, teaching and learning were facilitated by technological tools (Valverde-Berrocoso et al., 2021). John indicated that their school was closed without any form of teaching and learning taking place. This is what John had to say:

> *Researcher: "During the COVID-19 pandemic, was teaching and learning taking place in your school"?*
>
> *John: "No, it wasn't until when it was open for us to have schools, that we were able to do that. So, when it was still harsh, the schools were closed so we were not having lessons".*

He further indicated that the performance of Physical Science was affected as they had no form of contact with the learners. Hence, they experienced poor performance in the subject. According to one of the participants of the Sintema (2010) study, the performance of the science subject was expected to drop because of the reduced contact time due to the lockdown. The participant in that study further highlighted that learners have different learning styles, some grasp knowledge by reading on their own while others need the teacher to be there to guide them. In this way, the performance of the subject will be negatively impacted due to COVID-19 pandemic. John commented as follows:

> *Researcher: "So, how did that affect the performance of Physical Science"?*
>
> *John: "We did not perform very well, hence I said Physical Science need to be more practical, and the other thing is learners need to be doing things almost every day, so because of let's call it "stay way" it has impacted much on the performance of learners".*

John concluded by saying that if learners were also provided with technological tools such as tablets and internet connectivity, such as in Gauteng province where learners had these gadgets, learners would have not stayed for so long without teaching and learning taking place. He further highlighted that teachers and learners would have been able to engage in online teaching and learning.

> *Researcher: "Ok, what do you suggest has happened to assist with the teaching and learning of Physical Science during that time"?*
>
> *John: "If learners were provided with gadgets for example something that happened in Gauteng where learners were provided with tablets, it will help a lot. If learners had those tablets or access to cell phones and data, we can be able to do online teachings. Learners would not have stayed for a long time out of school"*.

Alluding to John's responses, it was shown that the COVID-19 national lockdown had an impact on the way teaching and learning were taking place in schools. This was evident during John's interview where he mentioned that teaching and learning were not taking place in their school due to the pandemic. He further highlighted that if learners were also equipped with technological devices, then teaching and learning would not be compromised. This brings a perspective that John understands that the COVID-19 pandemic had a negative impact on teaching and learning. He believed that the use of technology would have had a good impact on the teaching and learning process, such that teachers could have continued with their pedagogical activities.

## 4.4. Case Two - Katlego

### 4.4.1. Teachers' Understanding of Technology Use.

Raja and Nagasubramani (2018) showed that using modern technology and tools for teaching and learning made the transfer of knowledge to become easy, convenient, and effective. Katlego understood technology as something that made the teaching of Physical Science easier. He elaborated by saying that in a school where there are no apparatuses to conduct experiments, he could be able to use technological tools to do the demonstrations. This is what he had to say:

> *Katlego: "What comes to my mind is or is something that makes the teaching of Physical Science extremely simple or to be more understandable".*

Besides technology being used as a teaching and learning tool, Katlego further highlighted that in the case of performing experiments, technology can prevent them from inhaling hazardous gases produced during the experiment.

> *Katlego: "We can perform experiments using computers without smelling chemicals that are very much dangerous".*

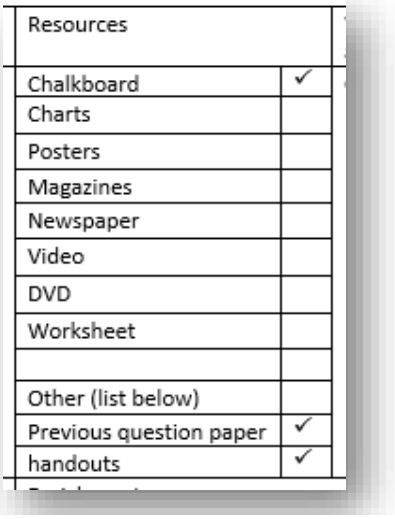
Based on Katlego's comments, he understood technology as something that made the teaching of Physical Science easier. During his interview, Katlego extended his understanding by giving an example, saying in a case where the school the lacked apparatus to conduct experiments, he could use some of the technological tools to do the demonstrations. Katlego's comment about technology use indicated that he understood the role that technology played in the teaching and learning of Physical Science. Katlego's understanding of technology is related to what Haleem et al. (2022) claimed about technology continuously attempting to create solutions to give access to learners who lack adequate educational facilities.

### 4.4.2 Technological Tools, Skills, and Qualifications

Katlego indicated that they did not have any means of technological tools to conduct teaching at their school except using a smartphone to download videos for some lesson preparations. This correlated with the findings in a study conducted by Msweli (2020) where teachers were lacking adequate technological resources, and as a result they went the extra mile and used their personal devices to enhance the teaching and learning process. This is evident in Katlego's response:

> *Researcher: "Ok, thank you Katlego. Do you have technological tools for teaching Physical Science"?*
>
> *Katlego: "Mmh! No! I don't have them at my school. I only use my smartphone to download videos".*

During the classroom observation, Katlego entered the classroom with chalk and previous question papers. He showed no intention of using any kind of technological device. He gave learners the previous question papers to work through. The chalks were mainly for clarifying concepts on the chalkboard whereas the previous question papers were used as a form of assessment to assess the learning outcomes of the lesson. Figure 4.2 below shows the resources that Katlego used in his lesson presentation.



| Resources | |
|---|---|
| Chalkboard | ✓ |
| Charts | |
| Posters | |
| Magazines | |
| Newspaper | |
| Video | |
| DVD | |
| Worksheet | |
| | |
| Other (list below) | |
| Previous question paper | ✓ |
| handouts | ✓ |

***Figure 4.2***: The resources used by Katlego during his lesson presentation

However, Katlego mentioned that he obtained a qualification in Information Communication and Technology for teachers which was essential to allow him to teach using technology. However, there was a challenge relating to the lack of technology-related facilities in his school. As a result, he was unable to apply the skills acquired in a classroom setting. He further mentioned that learners also lacked the necessary tools to engage in technology-enhanced learning. This is what he had to say:

> *Katlego: "I do have the skills but it's not simple for me to use them in the classroom situation because of the lack of proper facilities. I have attended ICT for educators, the information is there, but the only problem is the facilities at my school. We can't interact with learners".*

The data collected from Katlego highlighted that although he had the necessary skills to use technology for teaching, it was not enough if there were no proper facilities to allow for teaching to take place. This brings a perspective that, it was important for both teachers and learners to have technological tools for the teaching and learning process to be enhanced, otherwise technology integration in the classroom will remain a dream, especially in rural areas.

### 4.4.3 Teachers' Willingness to Use Technology.

Katlego indicated his willingness to use technology for teaching, he believed that it would make learners understand more. In a study by Li et al. (2019), it was indicated that most teachers perceive the value of the use of technology for themselves and their learners. Learners are probably to learn more if they are exposed to different

learning styles such as watching videos (Khalo, 2020). Katlego pointed out that technology brings different styles of learning such as visual learning. According to Katlego, visual learning would spark interest in learners other than theory-based learning. This is linked to what Khalo (2020) postulated when he said that implementing technology in the classrooms would probably stimulate learners' interest and improve their creative thinking. Katlego asserted:

> *Katlego: "Ooh yes, I would love to and like to use it. It makes learners understand more. Technology brings in the visual kind of learning for learners other than just learners learning theory. That is another way of tackling teaching in the classroom".*

However, as much as Katlego believed that technology promotes different styles of learning, a different view was observed during his lesson presentation. The content of the lesson was drawn only from the textbook and previous question papers. Although, Katlego managed to cover the lesson's objectives, he highlighted that learners were not able to see and feel what they were learning. They could only hear what they were learning. Katlego further highlighted that the only form of interaction which was taking place in his classroom was through the question-and-answer method. This suggests that the teacher was a source of information, and the learners were passive recipients of that information. Furthermore, it shows poor engagement or participation during the lesson.

During the interviews, Katlego further indicated that technology will improve the results of Physical Science and mathematics as well. Failure to implement technology in the classrooms will result in low academic performance (Khalo, 2020). Katlego commented:

> *Katlego: "Yes, I think so, because ever since we are trying to put in place technology in terms of Physical Science, I think Physical Science as well as mathematics results will improve".*

The data revealed that Katlego is willing to use technology for teaching. He had a perspective that it allows for different learning styles namely, learning by seeing and learning by hearing. However, this was not shown during his classroom observation. Learners did not actively engage in the lesson, as he had no technological devices to allow for such engagement. Learners were the sole recipients of the information from the teacher. Furthermore, Katlego held a positive view that the use of technology

would improve the performance of Physical Science and Mathematics subjects, which was contradictory to his actions in the classroom. However, he did mention that they had challenges associated with that.

### 4.4.4 Teachers' Challenges to Technology Use

Several research studies have pointed out a couple of challenges relating to technology use in the classroom. Availability and lack of access to resources are the main challenges that hinder teachers from adopting and implementing technology in the classroom (Khalo, 2020). Katlego has pointed lack of proper technological facilities as a challenge that prevented him from implementing technology in his classroom. He made a point that even if he has the necessary skills to use technology, it is just impossible to use it when the school does not have proper facilities.

This was evident during Katlego's classroom observation. The classroom where the observation took place was a mobile classroom which presented certain limitations. One notable constraint was the absence of electrical sockets which meant that technological devices requiring power could not be used in the classroom. This further restricted the integration of technology in teaching. He further indicated that learners should also have these technological devices for the implementation to be possible. This is what he had to say:

> *Katlego: "I do have the skills but it's not simple for me to use them in the classroom situation because of lack of proper facilities. Learners do not have the computers to interact with the programs like blackboard".*

The information gathered from Katlego on this theme showed that there were challenges associated with technology implementation in his classroom. The main challenges have been proper technological facilities such as electrical sockets. Although, Katlego was mentioned to having acquired the necessary skills to use technology, it was impossible for him to do so because of the existing challenges. Katlego's comment is in line with what Karunaratne et al. (2018) mentioned when they said lack of technological resources is one of the factors preventing the use of technology in the classroom.

### 4.4.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

Katlego indicated that teaching and learning were not taking place in their school during COVID-19 national shutdown. He pointed out that learners did not have the technological devices to continue with the lessons. He highlighted as follows:

> *Researcher: "During Covid 19 lockdown, was teaching and learning taking place in your school"?*
>
> *Katlego: "No, it wasn't taking place. The reason has been ermh! As simple as learners having smartphones. Learners where not having smartphones and they were not allowed to move to go anywhere. So, a simple technology such as a smartphone can restrict a lot so, we are supposed to use WhatsApp videos and all that but since learners didn't have smartphones, teaching and learning were not happening".*

The closure of schools had an impact on the structure of teaching and learning. It had an impact on the teaching and assessment methodologies (Tarkar, 2020). Katlego pointed out that shutting down schools without any form of teaching and learning taking place had a negative impact on the performance of Physical Science, as teachers and learners did not complete their Annual Teaching Plans due to time constraints. He further highlighted that they had to promote learners to other Grades without completing the syllabus. He commented as follows:

> *Katlego: "The performance of Physical Science subjects was negatively affected because learners didn't do all the chapters. We didn't have time anymore and the performance was low, the learners failed. Some went to other Grades without knowing the other chapters".*

According to Katlego's statements, it was shown that COVID-19 pandemic had destroyed the normal way of teaching and learning in schools. This was evident from the interview with Katlego, when he stated that schools were closed without any form of teaching and learning taking place. Further to that learners in Katlego's school did not have the technological devices to participate in teaching and learning at home during the national lockdown.

## 4.5 Case Three: Tebatso

### 4.5.1 Teachers' Understanding of Technology Use.

According to Lazar (2015), educational technology is a way of improving the educational process in a systematic and organised way. It includes teaching materials,

methods, and relationships. Tebatso understood the use of technology as the use of technological tools such as interacting whiteboards, overhead projectors, and cell phones to communicate with learners when teaching Physical Science. He highlighted as follows:

> *Tebatso: "Erh! The use of technology I think can be or includes erh using the interacting whiteboards, the computers, the overhead projectors, and cell phones where possible to communicate with learners or in order to teach learners Physical Science".*

However, the data collected from Tebatso during observations has shown a different perspective. Tebatso did not use any of the technological devices to do his lesson presentation, instead he used traditional methods to carry on with the lesson. Furthermore, Tebatso's classroom space was a mobile classroom with no electrical sockets, therefore, connecting these technological tools was impossible. This showed a contradiction in terms of Tebatso's perspectives on the use technology for teaching. As much as Tebatso understood that, the use of technology for teaching refers to the use of technological tools such as overhead projectors for teaching, he did not hold the same view during his lesson observation.

### 4.5.2 Technological Tools, Skills, and Qualifications

The introduction of technological tools such as mobile devices, tablets, smartboards, and virtual laboratories has brought changes in schools and institutions in terms of education (Haleema et al., 2022). Tebatso indicated that in their school every teacher was allocated a laptop. The school had overhead projectors. They used a projector to project content to clear misconceptions. This is what he had to say:

> *Tebatso: "Erh! Where am based there are only, ok everyone is given a laptop, or we have the laptops erh! we have the overhead projector sometimes they are connected to share some videos with learners trying to clear up some misconceptions in different aspects or topics".*

Tebatso further mentioned that even though they have some technological tools in their school, he did not acquire the necessary skills for using these technological tools, however, he is willing to learn. He highlighted as follows:

> *Tebatso: "I did not attend any training or acquire any skill but If it was possible, I would also like to learn how to use these tools should I get a chance".*

Although, Tebatso mentioned that they had some of these technological tools in their school, he did not use them during his classroom observation. During the classroom observation, Tebatso used traditional teaching techniques to deliver the lesson. He did not have any forms of technological devices. He brought handouts and a preparatory book to class which were the main sources of information for the lesson. Without the use of technological tools, the lesson relied heavily on verbal explanations and written materials. The absence of interactive whiteboards, computers, or other multimedia devices limited the visual and interactive aspects of the lesson. Haleema et al. (2022) argued that the usage of multimedia devices in the classroom makes studying captivating and entertaining for learners.

### 4.5.3 Teachers' Willingness to Use Technology.

Researchers have shown over a few decades that teachers' attitude predict whether teachers are willing to use technology or not, which influences their decision to participate in a technology-based teaching (Adov & Mäeots, 2021). The data collected from Tebatso showed that he was willing to use technology for teaching. He had a view that it had made life easier. He highlighted that it saved him time and prevented him from inhaling the dust produced by the chalks. He further highlighted that it becomes easier for him to revise lessons. This is what he had to say:

> *Tebatso: "The reason why am willing to use technology is, it makes life easy, life easy I mean if am not using technology am using chalk and a chalkboard, the time taken to write on the chalkboard and to erase some of the things written on the chalkboard and the dust the chalks provide is not good to our health and somehow it takes much of our time that we should be using for teaching Physical Science. But with the use of technology, everything will be clear, where there is a need to revise, you simply slide back, and you get to the slide that you need".*

The data further showed that Tebatso has a perception that the use of technology would improve the teaching of Physical Science because it stimulated interest in learners and as a result, they became motivated to learn. This was in line with what Haleema et al. (2022) maintained by saying children become more engaged if technology is used in the classroom. Children nowadays are adapted to using electronic gadgets and incorporating them into schooling will help to spark their interest. Haleema et al. (2022) claimed that using technology in education gives

learners an engaging experience and ensures that they remain interested in the subject. Tebatso further pointed out that the use of chalk, chalkboard, and duster every day makes learners loose interest and become demotivated. He alluded:

> *Tebatso: "Yes, the use of technology can improve the teaching of Physical Science in a sense that immediately learners get to technology things, or they see that everything you are using is technologically related erh! First, that allows them time, or it serves as a motivation that ok! Fine, it's time for class now, but if every day we are using the chalk and the chalkboard, duster somehow it is boring and demotivating to some of the learners but when we use technology, they are always encouraged to learn and they are also willing to enjoy the use of technology skills".*

Moreover, Tebatso pointed out that he would prefer to use technology for teaching Physical Science because he believed that if their school lacked apparatus to perform certain experiments, they would use technological tools to demonstrate. The tools would make it simple for learners to understand since they will see every step of the experiment. However, he further highlighted that if a chalk and a chalkboard were used, he could only highlight things and learners would not have any idea of what he was explaining, they could only assume what he was talking about. This is what he had to say:

> *Tebatso: "Erh! I prefer using technologically related tools for teaching Physical Science as it makes life easy and say for example, we would like to present some experiments and erh wherein we do not have enough apparatus, if we have the technology or the tools that we can use then that will help us a lot as everything can be clearly presented with all colours visible and if it is the experiment learners will be able to see every step of the process, the results, how they came about, the reasons. But when we are using chalk and a chalkboard, duster only, you only highlight things, learners don't have the idea, they only assume what happened without seeing what really takes place".*

As much as Tebatso stated his willingness to use technology for teaching and understood the impact that technology would have, he did not use the same ideas during his classroom presentation. As a result, the lesson was not exciting as he was predicting.

### 4.5.4 Teachers' Challenges to Technology Use

Tebatso mentioned the lack of proper internet connectivity as one of the factors that prevented the smooth implementation of technology for teaching Physical Science. He pointed out that learners lacked data and even if some had data, the network coverage was poor. As a result, learners could not access the activities provided to them on time. This challenge is related to what Rasheed et al. (2020) penned down when they said that learners experience poor internet connection and low internet speed when they try to access activities online. This is what Tebatso had to say:

> *Tebatso: "In some cases, learners don't have data to access the activities, erh! Sometimes others be having data but the network coverage where they are staying is not well".*

The classroom where Tebatso's observation took place was a mobile classroom with sufficient space to set up technological devices, if available. The classroom had no electrical sockets, indicating less potential for the installation of technological tools. Khalo (2020), argued that many schools especially in rural areas lacked computers and mobile devices as well as internet connectivity and it served as one of the factors hampering the integration of technology in teaching and learning.

Furthermore, the absence of interactive whiteboards, computers or other multimedia devices had limited the visual and interactive aspects of the lesson. This may have hindered the learners' ability to fully grasp and engage with the subject matter. Due to these challenges, Tebatso was not able to utilise technology for teaching during the observed lesson.

### 4.5.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

During the COVID-19 pandemic, schools were forced to close without any form of teaching except online teaching. This has forced teachers to design lessons, homework, assignments, and assessments online for teaching and learning to continue (Winter et al., 2021). Tebatso indicated that teaching and learning was taking place in their school, although it was not effective. They were using WhatsApp applications to give learners activities while they were at home, however, there were challenges associated with that. He pointed to the lack of internet connectivity as one of the challenges. He added that because of a lack of data or internet connectivity, some learners did not have access to the activities or when they did, the work had

already piled up and they ended up being demotivated to submit. This is what he had to say:

> *Tebatso: "Erh! It was taking place, but it was not that effective as such, when we were home, I was giving learners activities as per different topics then as you give them activities to conduct while they were at home, you find that erh! In some cases, learners don't have data to access the activities, erh! Sometimes others will be having data, but the network coverage is poor, you find that they miss a lot of work or when they get a chance to do the work, you find that the work is too much and that demotivated them".*

Tebatso's claims aligned with what Winter et al. (2021) claimed when they said that the transformation from face-to-face to online teaching has resulted in learning loss for learners. Learning loss is associated with stress, lack of motivation and less time spent learning (Winter et al., 2021). Tebatso held a positive view in terms of using technology for teaching, this was depicted on the fact that he used WhatsApp application to give assessments when learners were at home during the national lockdown. ref

## 4.6 Case Four -Thabo

### 4.6.1 Teachers' Understanding of Technology Use.

Thabo understood the use of technology as the use of technological devices for teaching Physical Science. However, he did not elaborate on what he meant by technological devices for teaching as mentioned by Haleema et al. (2022). Haleema et al. (2022) viewed the context in which this teaching occurs as a digital classroom. In a digital classroom, according to Haleema et al. (2022), the teaching and learning process takes place using technology. In this process, learners use technological tools such as laptops, tablets, etc. to learn instead of taking notes of what the teacher is teaching. Most of the curriculum is taught through engaging and interactive platforms (Haleema et al., 2022). Thabo highlighted as follows:

> *Researcher: "What do you understand about technology use in the teaching of Physical Science"?*
>
> *Thabo: "I think technology use is the use of technological devices in the teaching of Physical Science".*

During the classroom observations, Thabo showed his understanding of technology by using technological devices such as a laptop and a projector to teach. However, Thabo held a view that technology cannot replace the traditional way of teaching. He claimed that some concepts in Physical Science require the teacher to be there to explain whereas others require the teacher to use technology to do the explanations. Thabo viewed the use of technology for teaching as helping to a certain extent, he believes that in other instances technology can be hindering.

### 4.6.2 Technological tools, skills, and qualifications

Thabo mentioned overhead projectors, smartboards, and tablets as some of the technological devices they had at their school. According to Raja and Nagasubramani (2018), using projectors to aid teaching and learning is another great form of technology use. Using projectors in schools brings up interest, interaction, and motivation in learners. Learners become excited when they see and hear what they are learning, and it makes teaching and learning efficient (Raja & Nagasubramani, 2018). This is what Thabo had to say:

> *Researcher: "Ok, do you have technological tools for teaching Physical Science"?*
>
> *Thabo: "We have an overhead projector; we also have a smartboard as well as iPads for learners that they normally use to log in".*

During the classroom observation, Thabo entered the classroom with a laptop and a projector which were used during the lesson. Thabo appeared to be comfortable with connecting and using these tools efficiently. The classroom was equipped with electrical sockets, enabling the connection of Thabo's laptop and the projector. He utilized the whiteboard and projector to interact with the learners, providing examples and visual aids to support the lesson. Table 4.2 below provides the type of technological tools that were used and how they were used in the lesson.

**Table 4.2: The types of technological tools used and how they were used.**

| Types of technological tools | How they were used |
|---|---|
| 1. Laptop | The laptop was used to draw a lesson plan and to do the lesson presentation using PowerPoint software. |
| 2. Projector | The projector was used to project the lesson presentation so that learners could see what the teacher was presenting. |

| | |
|---|---|
| 3. Whiteboard | The whiteboard was used to display the lesson presentation. |

The lesson proceeded with Thabo projecting the content onto a whiteboard for all the learners to see. Thabo explained the concepts and requested the learners to diligently take notes. The use of technological tools allowed Thabo to enhance the explanation of the subject matter, as the learners were able to visualize what he was teaching. However, Thabo indicated that the use of technology in this way makes learners lose concentration on the explanations as they focus on coping the notes. He further highlighted that learners did not possess similar technological tools such as laptops and tablets.

Moreover, Thabo mentioned that, although they had these technological tools in their school, he has not acquired any skills for using them to teach Physical Science, except that he has attended visual training which according to him was inadequate. He commented as follows:

> *Researcher: "Ok so, do you have any skills in using these technological tools? Have you acquired skills or attended a workshop"?*
>
> *Thabo: "I haven't yet acquired skills; I only attended visual training but for me was not adequate".*

The data collected from Thabo showed that he had technological tools in his school, and he used them for teaching. Although he highlighted that he did not attend any formal training to use these tools, he showed confidence in using the tools.

### 4.6.3 Teachers' Willingness to Use Technology.

Thabo indicated that he was willing to use technology for teaching and he thought it would improve the teaching of Physical Science. However, according to him, it has both positive and negative impacts on teaching. The positive impact according to him, was that technology was time-efficient and effective, one could be able to complete a topic in a short period. He further highlighted those technological tools made learners actively engaged in learning. Furthermore, he added that technology helps with visualizations when one is teaching those topics which are abstract. The negative impact according to him is that he believed that it cannot replace the traditional way of teaching.

Thabo's claims aligned with Raja and Nagasubramani's (2018) claims about the positive and negative impacts of technology. The positive impact according to Raja and Nagasubramani (2018) is that it improves the teaching and learning process by using projectors, PowerPoint presentations etc. which helps learners to grasp concepts easily and effectively. In addition, learners find learning through visuals enjoyable. They can participate, and teachers can make their classes interactive and interesting. The negative impact according to Raja and Nagasubramani (2018), is that using modern technologies such as graphical calculators and high-tech watches promotes cheating during tests and exams. Thabo highlighted as follows:

> *Researcher: "Are you willing to use technology for teaching Physical Science"?*
>
> *Thabo: "Yes, I am willing to use it".*
>
> *Researcher: "Ok, do you think it will improve the teaching of Physical Science"?*
>
> *Thabo: "It can improve; however, I think it has both positive and negative sides of it. The positive side of using technology is that it is time efficient, and it is very effective. You can be able to complete a topic in a very short period, you know Physical Science have got a lot of content, so you can cover pacesetter or ATP within a given period of time. The other thing is that most learners like going to the science lab or media center where they will be able to use these tools, like login and checking information on the internet and all these things. The disadvantage for me is that even if technology is there to be used, I still believe it cannot replace the old way of teaching, the manual teaching, because some of the concepts in Physical Science need the teacher to be there, writing down the equations and writing their meanings, so technology will help with visualizations like if maybe, you are projecting something that needs learners to see how is done".*

The data revealed that Thabo is willing to use technology for teaching. He held a view that both the technological tools and traditional techniques played an important role in the teaching of Physical Science. Therefore, they must both be encouraged in the classroom.

### 4.6.4 Teachers' Challenges to Technology Use

Thabo mentioned the lack of proper training as one of the challenges he experienced when using technology for teaching. He mentioned that he only received a one-day

online training, which according to him was inadequate. He added that most of the skills he has, he has taught himself with the help of other teachers. From the interviews conducted in the study by Li et al. (2019), it emerged that most of these teachers felt their skills were insufficient for what was expected of them in terms of the use of technology for teaching science subjects. Furthermore, in a study conducted by Msweli (2020), the participants indicated that they are unable to use technology for teaching and those who know how to use it find themselves having to help others and it becomes a challenge for them. This is what Thabo had to say:

> *Researcher: "Ok so, do you have any skills in using these technological tools? Have you acquired skills or attended a workshop"?*
>
> *Thabo: "I only attended a visual training but for me was not adequate. It's a self-taught skill for me and help of other teachers who understand how this thing works".*

If teachers and learners were expected to use technological tools properly and optimally, teachers should be properly trained (Khalo, 2020). The data collected from Thabo during the interview revealed that training is important if the teachers were to use technology for teaching. However, during the observations Thabo seemed to be comfortable using the tools for teaching, although he mentioned to have taught himself during the interview.

### 4.6.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

Schools were closed in March 2020 due to COVID-19 pandemic. During that time, technological tools were the only way to mediate the relationship between teachers and learners (Valverde-Berrocoso et al., 2021). Thabo indicated that during the COVID-19 pandemic, he was teaching through the WhatsApp platform. In this platform, Thabo was able to engage learners in discussions and give them activities, some learners were able to access them on time whereas others would access them later. This is what he had to say:

> *Researcher:* "*Ok, so during the COVID-19 pandemic was teaching and learning taking place in your school"?*
>
> *Thabo: "Yes, I was teaching online using the WhatsApp platform. I was talking the learners that we will be discussing this at this time and at that time we log*

*in and introduce the topic and ask them questions, some will respond either at the time or they will record voice notes".*

He highlighted further that Physical Science was a continuous subject, and the topics in Physical Science were integrated from Grades 10-12, hence it was important that the teaching and learning of Physical Science continued even when there was a national lockdown. Besides, if the teaching and learning of Physical Science did not continue, it was going to create a content gap among learners. As a result, learners were going to have difficulties in understanding questions, especially high-order questions. This is what he had to say:

*Researcher: "Alright, so according to you, was it important for teaching and learning of Physical Science to continue during the national lockdown"?*

*Thabo: "Obviously it was very important because Physical Science is a continuous learning subject, you cannot stop somewhere because once you stop you forget and if learners for example know that they were not taught during that time, they experience problems when they go to other Grades. Since most topics are integrated as you move from Grade 10-12 so, that content barrier will have a negative impact on understanding some questions, especially high-level questions that require previous knowledge, especially in Grade 12"*.

The data collected from Thabo highlighted the importance of teaching and learning continuing during COVID-19 pandemic. It was stated that the performance of Physical Science was going to be compromised if the teaching and learning did not continue during that time. Further to that, learners were going to develop content gaps and misconceptions. This highlighted that Thabo had a positive perception about the use of technology for teaching physical sciences. He believed that the subject matter was going to be compromised if teaching and learning were not taking place during the COVID-19 lockdown.

## 4.7 Case Five: Lebo

### 4.7.1 Teachers' Understanding of Technology Use.

Schools were forced to adopt online teaching modes to sustain the education system due to the COVID-19 pandemic (Haleema et al., 2022). Lebo understood technology as something important in a way that during the COVID-19 pandemic, it has enabled

communication between teachers and learners. The education system was saved during this critical time using digital technologies (Haleema et al., 2022). Educational technology enabled Lebo to use it to download videos of practical activities to share with learners since they lacked apparatus in their school. This is in line with Haleema et al. (2022) claims when they said educational technology searches to fill the gap to expand access to education for learners who lack adequate educational resources. This suggests that Lebo did see the advantage that came with the use of technology for teaching. She highlighted as follows:

> *Lebo: "Ok, technology is very important now, we have seen during covid 19, it has really helped us to communicate with learners through online platforms and WhatsApp groups. So, technology is very important plus some of the schools are very poor, we don't have laboratories and staff like that. We are just downloading videos and showing them to learners so, things are much easier now compared to the time we were relying on a textbook".*

The data collected from Lebo highlighted the role played by technology especially during COVID-19 pandemic. Lebo pointed out that videos were used to demonstrate practical work in case there was a lack of apparatus to perform certain experiments. Further to that technology served as a source of communication amongst teachers and learners.

### 4.7.2 Technological Tools, Skills, and Qualifications

Lebo indicated that they do have laptops and computers at their school, however, they are not using them for teaching. As Winter et al. (2021) mentioned in their study, some teachers lack confidence in using technological tools which affects their use of these tools. It may suggest that Lebo had no confidence or school support in using technological tools for teaching. She further highlighted that she has acquired certificate in teaching with technology for a short course that she attended on data science for programming with Python. Despite having received training she is still not using technology for teaching. Or it may suggest that the kind of training she received was not appropriate for teaching in the classroom. She ventilated:

> *Lebo: "Yes, I did this other certificate of teaching with technology, so yeah, I acquired a bit of knowledge in terms of technology. I have done a short course on data science and programming with Python".*

Drawing from Lebo's classroom observation, it can be concluded that she was not motivated to use technology for teaching as she claims that learners did not have any of the technological tools. Lebo primarily relied on the question-and-answer method to interact with the learners. In this method, Lebo highlighted that she was asking learners questions, and they responded by providing answers. In short, during the observation, Lebo conducted the lesson using traditional teaching methods without utilizing any technological tools.

### 4.7.3 Teachers' Willingness to use Technology.

Lebo indicated that she was willing to use technology for teaching. She held a view that it would improve the teaching and learning of Physical Science. She pointed out that since their school lacked proper facilities for performing experiments, then it would be much easier for them to use technology for downloading videos to show to learners. She further highlighted that learners learn more when they see what they are taught. This is what she had to say:

> *Researcher: "Are you willing to use technology for teaching Physical Science"?*
>
> *Lebo: "Yes, as I mentioned before, some of the schools do not have equipment for practical work. So, we download videos and show them to learners and learners nowadays learn more when they see things through videos other than just talking verbally*.

As much as Lebo indicated that she was willing to use technology for teaching, a different view was observed during her classroom observation. Lebo came to class with only previous question papers as the resources that would be used for the lesson. There was no technology used in the classroom. However, other contextual factors were observed that might have contributed to Lebo not attempting to use technology during her lesson. The contextual factors observed include a lack of electrical sockets and a lack of some technological devices for learners. This brings a perspective that Lebo is willing to use technology for teaching, however there are factors that hinders the use of this technology for teaching.

### 4.7.4 Teachers' Challenges to Technology Use

Lebo mentioned the lack of technological devices and proper internet connectivity by learners as the challenge she encountered when using technology for teaching. The inequalities in learners' access to technological devices influence the type of learning

the teacher offers learners (Winter et al., 2021). Furthermore, during the classroom observation, it was noticed that the classroom lacked the electrical outlets required for connecting technological tools. This absence of electrical infrastructure restricted the use of laptops, computers, projectors, or other digital devices that could enhance the teaching and learning experience. The lack of technological resources in the classroom made the teacher more dependent on traditional methods, including using chalk and question papers according to the researcher's observations. Lebo highlighted as follows:

*Researcher: "Were you using technology for teaching Physical Science"?*

*Lebo: "No most of the learners did not have cell phones and data or Wi-Fi".*

The data collected from Lebo showed that, although Lebo might have been interested in using technology for teaching, it would have been impossible due to the challenges mentioned and observed. These challenges were the main factors contributing to Lebo been reluctant to use technology for teaching.

### 4.7.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

Lebo indicated that teaching and learning were not taking place in their school during the COVID-19 national lockdown and as a result, the performance of Physical Science was negatively affected. Sintema (2020) claims that the reason for this low performance in Physical Science was due to loss of contact hours and lack of e-learning resources. E-learning resources would have enabled interaction between teachers and learners, according to Sintema (2020). Furthermore, Lebo highlighted that the loss of contact time during COVID-19 resulted in learners especially in lower Grades (10 &11) developing content gaps. This is what she had to say:

*Researcher: "During covid 19 lockdown was teaching and learning taking place in your school"?*

*Lebo: "No, it was not".*

*Researcher: "How did that affect the performance of the Physical Science subject"?*

*Lebo: "For lower Grades, Grades 10 & 11, it has affected them badly because we went back to school and focused only on Grade 12. So, for 10 & 11, we are*

*suffering the consequences, because they don't have that basic knowledge, they have missed some things during that lockdown".*

The data collected from Lebo showed that teaching and learning were not taking place in Lebo's school during the COVID-19 pandemic and as a result, the performance of the subject was affected.

## 4.8 Case Six: Peter

### 4.8.1 Teachers' Understanding of Technology Use.

Technology can help improve education in so many ways. It can make it easier for teachers to generate instructional materials and enable them to provide learners with new methods of learning and collaboration (Haleema et al., 2022). Peter understood technology as something that can simplify the teaching and learning of Physical Science. Peter used a laptop to download videos to share with learners in the absence of apparatus during practical work. He further mentioned the YouTube application as another way in which learners can learn. This is what he had to say:

*Peter: "We talk about something that can simplify teaching and learning in the classrooms. For example, with laptops, teachers can use videos for the learners if you don't have apparatus for performing experiments. You can use U-tube videos just to help you to make learners understand".*

Drawing from Peter's interview, it showed that he understood the benefits that technology offered, especially in the absence of experimental apparatus. He understood that technology can offer learners more content without the teacher being there and facilitating the lesson. This was evident in his statement when he pointed to applications such as YouTube in which learners can learn.

### 4.8.2 Technological Tools, Skills, and Qualifications

Looking at today's technological growth, teachers must learn how to use various technological devices such as smartphones, tablets, computers etc. to avoid marginalisation (Haleema et al., 2022). Peter mentioned a cell phone and laptop as the technological devices he had and sometimes used for teaching. However, he indicated not having attended any formal training except for a one-day workshop on basic computer skills that he found ineffective. Otherwise, the rest of the skills he acquired by himself with the help of others. This is what he had to say:

*Researcher: "Ok, so do you have any skills in using technological tools for teaching? Have you acquired certain skills"?*

*Peter: "Aah...no! No! but I've just learned myself. I didn't go any further about this".*

*Researcher: "It means you haven't attended any training"?*

*Peter: "Yes, yes. But I am willing to learn. If I don't know something I ask other people, how do we do this"?*

*Researcher: "So, do you have any qualifications in technology-related studies"?*

*Peter: "No! no! It was just a one-day course for this summer, talking about how to use these computers. It was only for one day".*

During the classroom observation, Peter arrived in class with a laptop, a projector, and previous question papers. He planned to conduct the class using a laptop and a projector to include technology in his lesson. However, he encountered difficulties in connecting the tools. The difficulties he experienced include inability to connect and setting up the devices.

Figure 4.3 below, provides some of the resources used during Peter's lesson presentation.

| Resources | |
|---|---|
| Chalkboard | ✓ |
| Charts | |
| Posters | |
| Magazines | |
| laptop | ✓ |
| Video | |
| projector | ✓ |
| Worksheet | |
| | |
| Other (list below) | |
| Previous question paper | ✓ |
| handouts | |

***Figure 4.3***: The resources used by Peter during his lesson.

Drawing from Peter's comments, he was willing to learn more about using technology for teaching. Unfortunately, he did not get a chance to do so. Valverde-Berrocoso et al. (2021) argue that teachers must be trained beyond basic digital skills, the training

must integrate the interpretative and creative potential of technology. Otherwise, teachers may feel like they are not sufficiently trained. This is in line with what Peter mentioned earlier that he feels like the one-day training was ineffective.

### 4.8.3 Teachers' Willingness to Use Technology.

Adov and Mäeots (2021) argue that teachers' attitudes towards technology in teaching to determine their willingness to use it. Peter showed a positive attitude when he mentioned his willingness to use technology for teaching, he believed that without technology life would not be easy. Furthermore, he highlighted that he would prefer to use technology for teaching rather than chalk and a chalkboard. This is what he had to say:

> *Researcher: "Are you willing to use technology for teaching Physical Science"?*
>
> *Peter: "Yes, because technology is used every day, without technology, you will never know anything".*
>
> *Researcher: "So do you think it will improve the teaching of Physical Science"?*
>
> *Peter: Yes, the world is changing every day".*

Marpa (2021) argues that teachers must be competent in using technology for teaching, as a result they should establish a positive attitude towards technology to be competent enough. During classroom observation, Peter showed his positive attitude towards the use of technology by bringing a laptop and a projector which he was aiming to use during the lesson. However, the aim was not achieved as he struggled to project the information clearly onto the board. This may suggest that teachers need proper training for them to be competent enough in using these technological tools (Khalo, 2020).

### 4.8.4 Teachers' Challenges to Technology Use

Peter pointed lack of technological tools and proper internet connectivity as one of the challenges he faced when using technology. In a study conducted by Winter et al., (2021), it was pointed out that some of the factors influencing technology use are the availability of technology in the classroom and teacher training. If teachers lack one of these factors, they will lose confidence and become reluctant. Peter highlighted as follows:

*Peter: "Learners must have tablets and Wi-Fi, so that they can do their own research. It will simplify learning".*

Although Peter mentioned a lack of technological tools and proper internet connectivity as some of the challenges he encountered, the observation results propose a lack of proper training as a challenge that Peter had. This was evident during his classroom observation when he encountered difficulties in connecting the tools, resulting in a significant amount of time being lost for teaching and learning. The learners were unable to see the material that he was trying to project using a projector. Therefore, to continue the lesson, Peter had to resort to using printed copies of the previous exam papers and a chalkboard as teaching tools. The lesson's effectiveness was compromised by this reliance on printed materials as opposed to maximizing technology's capabilities.

The decision to use chalkboard versus the technology available suggested a lack of confidence or familiarity with using technology for the teaching and learning process. Looking at Peter's statement, it has shown that even if he wanted to use technology for teaching, it would be difficult since learners did not have these technologies. Khalo (2020) argues that availability and lack of access to resources are the two main challenges that prevent teachers from adopting and implementing technology in teaching.

### 4.8.5 Teachers' Perspectives on the Impact of COVID-19 on the Teaching of Physical Science

Due to the COVID-19 pandemic, teachers were faced with new challenges such as creating online educational content and encouraging learners to engage in online activities (Haleema et al., 2022). Peter pointed out that he resorted to using WhatsApp applications for teaching and assessment during the national lockdown. Haleema et al. (2022) argue that creating online educational content and encouraging learners to engage in online activities poses a challenge to the learners as some are striving to adjust to online learning whereas others are struggling to get support from home. He further pointed out that; learners who were struggling to learn during face-to-face interactions may struggle even more in the new teaching arrangement. Peter pointed out that learners must be supplied with tablets and WI-FI for online teaching to be successful. This is what he had to say:

*Researcher: “Ok, during covid 19 lockdown, was teaching and learning taking place in your school”?*

*Peter: “Yes, I was sometimes using WhatsApp talk to the learners at home. I believe learners must have tablets and Wi-Fi, so that they can do their own research. It will simplify learning”.*

The data collected from Peter indicated that he used WhatsApp applications to give learners work while they were at home during the COVID-19 pandemic. However, Haleema et al. (2022) showed that it might be difficult for learners to learn through online platforms especially those learners who had difficulties learning face-to-face. As a result, learning through online platforms has its challenges that affect it. The challenges associated with online teaching include among other things lack proper internet connectivity (Khalo, 2020).

### 4.9 Chapter Summary

This chapter was based on the presentation and discussion of data collected from six Physical Science teachers from different schools. The first stage of data collection was a semi-structured interview, where teachers had to respond to questions which were generated from a literature review and conceptual framework. The second stage was the classroom observations, where each teacher was observed once, and the results were recorded on the observation template. The third stage was document analysis, where each of the documents used by the teacher during the lesson presentation was analyzed. The data presentation of the six Physical Science teachers was done through four themes from the research questions. The next chapter will be a summary of the findings and conclusions.

# CHAPTER 5

# SUMMARY OF FINDINGS AND CONCLUSIONS

## 5.1. Introduction

This chapter presents findings to the research questions. These findings are presented per case on each sub-question to gain an in-depth understanding of how Physical Science teachers perceive the use of technology in their classrooms. The chapter further presents the study contributions which were formulated by the unified Theory of Acceptance and Use of Technology (UTAUT) framework, the limitations of the study, the recommendations of the study as well as the conclusion that provides a summary of this chapter.

## 5.2. Research Questions

This study aimed to explore Physical Science teachers' perspectives on the use of technology in their Physical Science classrooms. The main question that guided the study was:

- What are the physical science teachers' perspectives on the use of technology in their classrooms and the challenges they encountered pre- and post-COVID-19 pandemic?

Physical Science teachers' perspectives were explored through the following sub-questions:

- What do Physical Science teachers understand as technology use in their classrooms?
- What are the teachers' views on the use of technology in their Physical Science classroom?
- What are the challenges if any, teachers face when using technology in their Physical Science classroom?
- How did the COVID-19 global pandemic impact technology use in Physical Science classrooms?

The study findings addressed the main research question through the four sub-questions. The findings of these four sub-questions were presented in the form of themes. These themes provided a summary of responses from the six Physical

Science teachers who participated in the study. Below is a summary of the findings of each sub-questions presented per case.

### 5.2.1. What do Physical Science teachers understand as technology use in their classroom?

**Case One: John**

The study discovered that John understood technology to encompass gadgets such as laptops and smartphones that were used in the classroom to teach. He saw the use of these tools as an alternative way to close a gap when a school lacked the apparatus to conduct the experiments. Furthermore, John believed that these tools could be used to access educational websites such as YouTube channels. During his classroom observation, John demonstrated his understanding of technology by using a laptop to present his lesson. He seemed to be comfortable using it to teach, although he mentioned that he had not received any formal training.

**Case Two: Katlego**

The study revealed that Katlego understood technology as something that made the teaching of Physical Science easier. He gave an example by saying that if the school lacks the apparatus to conduct experiments, he could use some of the technological tools to demonstrate. Katlego held the same idea as John when he mentioned using technology in the absence of experimental apparatus. This suggested that Katlego and John understood technology as an alternative strategy to enhance the teaching of Physical Science. Katlego further demonstrated that the use of technology in the classroom cannot only make teaching easier, but it could also prevent the inhaling of poisonous gases during practical activities. Although Katlego saw technology as something that made the teaching of Physical Science easier, he did not possess any technological tools during his classroom observation. He raised several factors that prevented him from using technology in his lesson. Some of the factors included a lack of proper facilities.

**Case Three: Tebatso**

The study showed that Tebatso understood the use of technology as the use of technological tools such as interacting whiteboards, overhead projectors, and cell phones to communicate with learners when teaching Physical Science. Although Tebatso understood technology as the use of some of these technological tools to

communicate with learners, the same idea was not shown during his classroom observation. He did not use any technological tools to communicate with learners, he used traditional methods throughout his lesson. During his interview, he highlighted that each teacher in his school was allocated a laptop, but still did not use it during his lesson presentation. Based on the observations made in his classroom context, there was no possibility of these tools being used, as the classroom was a mobile classroom with no electrical sockets.

**Case Four: Thabo**

The study revealed that Thabo understood the use of technology as the use of technological devices for teaching Physical Science. Thabo demonstrated his understanding by using some of the technological devices to teach during his lesson. He used a laptop and a projector to present his lesson. Although Thabo used some of these technological tools during his Physical Science lesson, he held a belief that technology could not replace the traditional way of teaching. He claimed that in Physical Science, there were topics that required the teacher to elaborate using chalk and chalkboard whereas others needed to be demonstrated through a projector.

**Case Five: Lebo**

The study discovered that Lebo understood technology as something important in a way that during the COVID-19 pandemic, it had enabled communication between teachers and learners. Lebo held the same view as Tebatso when she said technology-enabled communication when teachers and learners could not meet face-to-face. However, during her classroom observation, she did not demonstrate the same understanding. Lebo did not use any technology to communicate or teach, instead, she used a chalk and chalkboard to present her lesson. Furthermore , Lebo mentioned during her interview that although her school had computers, she did not use them to present her lesson. She elaborated more on her understanding saying that technology enabled her to download videos to share with learners when her school lacked experimental apparatus. Lebo’s sentiments about the use of technology were similar to John, Katlego and Tebatso.

**Case Six: Peter**

The study revealed that Peter understood technology as something that could simplify the teaching and learning of Physical Science. Peter held the same opinion as Katlego

when he said technology was something that made the teaching of Physical Science easier. During his classroom observation, Peter attempted to use technology for teaching, however, he was faced with difficulties trying to connect with the technological tools. As a result, Peter resorted to using printed copies of previous question papers rather than the electronic ones he initially prepared.. He further demonstrated the same view as John, Katlego, Tebatso, and Lebo when he said the technology could be used as an alternative way to demonstrate practical work in the absence of apparatus. He mentioned applications such as YouTube as a way in which learners can learn easily.

#### 5.2.1.1. Summary of findings of the first research question

The study revealed that some teachers understood technology as devices such as laptops, projectors and cell phones which are used for teaching. Whereas other teachers understood technology as something that simplifies the teaching and learning process. Raja and Nagasubramani (2018) described technology as hardware and software applications that are used in the classroom for teaching. Moreover, Haleem et al. (2022) argue that technology is a powerful tool for improving education, which aligns with other teachers' understanding of technology that it simplifies the teaching and learning process. Many of the teachers in this study further demonstrated their understanding of technology by saying it serves as an alternative way of presenting certain educational concepts such as visual experiments, particularly in the Physical Science subject. These findings suggest that teachers in the Makhutswe circuit had an idea of what technology is and how it can be used for the teaching of Physical Science.

### 5.2.2. What are the teachers' viewpoints on the use of technology in their Physical Science classroom?

**Case One: John**

It was discovered that John viewed technology as something that made the teaching of Physical Science easier. He believed that technology enhanced learning by introducing a more visible form of learning than traditional theory-based instruction. He claimed that Physical Science is a practical subject; therefore, learners should participate in various learning styles. This was evident during his classroom observation whereby he used a laptop and a projector to conduct the lesson. The use

of these technological tools enabled him to project visual content, enhancing learners' understanding and engagement. The learners were excited to see the lesson being projected, and the visual aspect made it easier for John to convey the content effectively.

**Case Two: Katlego**

It was revealed in this study that Katlego viewed technology as something that would make learners want to learn more. He believed that technology brings different styles of learning such as visual learning. According to Katlego, visual learning would spark interest in learners in contrast to theory-based learning. This is the same view held by John when he mentioned that technology was associated with different styles of learning. However, as much as Katlego believed that technology promoted different styles of learning, he did not demonstrate the same idea during his classroom observation. He used the same style of learning throughout the lesson. He used the traditional way of teaching without learners engaging in different styles of learning. However, the study did reveal that there were challenges relating to the use of technology in his classroom.

**Case Three: Tebatso**

The study discovered that Tebatso believed that technology made life easier. His view was that it saved time and prevented him from inhaling the dust produced by the chalk. He further highlighted that it made it easy for him to do revisions. Tebatso believed that the use of technology would improve the teaching of Physical Science because learner interest would be stimulated which motivated them to learn. Thus, he held the same view as Katlego when he mentioned that the use of technology encouraged learners to learn more. Tebatso further pointed out that the use of chalk, chalkboard, and duster every day made learners lose interest and become demotivated. It was further revealed in this study that Tebatso would prefer to use technology for teaching Physical Science because in a case where the school lacks apparatus to perform certain experiments, the school could use technological tools to do the demonstrations. The tools would make it simple for learners to understand since they would see every step of the experiment. As Tebatso pointed out, if a chalkboard and chalk were used, he would only highlight things, and learners would have no idea what he was explaining, they would only assume what he meant.

**Case Four: Thabo**

The study revealed that Thabo is willing to use technology in the classroom, believed that it would improve the teaching of Physical Science. However, according to him, it had both positive and negative impacts on teaching. He said the positive impact of technology was that it was time-efficient and effective, enabling people to finish topics in a short time. Tebatso shared the same sentiments with Thabo that technology saved time. He further highlighted that technological tools stimulated interest in learners and motivated them to learn. With this view, he held the same opinion as Katlego and Tebatso, when they mentioned that technology inspired learners to learn more. In addition, Thabo believed that technology helped with visualizations in a case where one was teaching abstract topics. According to him, the negative impact was that he believed it could not replace the traditional way of teaching.

**Case Five: Lebo**

According to this study, Lebo believed that using technology in the teaching of Physical Science would enhance the teaching and learning of the subject She pointed out that since their school lacked proper facilities for performing experiments, then it would be much easier for them to use technology for downloading videos to show to learners. She further highlighted that learners learn more when they see what they are taught than merely hearing the content. This is the same view held by John and Katlego who mentioned that technology brings different styles of learning which enhances learning.

**Case Six: Peter**

The study revealed that Peter believed that life would not be easy without technology. Furthermore, it was revealed that Peter would prefer to use technology for teaching Physical Science rather than using chalk and a chalkboard.

#### 5.2.2.1. Summary of findings of the Second Research Question

The study discovered that all the teachers held a view that technology can improve the teaching and learning of Physical Science. They emphasized this point by saying that it enables the visual aspect of learning where learners would not only hear what they are learning but would also see what they are learning. This is elaborated by Abdulrahaman et al. (2020) when they argued that, learners' interest in the subject matter becomes stimulated when they visualise and hear during a learning process. The study further revealed that some of the teachers had a perception that technology

is time-efficient, it enables them to convey the content of the lesson both efficiently and effectively. Onyema et al. (2019) emphasized this point by saying other than being efficient, technology makes the transfer of knowledge to be effortless and convenient. These findings suggest that teachers in this study held a positive view towards technology use in their classrooms as they understood its benefits in the educational curricula.

### 5.2.3. What are the challenges if any, teachers face when using technology in their Physical Science classroom.

**Case One: John**

The study revealed that John saw the lack of technological tools for learners as a challenge. Although John had access to technological tools such as a laptop and projector, he mentioned that learners did not have some of these technological tools. The study discovered that learners relied on traditional resources such as textbooks and classwork books as their learning materials. John further stated that the lack of proper connectivity was one of the barriers that prevented teachers from using these technological tools.

**Case Two: Katlego**

The study showed that Katlego pointed to the lack of proper technological facilities as a challenge that prevented him from implementing technology in his classroom. He made a point that even if he had the necessary skills to use technology in his classroom, it was impossible to apply them because the school did not have proper facilities to cater for that. This was evident during Katlego's classroom observation, the classroom where the observation took place was a mobile classroom which presented certain limitations. One notable constraint was the absence of electrical sockets. This meant that technological devices which require power could not be used in the classroom. This presented further restrictions to the integration of technology in teaching. He further highlighted that learners should also have these technological devices for the implementation to be possible. Katlego shared the same opinion with John about learners having the same technological tools as teachers for the smooth implementation of technology in the classroom.

**Case Three: Tebatso**

The study revealed that Tebatso pointed to the lack of proper internet connectivity as one of the factors that hindered the smooth implementation of technology for teaching Physical Science. He pointed out that learners lacked data and even if some had data, the network coverage was poor. As a result, the study discovered that learners cannot access the activities provided to them on time. This showed that Tebatso shared the same challenge as John about poor internet connection. The study further revealed that Tebatso's classroom context presented more challenges for the implementation of technology. This was evident during his classroom observation, the classroom was a mobile classroom that had no electrical sockets, indicating less potential for installation of technological tools.

**Case Four: Thabo**

The study showed that Thabo saw the lack of proper training as one of the challenges he experienced when using technology for teaching. He mentioned that he only received a one-day online training, which according to him was inadequate. He added that most of the skills he had, he had taught himself with the help of other teachers.

**Case Five: Lebo**

The study discovered that Lebo saw a lack of technological devices for learners and improper internet connectivity as the challenges she encountered when using technology for teaching. It was further discovered that the classroom where the observations took place lacked the electrical outlets required for utilizing and connecting technological tools. This absence of electrical infrastructure restricted the use of laptops, computers, projectors, or other digital devices that could enhance the teaching and learning experience. Moreover, the lack of technical resources in the classroom made the teacher more dependent on traditional methods, including using chalk and question papers. John, Tebatso, and Katlego shared the same challenges as Lebo regarding proper technological facilities, internet connectivity and technological devices for learners.

**Case Six: Peter**

The study revealed that Peter saw the lack of technological tools and proper internet connectivity as one of the challenges he faced when using technology. Although Peter mentioned a lack of technological tools and proper internet connectivity as some of

the challenges he encountered, the study discovered a lack of proper training as a challenge that Peter had. This was evident during his classroom observation when he encountered difficulties in connecting the tools, resulting in a significant amount of time being lost for teaching and learning. The learners were unable to see the material that he was trying to project using a projector. Therefore, to continue with the lesson, Peter had to resort to using printed copies of the previous exam papers and a chalkboard as teaching tools. The lesson's effectiveness was compromised by this reliance on printed materials as opposed to maximising technology's capabilities. The decision to use a chalkboard versus the technology available suggested a lack of confidence or familiarity with integrating technology into the teaching and learning process.

#### 5.2.3.1. Summary of findings of the Third Research Question

The study discovered that most teachers pointed to lack of technological tools as a challenge they encountered when using technology in their classrooms. They emphasized this point by saying that, even if they had the necessary skills for using technology in their classrooms, the lack of these tools made it impossible for them to apply them. Khalo (2020) argued that the main complex challenge that prevents teachers from using technology in their classrooms is the lack of access to technological resources. In a study conducted by Lestiyanawati (2020), it was discovered that teachers who could not access the technological tools resorted to using the traditional way of teaching. In addition, in this study, some of the teachers who did not have proper technological facilities were using the traditional way of teaching. Furthermore, this lack of technological tools can potentially be an obstruction to the kind of education learners acquire which would subsequently affect their performance negatively (Karunaratne et al., 2018).

Some of the teachers in this study further pointed to a lack of teacher training as one of the challenges that they encountered when using technology in their classrooms. They indicated that the training they had acquired was not adequate. However, these teachers did not let that distract them, instead, they acquired the skills by themselves and through the help of others. This showed that teachers in this study were committed to using technology for teaching. Some of them went as far as using their cell phones to download educational videos to show to their learners for learning purposes. Although these findings with regard to the challenges teachers faced when using

technology for teaching were previously discovered in previous research studies, they remain speculations for teachers in the Makhutswe circuit.

### 5.2.4. How did the COVID-19 global pandemic impact technology usage in Physical Science classrooms?

**Case One: John**

The study revealed that John's school was closed without any form of teaching and learning taking place. He highlighted that the performance of Physical Science was negatively affected as they had no form of contact with the learners. Hence, they experienced poor performance in the subject. During the semi-structured interview, John indicated that learners lacked the proper technological tools to engage in teaching and learning. He concluded by saying that if learners were provided with technological tools such as tablets and internet connectivity, such as in Gauteng province where learners have these gadgets, learners would have not stayed for so long without teaching and learning taking place.

**Case Two: Katlego**

The study has shown that teaching and learning were not taking place in Katlego's school during the COVID-19 national shutdown. He pointed out during the semi-structured interview that learners did not have the technological devices to continue with the lessons. He further highlighted that the shutting down of schools without any form of teaching and learning taking place hurt the performance of Physical Science learners, as teachers and learners did not complete their Annual Teaching Plans due to time constraints. Katlego shared the same sentiments with John when he highlighted the lack of technological tools for learners as the main reason that hindered teaching and learning, which resulted in poor performance in the subject.

**Case Three: Tebatso**

The study discovered that teaching and learning were taking place in Tebatso's school, although it was not effective.. Tebatso used the WhatsApp application to give learners activities while they were at home, however, there were challenges associated with that. Tebatso pointed to the lack of internet connectivity as one of the challenges they experienced. He added that because of a lack of data or internet connectivity, some learners did not have access to the activities or when they did, the work had already piled up and they ended up being demotivated to submit.

**Case Four: Thabo**

The findings showed that during the COVID-19 pandemic Thabo was teaching through the WhatsApp platform. In this platform, Thabo was able to engage learners in discussions and provide them with activities, some learners were able to access them on time whereas others would access them later. Thabo used the same platform as Tebatso for assessments during the COVID-19 pandemic. They both highlighted the fact that some learners were able to access the activities on time while others accessed them later due to poor network connectivity or lack of data. During the interview, Thabo gave an opinion that Physical Science is a continuous subject, and the topics in Physical Science are integrated from Grade 10-12, hence it was important that the teaching and learning of Physical Science continue even when there was a national lockdown. He further highlighted that if the teaching and learning of Physical Science did not continue, it was going to create a content gap among learners. As a result, learners were going to have difficulties understanding questions, especially high-order questions.

**Case Five: Lebo**

The study revealed that there was no teaching and learning taking place in Lebo's school. During the semi-structured interview, Lebo claimed that the performance of Physical Science learners was negatively affected by this fact. Lebo further gave an opinion that the loss of contact time has resulted in learners especially in lower Grades (10-11) developing content gap.

**Case Six: Peter**

The study discovered that teaching and learning were taking place in Peter's school during COVID-19 national lockdown. He highlighted that he resorted to using WhatsApp application for teaching and assessment during that time. He recommended that to have a successful online teaching and learning, learners must be supplied with tablets and WI-FI. Peter used the same software application as Thabo, Tebatso and John.

#### 5.2.4.1. Summary of findings of the Fourth Research Question

It was discovered in this study that teaching and learning were not taking place in some of the teacher's schools during the COVID-19 national lockdown. During this period, teachers had to move from face-to-face mode of teaching to online teaching

with little or no preparations in terms of resources, teacher training and internet connectivity (Tamah et al., 2020). Most of the teachers in this study pointed to a lack of technological tools for learners and poor internet connectivity as some of the reasons why teaching and learning were not taking place in their schools. However, some of the teachers indicated that teaching and learning were taking place in their schools. They elaborated that they were using a WhatsApp application to send learners activities, although, it was not effective as learners were taking time to submit the activities due to lack of internet connectivity. This suggests that the COVID-19 global pandemic had a negative impact on the teaching and learning process, however, it had a positive impact on technology use. This was evident as some of the teachers used a WhatsApp software application to give activities to learners. This was done using a cell phone which is a type of technological tool. The COVID-19 global pandemic has encouraged the use of technology for teaching according to the researcher's analysis.

### 5.3. Contributions of the Study

The Unified Theory of Acceptance and Use of Technology (UTAUT) Model played an important role as a conceptual framework in this study. It was used mainly for its two variables i.e., exogenous and endogenous variables. The exogenous variables include four components i.e., Performance expectancy, Effort expectancy, social influence, and Facilitating conditions. Endogenous variables include two components which are the Intention to use technology and use behaviour. The idea behind this framework was that there are several factors associated with teacher's use of technology in their classrooms. Furthermore, the impact of these factors influences their perspectives regarding the use of technology in their classrooms. Each of these exogenous and endogenous variables are elaborated below as to how they have influenced teacher's perspectives when using technology for teaching.

With regards to performance expectancy (perceived benefits), the study discovered that teachers have a perception that using technology for teaching would improve the teaching and learning of physical sciences, they held a view that the use of technology would improve the performance of the subject. By effort expectancy (ease of use), the study discovered that it would be easier for teachers to use technology for teaching if both the teachers and the learners had technological tools and knew how to use them. With social influence (influence from colleagues or peers) and facilitating conditions

(external support and infrastructure), the study discovered that the COVID-19 national lockdown has had a positive influence on the use of technology for teaching. The teachers had to move from face-to-face teaching to remote teaching. This suggests that teachers can be able to use technology for teaching if they do not have any other option. Furthermore, with the intention to use and use behavior, the study discovered that teachers are willing to use technology for teaching, however, some challenges hinder them from using it for teaching such as a lack of technological tools, infrastructure that supports the use of these tools, and proper training.

The study revealed that all the teachers who participated in this study were aware of what educational technology is and how it can be used in the classroom, however, there were factors that prevented them from using this technology optimally for teaching and learning. This was evident during the classroom observations where some teachers came to class without these technological tools whereas others struggled to connect them. This could have been that teachers were not properly trained to use these technological tools, or they were not motivated to use them in the teaching and learning environment.

It was further discovered that teachers did not deliberately leave their technological devices behind when coming to class, they did not have them or the school's infrastructure did not allow for connection of these technological tools. For example, lack of electrical sockets in a classroom. This should be brought to the attention of the Department of Education as it is one of the main reasons why some teachers cannot use technology for teaching Physical Science.

The study further discovered that educational technology can be used as an alternative way to perform experiments as Physical Science is a practical subject. This was highlighted by the majority of the Physical Science teachers especially because they were coming from rural areas where resources are limited. Further to that, teachers highlighted the benefit of performing experiments through technological devices by saying it would prevent them from inhaling hazardous substances produced from the experiments. Moreover, the study discovered that the use of technology for teaching allowed learners with various learning styles to learn more, as a result the performance of Physical Science could thus be improved.

Therefore, the study has been able to reveal Physical Science teachers' perspectives on the use of technology in their classrooms. It has been able to add to the body of

knowledge where there was a gap in teachers' perspectives on the use of technology in the Makhutswe circuit, Limpopo. As such it paves the way for future research especially in rural areas.

### 5.4. Limitations of the Study

- The study focused only on six Physical Science teachers from six secondary schools in the Makhutswe circuit. Therefore, one cannot be able to generalise these findings because only a small portion was taken from the rest of the population of the Makhutswe circuit. Nevertheless, it is worth noting that, the objective of a qualitative study lies not in generalising the findings.
- The study did not explore the perspectives of other stakeholders such as learners, parents, school administrators, and the school principal regarding the use of technology for teaching, instead it focused only on the teachers. Therefore, the study could not draw full conclusions.

### 5.5. Recommendations of the Study

Based on the study findings, although they cannot be generalised to a broader population, the study recommends the following:

- It is recommended that Physical Science teachers use technological tools in their classrooms to teach Physical Science, because it was discovered by the study that it simplifies the teaching and learning of Physical Science by acting as an alternative way to perform experiments through the use of videos.
- It is recommended that the Department of Basic Education and the government make a provision for technological tools in schools, especially schools in rural areas to allow for effective teaching and learning of Physical Science to occur. Furthermore, teachers must be well trained on how to use these tools as that was a challenge as well.
- It is recommended that more time be allocated to all subjects including Physical Science to allow for the connection and smooth operation of these technological tools.
- It is recommended that more workshops be conducted to update teachers on new technologies that emerge to ensure that they are on track with new technologies necessary for the teaching and learning of Physical Science.

## 5.6. Suggestions for Future Research

- The research studies should expand to explore the perspectives of other educational stakeholders to draw full conclusions on the use of technology for teaching Physical sciences.
- Research studies should be conducted to do a comparison on the performance of the Physical Science subject for teachers who use technological tools in their classrooms and those who use the traditional way of teaching.
- Small-scale international comparative research into Physical Science teachers ‘perspectives on the use of technology in their classrooms would be valuable.

## 5.7. Conclusion

This chapter presented a summary of the findings from all the participants which were presented in the form of cases, followed by the study contributions as well as the recommendations of the study. It was suggested that the Department of Education together with the government ensure that technology be used in Physical Science classrooms. This study showed that teachers were willing to use technology in their classrooms, the only main challenges they had were the availability of technological tools, internet connectivity and proper training. If all these challenges can be addressed, then using technology for teaching might not be a problem.

## References


Abbad, M. M. (2021). Using the UTAUT model to understand students' usage of e-learning systems in developing countries. *Education and Information Technologies*, *26*(6), 7205-7224.B

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., ... & Azeez, A. L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon*, *6*(11).

Adov, L., & Mäeots, M. (2021). What can we learn about science teachers' technology use during the COVID-19 pandemic? *Education sciences*, *11*(6), 255.

Ahmad, S., Wasim, S., Irfan, S., Gogoi, S., Srivastava, A., & Farheen, Z. (2019). Qualitative v/s. quantitative research-A summarized review. *population*, *1*(2).

Al-Balushi, S. M., Ambusaidi, A. K., Al-Balushi, K. A., Al-Hajri, F. H., & Al-Sinani, M. S. (2020). Student-centred and teacher-centred science classrooms as visualized by science teachers and their supervisors. *Teaching and Teacher Education*, *89*, 103014.

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3), 39-43.

Al-Maroof, R. S., Salloum, S. A., Hassanien, A. E., & Shaalan, K. (2023). Fear from COVID-19 and technology adoption: the impact of Google Meet during Coronavirus pandemic. *Interactive Learning Environments*, *31*(3), 1293-1308.

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontiers in psychology*, *13*, 920317.

Armstrong, C. (2020). *Key methods used in qualitative document analysis.* The University of Zambia. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3996213.

Asenahabi, B. M. (2019). Basics of research design: A guide to selecting appropriate research design. *International Journal of Contemporary Applied Researches*, *6*(5), 76-89.

Attuquayefio, S., & Addo, H. (2014). Using the UTAUT model to analyze students' ICT adoption. *International Journal of Education and Development using ICT*, *10*(3).

Barbour, M. K., LaBonte, R., Hodges, C. B., Moore, S., Lockee, B. B., Trust, T., ... & Kelly, K. (2020). Understanding pandemic pedagogy: Differences between emergency remote, remote, and online teaching. *State of the Nation: K-12 e-Learning in Canada*.

Baxter, p. & Jack, S. (2008). Qualitative case study methodology: study design and implementation for novice researchers. *The qualitative report,* 13(4) 544-559.

Bozkurt, A. (2019). From distance education to open and distance learning: A holistic evaluation of history, definitions, and theories. In *Handbook of Research on Learning in the Age of Transhumanism* (pp. 252-273). IGI Global.

Brem, A., Viardot, E., & Nylund, P. A. (2021). Implications of the coronavirus (COVID-19) outbreak for innovation: Which technologies will improve our lives? *Technological forecasting and social change*, *163*, 120451.

Bugarso, J. M. S., Cabantugan, R. E., Que-ann, D. T., & Malaco, A. C. (2021). Students' learning experiences and preference in performing science experiments using hands-on and virtual laboratory. *Indonesian Journal of Teaching in Science*, *1*(2), 147-152.

Chisango, G., Marongwe, N., Mtsi, N., & Matyedi, T. E. (2020). Teachers' perceptions of adopting information and communication technologies in teaching and learning at rural secondary schools in eastern cape, South Africa. *Africa Education Review*, *17*(2), 1-19.

Chen, Y. M. (2022). Understanding foreign language learners' perceptions of teachers' practice with educational technology with specific reference to Kahoot! and Padlet: A case from China. *Education and information technologies*, *27*(2), 1439-1465.

Chomunorwa, S., Mashonganyika, E. S., & Marevesa, A. (2023). Digital transformation and post-COVID-19 education in South Africa: a review of literature. *South African Computer Journal*, *35*(1), 91-100.

Ciotti, M., Angeletti, S., Minieri, M., Giovannetti, M., Benvenuto, D., Pascarella, S., ... & Ciccozzi, M. (2020). COVID-19 outbreak: an overview. *Chemotherapy*, *64*(5-6), 215-223.

Clark-Wilson, A., Robutti, O., & Thomas, M. (2020). Teaching with digital technology. *Zdm*, 1-20.

Corry, M., & Stella, J. (2018). Teacher self-efficacy in online education*. Research in learning Technology, 26*, 1-9. https://doi.org/10.25304/rlt.v26.2047

Courtney, S. A., Miller, M. E., & Gisondo, M. J. (2022). The impact of COVID-19 on teachers' integration of digital technology. *Contemporary Educational Technology*, *14*(4), ep387.

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: a balance of relationship and rigour. *Family medicine and community health*, *7*(2).

Department of Basic Education. (2011). *Curriculum and assessment policy statement (CAPS): Physical Science.* Pretoria: Department of Education.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of educational technology systems*, *49*(1), 5-22.

Doh Nubia, W., & Blignaut, S. (2023). Rethinking curriculum implementation in time of COVID-19 and beyond: lessons learnt from rural science teachers. *Curriculum Perspectives*, 1-10.

Döringer, S. (2021). 'The problem-centred expert interview'. Combining qualitative interviewing approaches for investigating implicit expert knowledge. *International Journal of Social Research Methodology*, *24*(3), 265-278.

Du Plessis, P., & Mestry, R. (2019). Teachers for rural schools–a challenge for South Africa. *South African Journal of Education*, *39*.

Dube, B. (2020). Rural online learning in the context of COVID 19 in South Africa: Evoking an inclusive education approach. *REMIE: Multidisciplinary Journal of Educational Research*, *10*(2), 135-157.

Duma, N. M., Mlambo, S., Mbambo-Mkwanazi, S., & Morgan, W. (2021). Digital inequalities in rural schools in South Africa. *Open Science Journal*, *6*(3).

Emre, D. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology*, *10*(4), 381-398.

Feder, T. (2020). Universities overcome bumps in transition to online teaching. *Physics today*, *73*(6), 22-25.

Gever, V. C., Tunca, E. A., Boluwatife, A. A., Nwogbo, V. C., Chinweobo-Onuoha, B. N., Ugwuoke, J. C., & Talabi, F. O. (2021). Visual media and learning: Effect of interactive television instruction as an intervention strategy for improving the critical thinking skills and disposition of out-of-school nomadic children in Nigeria. *Learning and Motivation*, *76*, 101767.

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

Ghory, S., & Ghafory, H. (2021). The impact of modern technology in the teaching and learning process. *International Journal of Innovative Research and Scientific Studies*, *4*(3), 168-173.

Goodman, J., Melkers, J., & Pallais, A. (2019). Can online delivery increase access to education? *Journal of Labor Economics*, *37*(1), 1-34.

Govender, S. (2018). South African teachers' perspectives on support received in implementing curriculum changes. *South African Journal of Education*, *38*(1).

Hakim, B. (2020). Technology integrated online classrooms and the challenges faced by the EFL teachers in Saudi Arabia during the COVID-19 pandemic. *International Journal of Applied Linguistics and English Literature*, *9*(5), 33-39.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275-285.

Hancock, D. R., Algozzine, B., & Lim, J. H. (2021). *Doing case study research: A practical guide for beginning researchers.* Teachers College Press.

Harvey, G. (2021). Field Research and participant observation. In *The Routledge handbook of research methods in the study of religion* (pp. 273-299). Routledge.

Hasudungan, A. N., & Ningsih, T. Z. (2021). Learning loss: A real threat in education for underprivileged students and remote regions during the COVID-19 pandemic. *International Journal of Distance Education and E-Learning*, *7*(1), 12-23.

Hebebci, M. T., Bertiz, Y., & Alan, S. (2020). Investigation of views of students and teachers on distance education practices during the Coronavirus (COVID-19) Pandemic. *International Journal of Technology in Education and Science*, *4*(4), 267-282.

Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers & Education*, *153*, 103897.

Hodgson, T. F., & Khumalo, S. (2016). *Too many children left behind: Exclusion in the South African inclusive education system*. Ministry of Health Report. https://www.dailymaverick.co.za/article/2022-01-17-covid-drives-rapid-rise-of-online-schooling-in-south-africa/.

Huang, R. (2019). *Educational technology a primer for the 21st century*. Springer Nature Singapore.

Humble, N., & Mozelius, P. (2022, May). Content analysis or thematic analysis: Similarities, differences and applications in qualitative research. In *European Conference on Research Methodology for Business and Management Studies,* 21(1), 76-81.

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in human behavior*, *119*, 106713.

.

Ilgaz, H. (2019). Adult Learners' Participation in a Blended Learning Environment: A Case Study on Imposed Pace Learning. *Malaysian online journal of educational technology*, *7*(4), 15-29.

Jelly, P., Choudhary, S., Sharma, R., Mahala, P., & Aggarwal, P. (2021). Role of mass media on mankind: Time to rethink. *Pondicherry J Nurs*, *14*, 37-41.

Johnson, A. M., Jacovina, M. E., Russell, D. G., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom. In *Adaptive educational technologies for literacy instruction* (pp. 13-30). Routledge.

Jumamuratov, R., & Kaipbergenov, A. (2023). Application of information and computer technologies in teaching Chemistry. *Евразийский журнал академических исследований*, *3*(7), 21-26.

Kalanda, K. & De Villiers, M.R. (2013). E-Learning in the Science curriculum: A study in selected high schools in Lesotho. *Proceedings of EdMedia 2013--World Conference on Educational Media and Technology* (pp. 1664-1673). Retrieved February 9, 2024 from https://www.learntechlib.org/primary/p/112189/

Kankam, P. K. (2019). The use of paradigms in information research. *Library & Information Science Research*, *41*(2), 85-92.

Karunaratne, T., Peiris, C., & Hansson, H. (2018). Implementing small scale ICT projects in developing countries–how challenging is it? *International Journal of Education and Development using ICT*, *14*(1).

Khalo, X. (2020). Exploring information and communication technology integration in life sciences teaching in rural schools in south africa. In *EDULEARN20 Proceedings* (pp. 8954-8961). IATED.

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical teacher*, *42*(8), 846-854.

Krönke, M. (2020). *Africa's digital divide and the promise of e-learning.* https://africaportal.org/publication/africas-digital-divide-and-promise-e-learning/

Kumatongo, B., & Muzata, K. K. (2021). Research paradigms and designs with their application in education. *Journal of Lexicography and Terminology (Online ISSN 2664-0899. Print ISSN 2517-9306).*, *5*(1), 16-32.

Kyngäs, H. (2020). Qualitative research and content analysis. *The application of content analysis in nursing science research*, 3-11.

Lambert, S. R. (2020). Do MOOCs contribute to student equity and social inclusion? A systematic review 2014–18. *Computers & Education*, *145*, 103693.sss.

Lazar, S. (2015). The importance of educational technology in teaching. *International Journal of Cognitive Research in Science, Engineering and Education*, *3*(1), 111-114.

Lestiyanawati, R. (2020). The strategies and problems faced by Indonesian teachers in conducting e-learning during COVID-19 outbreak. *CLLiENT (Culture, Literature, Linguistics, and English Teaching)*, *2*(1), 71-82.

Li, Y., Garza, V., Keicher, A., & Popov, V. (2019). Predicting high school teacher use of technology: Pedagogical beliefs, technological beliefs and attitudes, and teacher training. *Technology, Knowledge and Learning*, *24*, 501-518.

Lin, C. H., & Zheng, B. (2015). Teaching practices and teacher perceptions in online world language courses. *Journal of Online Learning Research*, *1*(3), 275-303.

Lincoln, Y., & Guba, E. (1985). Naturalistic inquiry. Beverly Hills: Sage master, peter (1999) editorial. *English for Specific Purposes*, *18*, 102-4.

Lombardini, S. (2019). *Understanding Survey Sampling*. http://hdi.handle.net/10546/615904.

Lutfiani, N., & Meria, L. (2022). Utilization of big data in educational technology research. *International Transactions on Education Technology*, *1*(1), 73-83.

Maatuk, A. M., Elberkawi, E. K., Aljawarneh, S., Rashaideh, H., & Alharbi, H. (2022). The COVID-19 pandemic and E-learning: challenges and opportunities from the perspective of students and instructors. *Journal of computing in higher education*, *34*(1), 21-38.

Mabeya, M. T. (2020). Distance learning during COVID-19 crisis: Primary and secondary school parents' experiences in Kenya. *East African Journal of Education Studies*, *2*(1), 173-186.

Mahaye, N. E. (2020). The impact of COVID-19 pandemic on education: navigating forward the pedagogy of blended learning. *Research online*, *5*, 4-9.

Makhubele, P. (2016). *Implementation of Natural Sciences and Technology practical activities by novice and expert teachers* (Doctoral dissertation, University of Pretoria).

Maphosa, V. (2021). Teachers' perspectives on remote-based teaching and learning in the COVID-19 era: Rethinking technology availability and suitability in Zimbabwe. *European Journal of Interactive Multimedia and Education*, *2*(1), e02105.

Marpa, E. P. (2021). Technology in the Teaching of Mathematics: An Analysis of Teachers' Attitudes during the COVID-19 Pandemic. *International Journal on Studies in Education (IJonSE)*, *3*(2).

Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*, *13*(6), 522-526.

McMahon, E. (2021). Designing effective online courses: Exploring the relationships amongst online teaching self-efficacy, professional development, online teaching experience, and reported implementation of effective higher education online course design practices. *The Interactive Journal of Global Leadership and Learning*, *2*(1), 5.

Meinck, S., Fraillon, J., & Strietholt, R. (2022). The Impact of the COVID-19 Pandemic on Education: International Evidence from the Responses to Educational Disruption Survey (REDS) (Eric Number: ED618542). ERIC. https://files.eric.ed.gov/fulltext/ED618542.pdf*International Association for the Evaluation of Educational Achievement*.

Mercader, C., & Gairín, J. (2020). University teachers' perception of barriers to the use of digital technologies: the importance of the academic discipline. *International Journal of Educational Technology in Higher Education*, *17*(1), 4.

Mhlanga, D., & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa? *Education sciences*, *10*(7), 180.

Morgan, H. (2022). Conducting a qualitative document analysis. *The Qualitative Report*, *27*(1), 64-77.

Mpungose, C. B. (2021). Reconceptualising the Physical Science Curriculum and Assessment Policy Statement in a South African Context. *International Journal of Higher Education*, *10*(2), 116-127.

Msweli, S. J. (2020). *Exploring experiences of teachers leading teaching and learning in the era of advanced technology: a case study of teachers in two rural schools* (Doctoral dissertation). University of KwaZulu-Natal, Pietermaritzburg.

Noor, S., Isa, F. M., & Mazhar, F. F. (2020). Online teaching practices during the COVID-19 pandemic. *Educational Process: International Journal*, *9*(3), 169-184.

Obilor, E. I. (2023). Convenience and purposive sampling techniques: Are they the same. *International Journal of Innovative Social & Science Education Research*, *11*(1), 1-7.

Ogegbo, A. A., Gaigher, E., & Salagaram, T. (2019). Benefits and challenges of lesson study: A case of teaching Physical Science in South Africa. *South African Journal of Education*, *39*(1).

Ojo, O. A., & Adu, E. O. (2018). The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province. *South African Journal of Education*, *38*(1).

Ojo, T. A., & Mathabathe, R. (2021). An investigation into the effectiveness of the curriculum and assessment policy statement (caps) in south African schools. *International Journal on Integrating Technology in Education (IJITE), 10(2),*23-25. https://aircconline.com/ijite/V10N2/10221ijite03.pdf.

Okebukola, P. A., Suwadu, B., Oladejo, A., Nyandwi, R., Ademola, I., Okorie, H., & Awaah, F. (2020). Delivering high school Chemistry during COVID-19 lockdown: Voices from Africa. *Journal of Chemical Education*, *97*(9), 3285-3289.

Oliveira, A., Feyzi Behnagh, R., Ni, L., Mohsinah, A. A., Burgess, K. J., & Guo, L. (2019). Emerging technologies as pedagogical tools for teaching and learning science: A literature review. *Human Behavior and Emerging Technologies*, *1*(2), 149-160.

Onyema, E. M., Deborah, E. C., Alsayed, A. O., Noorulhasan, Q., & Sanober, S. (2019). Online discussion forum as a tool for interactive learning and communication. *International Journal of Recent Technology and Engineering*, *8*(4), 4852-4859.

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal*, *29*(2), 36-65.

Pandey, D., Ogunmola, G. A., Enbeyle, W., Abdullahi, M., Pandey, B. K., & Pramanik, S. (2021). COVID-19: A framework for effective delivering of online classes during lockdown. *Human Arenas*, 1-15.

Perienen, A. (2020). Frameworks for ICT integration in mathematics education-A teacher's perspective. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(6), em1845.

Pervin, N., & Mokhtar, M. (2022). The Interpretivist research paradigm: A subjective notion of a social context. *International Journal of Academic Research in Progressive Education and Development*, *11*(2), 419-428.

Prayudi, R. A., Hakiki, A. K., Putra, N. R. D., Anzka, T. O., & Ihsan, M. T. (2021). The use of technology in english teaching & learning process. *Jurnal Riset Dan Inovasi Pembelajaran*, *1*(2), 102-111.

Purwanto, A. (2020). COVID-19 pandemic and home online learning system: Does it affect the quality of pharmacy school learning? *Sys Rev Pharm*, *11*(8), 524-530.

Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. *Journal of Applied and Advanced Research*, *3*(1), 33-35.

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2021). Balancing technology, pedagogy and the new normal: Post-pandemic challenges for higher education. *Postdigital Science and Education*, *3*(3), 715-742.

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education*, *144*, 103701.

Renjith, V., Yesodharan, R., Noronha, J. A., Ladd, E., & George, A. (2021). Qualitative methods in health care research. *International journal of preventive medicine*, *12*.

Saad, N., & Sankaran, S. (2020). Technology Proficiency in Teaching and Facilitating. Oxford Research Encyclopaedia of Education. Retrieved 9 Feb. 2024, from https://doi.org/10.1093/acrefore/9780190264093.013.591

Saarijärvi, M., & Bratt, E. L. (2021). When face-to-face interviews are not possible: tips and tricks for video, telephone, online chat, and email interviews in qualitative research. *European Journal of Cardiovascular Nursing*, *20(4),* 392–396. https://doi.org/10.1093/eurjcn/zvab038

Sadeghi, M. (2019). A shift from classroom to distance learning: Advantages and limitations. *International Journal of Research in English Education*, *4*(1), 80-88.

Saparov, K., Rasulov, A., & Nizamov, A. (2021). Making geographical names conditions and reasons. *World Bulletin of Social Sciences*, *4*(11), 95-99.

Sileyew, K. J. (2019). Research design and methodology. *Cyberspace*, 1-12.

Singh, M. N. (2021). Inroad of digital technology in education: Age of digital classroom. *Higher Education for the Future*, *8*(1), 20-30.

Sintema, E. J. (2020). Effect of COVID-19 on the performance of Grade 12 students: Implications for STEM education. *EURASIA Journal of mathematics, science, and technology education*, *16*(7), em1851.

Stahl, N. A., & King, J. R. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research. *Journal of Developmental Education*, *44*(1), 26-28.

Suson, R., & Ermac, E. (2020). Computer aided instruction to teach concepts in education. *International Journal on Emerging Technologies*, *11*(3), 47-52.

Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, *65*, 101565.

Tamah, S. M., Triwidayati, K. R., & Utami, T. S. D. (2020). Secondary school language teachers' online learning engagement during the COVID-19 pandemic in Indonesia. *Journal of Information Technology Education: Research*, *19*, 803-832.

Tarkar, P. (2020). *Impact of COVID-19 pandemic on education system. International Journal of Advanced Science and Technology, 29(9), 3812-3814.*

Tomaszewski, L. E., Zarestky, J., & Gonzalez, E. (2020). Planning qualitative research: Design and decision making for new researchers. *International Journal of Qualitative Methods*, *19*, 1609406920967174.

Tugun, V., Bayanova, A. R., Erdyneeva, K. G., Mashkin, N. A., Sakhipova, Z. M., & Zasova, L. V. (2020). The Opinions of Technology Supported Education of University Students. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(23), pp. 4–14. https://doi.org/10.3991/ijet.v15i23.18779.

UNESCO, & Wallet P. (2014). *Information and communication technology (ICT) in education in Asia: A comparative analysis of ICT integration and e-readiness in schools across Asia. Paris*: UNESCO Institute for Statistics. Information paper 22.

Valverde-Berrocoso, J., Fernández-Sánchez, M. R., Revuelta Dominguez, F. I., & Sosa-Díaz, M. J. (2021). The educational integration of digital technologies preCOVID-19: Lessons for teacher education. *PloS one*, *16*(8), e0256283.

Vargo, D., Zhu, L., Benwell, B., & Yan, Z. (2021). Digital technology use during COVID-19 pandemic: A rapid review. *Human Behavior and Emerging Technologies*, *3*(1), 13-24.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Wijaya, T. T., Cao, Y., Weinhandl, R., Yusron, E., & Lavicza, Z. (2022). Applying the UTAUT model to understand factors affecting micro-lecture usage by mathematics teachers in China. *Mathematics*, *10*(7), 1008.

Winter, E., Costello, A., O'Brien, M., & Hickey, G. (2021). Teachers' use of technology and the impact of COVID-19. *Irish educational studies*, *40*(2), 235-246.

Wyant, J., & Baek, J. H. (2019). Re-thinking technology adoption in physical education. *Curriculum Studies in Health and Physical Education*, *10*(1), 3-17.

Xie, X., Siau, K., & Nah, F. F. H. (2020). COVID-19 pandemic–online education in the new normal and the next normal. *Journal of information technology case and application research*, *22*(3), 175-187.

Yee, M. L. S., & Abdullah, M. S. (2021). A review of UTAUT and extended model as a conceptual framework in education research. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *11*, 1-20.

# APPENDICES

## APPENDIX A: ETHICS CLEARANCE LETTER

UNISA university of south africa

**UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE**

Date: 2022/06/08

Ref: **2022/06/08/64053202/24/AM**
Name: Ms TM Mohale
Student No.:64053202

Dear Ms TM Mohale

**Decision:** Ethics Approval from 2022/06/08 to 2025/06/08

**Researcher(s):** Name: Ms TM Mohale
E-mail address: 64053202@mylife.unisa.ac.za
Telephone: 0766448573

**Supervisor(s):** Name: Mrs P Photo
E-mail address: photop@unisa.ac.za
Telephone: 0124292662

**Title of research:**

**Exploring Physical Science teachers' perspectives on the use of technology in some schools in Makhutswe circuit**

**Qualification:** MEd Natural Science Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2022/06/08 to 2025/06/08.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2022/06/08 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
8. No field work activities may continue after the expiry date **2025/06/08**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

*Note:*

*The reference number* **2022/06/08/64053202/24/AM** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

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

**Prof Mpine Makoe**
**ACTING EXECUTIVE DEAN**
qakisme@unisa.ac.za



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

## APPENDIX B

## PERMISSION LETTER FROM DBE LIMPOPO

**CONFIDENTIAL**


Office of the Premier

Research and Development Directorate

Private Bag X9483, Polokwane, 0700, South Africa

Tel: (015) 230 9910, Email: mokobij@premier.limpopo.gov.za

---

**LIMPOPO PROVINCIAL RESEARCH ETHICS**

**COMMITTEE CLEARANCE CERTIFICATE**

**Online Review Date: 16 September 2022**

**Project Number: LPREC/42/2022: PG**

**Subject: Exploring Physical Science Teachers' Perspectives on the Use of Technology in Some Schools in Makhutswe Circuit**

**Researcher: Mohale TM**

Dr Thembinkosi Mabila

Chairperson: Limpopo Provincial Research Ethics Committee

The Limpopo Provincial Research Ethics Committee (LPREC) is registered with National Health Research Council (NHREC) Registration Number **REC-111513-038.**

**Note:**

i. **This study is categorized as a Low Risk Level in accordance with risk level descriptors as enshrined in LPREC Standard Operating Procedures (SOPs)**

ii. **Should there be any amendment to the approved research proposal; the researcher(s) must re-submit the proposal to the ethics committee for review prior data collection.**

iii. **The researcher(s) must provide annual reporting to the committee as well as the relevant department and also provide the department with the final report/thesis.**

iv. **The ethical clearance certificate is valid for 12 months. Should the need to extend the period for data collection arise then the researcher should renew the certificate through LPREC secretariat. PLEASE QUOTE THE PROJECT NUMBER IN ALL ENQUIRIES.**

# APPENDIX C

# INTERVIEW TEMPLATE

**Theme: Exploring physical science teachers' perspective on the use of technology.**

Interviewee.....

Interviewer..... Date.....

We are conducting this research to find out how physical science teachers perceive the use of technology in their classroom. Do you mind being asked a few questions on how you conduct your physical science lessons?

Your participation in this study is entirely voluntary. Any information you will provide will be treated with confidentiality. All responses and your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalised. You can refuse to answer any questions that make you feel uncomfortable. The information you will provide will only be used for research purposes.

**Section A. (Introduction)**

1. Any questions/ comments before we start?

**Section B (Background)**

This section is based on the background information of the participant.

1. What do you understand by technology use in the teaching of physical sciences?
2. Do you have technological tools for teaching physical sciences?
3. Do you have any skills of using technological tools for teaching?
4. Have you attended any training to help with the necessary skills to advance in technology for teaching?
5. Do you have any qualification with technology related studies?
6. What is your age range?

| Notes: |
| --- |
| |

**Section C (viewpoints)**

This section is based on participants' views on the use of technology for teaching physical sciences.

1. Are you willing to use technology for teaching physical science?
2. If no, why are you not willing to use it?
3. If yes, do you think it will improve the teaching of physical sciences?
4. Do you prefer teaching physical science using technological tools or chalk board?

5. During covid-19 pandemic, was teaching and learning taking place in your school?
6. If not, how did that affect the performance of the physical science subject?
7. Was it important for teaching and learning of physical science to continue even when there was a national lockdown?
8. What would you suggest happened to assist with the teaching and learning of physical sciences?

| Notes: |
| --- |
| |

**Section D (Conclusion)**

This section gives the participant a chance to make recommendations on whether technology can be used or not in the teaching of physical sciences.

1. Do you recommend that technology be used in the teaching of physical sciences?
2. What can be done to ensure a smooth operation of technology in the teaching of physical sciences?
3. If I want to clarify any of your answers, may I contact you again?
4. Would it be best to contact you later?

| Notes: |
| --- |
| |

# APPENDIX D

# OBSERVATION SCHEDULE

Observation date and time.....

Participants..... School name.....

1. Observation on how physical science teachers conduct lessons in the classroom.

**a) Lesson procedure**.

I) Does the teacher have any technological tools to conduct the physical science lesson?

II) If yes, are they used to conduct the lesson?

III) Are they easy to use?

IV) Are they time efficient?

V) Do they have any impact on the lesson?

VI) How do learners react to this mode of lesson delivery?

| Notes: |
|---|
| |

**b) Classroom setting**

VII) Do the learners have proper technological tools to facilitate the lesson using technology?

VIII) Does the classroom have the proper facilities (internet connections, electrical sockets, projector, white board etc?) To conduct a lesson using these technological tools?

IX) Does the use of technology in the classroom setting promote teacher-learner interaction?

| Notes: |
|---|
| |

2. Other relevant observations not covered by 1.

| Notes: |
|---|
| |

3. Reflection on the observation.

| Notes: |
|---|
| |

## APPENDIX E

## INFORMED CONSENT LETTER TO THE CIRCUIT MANAGER

**Permission- Circuit Manager**

**Request for permission to conduct research from the Circuit Manager.**
Exploring physical science teacher's perspectives on the use of technology.

Date: ...../...../2022

The circuit manager

Dear Sir/Madam

I, Mohale Thabiso Melvar am conducting research under the supervision of Mrs. P Photo, the lecturer at the University of South Africa towards a master's degree at the University of South Africa. I wish to request for your permission to conduct research at schools in your circuit in a study entitled: Exploring physical sciences teachers' perspectives on the use of technology.

The aim of the study is to explore physical science teachers' perspectives on the use of technology. To achieve this aim, data needs to be collected from classroom observations, semi-structured interviews, and analysis of participants (teachers) lesson plans.

The benefits of the study are that it will enable the Department of Education to identify the challenges in terms of teachers' perceptions regarding the use of technology in schools. Once these challenges are addressed the use of technology in teaching and learning will improve. Furthermore, the study will provide the Department of Education with the information that is important for decision-making concerning adoption of technology in South African schools, and overcoming the challenges posed by covid-19 pandemic in 2020 academic year.

There are no potential risks involved with this research. There will be no reimbursement or any incentives for participating in this research. The teachers' participation in this study is voluntary. Teachers may refuse to participate or withdraw from the study at any time with no negative consequences. Confidentiality and anonymity of records will be maintained by the College of Education, Unisa.

Upon completion of the research, the participants will be invited to a presentation of the findings of it. An electronic summary of the findings will also be made available to the participants on their request.

Yours sincerely

Mohale Thabiso Melvar
Student

# APPENDIX F

## INFORMED CONSENT LETTER TO THE SCHOOL PRINCIPAL

**Permission of Principal**

**Request for permission to conduct research from the principal.**

Exploring physical science teacher's perspectives on the use of technology.

Date: ...../...../2022

The principal Dear Sir/Madam

I, Mohale Thabiso Melvar am conducting research under the supervision of Mrs. P Photo, the lecturer at the University of South Africa towards a master's degree at the University of South Africa. I wish to request for your permission to conduct research at your school in a study entitled: Exploring physical sciences teachers' perspectives on the use of technology.

The aim of the study is to explore physical science teachers' perspectives on the use of technology. To achieve this aim, data needs to be collected from classroom observations, semi-structured interviews, and analysis of participants (teachers) lesson plans.

The benefits of the study are that it will enable the Department of Education to identify the challenges in terms of teachers' perceptions regarding the use of technology in schools. Once these challenges are addressed the use of technology in teaching and learning will improve. Furthermore, the study will provide the Department of Education with the information that is important for decision-making concerning adoption of technology in South African schools, and overcoming the challenges posed by covid-19 pandemic in 2020 academic year.

There are no potential risks involved with this research. There will be no reimbursement or any incentives for participating in this research. The teachers' participation in this study is voluntary. Teachers may refuse to participate or withdraw from the study at any time with no negative consequences. Confidentiality and anonymity of records will be maintained by the College of Education, Unisa.

Upon completion of the research, the participants will be invited to a presentation of the findings of it. An electronic summary of the findings will also be made available to the participants on their request.

Yours sincerely

Student: Mohale Thabiso Melvar

Response of Principal: I..... (Full names of principal) hereby confirm that I understand the contents of this document, the nature of the research and I grant the researcher permission to distribute/conduct the relevant data collection instruments among/to the physical Sciences teachers.

..... .....

Signature of Principal Date

# APPENDIX G

# INFORMED CONSENT LETTER TO THE TEACHER

**Participant information sheet**

Exploring physical science teacher's perspectives on the use of technology.

……. /…… /2022

DEAR PROSPECTIVE PARTICIPANT

My name is Mohale Thabiso Melvar, I am conducting research under the supervision of Mrs. P Photo, the lecturer at the University of South Africa towards a master's degree at the University of South Africa. We are inviting you to participate in a study entitled: Exploring physical sciences teachers' perspectives on the use of technology.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could assist me in exploring the physical science teachers' perspectives on the use of technology.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are a physical Sciences teacher currently implementing the Curriculum Assessment policy Statement for physical Sciences. I obtained your contact details from your principal. The approximate number of participants is four physical Sciences teachers.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves a lesson plan, and audio taping of both classroom observations and semi – structured interviews. The classroom observations and semi – structured interviews will take 20-35 minutes.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

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

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Benefits to you includes, the study creating awareness of teachers' perceptions towards technology and allowing you to accept the inevitability of technology introduction for appropriate actions to be taken. This will further attract your interest to integrate technology in your school and it is likely to inspire other schools to implement the technological strategies as well.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There are no negative consequences if you decide to participate in the research.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the College of Education, Unisa for future research or academic purposes. Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hardcopies will be shredded, and electronic copies will be permanently deleted from the hard drive of the computer using a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

The participants will not receive any payment or incentives for participating in this research.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

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

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mohale Thabiso Melvar on 076 6448 573 or email 64053202@mylife.unisa.ac.za. Should you require any further information or want to contact the researcher about any aspect of this study you can use the above contact details.

Should you have concerns about the way in which the research has been conducted, you may contact Mrs. P Photo on 012 429 2662 or at photop@unisa.ac.za

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

_____

Mohale Thabiso Melvar

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

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

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

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

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

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

I agree to the recording of the classroom observation and the semi – structured interview.

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

Participant Name & Surname (please print) _____

_____ _____

Participant Signature Date

Researcher's Name & Surname (please print) _____

_____ _____

Researcher's signature Date

## APPENDIX H

## JOHN INTERVIEW TRANSCRIPT

**Researcher**: the theme of this interview is exploring Physical Science teachers' perspectives on the use of technology. We are conducting this research to find out how Physical Science teachers perceive the use of technology in their classrooms. Do you mind been asked a few questions about how you conduct your Physical Science lessons?

**John**: nah, you can. No problem.

**Researche**r: ok, your participation in this study is entirely voluntary, any information you will provide will be treated with confidentiality. All your responses ad your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that makes you uncomfortable. The information you will provide will only be used for research purposes. Now we are getting into section A of the interview. Any questions or comments before we start?

**John**: no, I don't. I am ok.

**Researcher**: ok, now we are heading to section B, this is about the background. Question number one, what do you understand about technology use in the teaching of Physical Science?

**John**: yah, that will be using the gadgets we have, using the laptops, using the cellphones to check or do lessons that the learners might be doing sometimes we have practical that we cannot for example do at school level but on the internet and everywhere else, the U-tube and others, you may find out that there are those topics or the experiments that can help learners look and to watch videos to see what is happening. They can also be used for normal teaching.

**Researche**r: ok, do you have technological tools for teaching Physical Science?

**John**: specifically for teaching Physical Science?

**Researcher**: just technological tools for teaching.

**John**: yah, I would say we do have our laptops, we have projectors, we also connected, we have a Wi-Fi.

**Researcher**: ok, so do you have any skills in using technological tools for teaching, have you acquired any kind of skill for this?

**John**: self-taught, I just have a self-taught skill. It's not about having gone to a specific training or what, it's just that we learn as we go along. I just taught myself.

**Researcher**: ok, this one answer question number 4 that says have you attended any training to help with the necessary skills to advance in technology for teaching. So, you are saying you haven't?

**John**: I haven't.

**Researcher**: alright, do you have any qualifications in technology related studies?

**John**: no, not any technological qualifications.

**Researcher**: ok, what is your age range?

**John**: I am between40-49

**Researcher**: ok, now we will go to section C which talks about the viewpoints, so, are you willing to use technology for teaching Physical Science?

**John**: yes.

**Researcher**: ok, do you think it will improve the teaching of Physical Science?

**John**: it can drastically so, it can improve.

**Researcher**: ok, do you mind elaborating at least how you think it can help improve the teaching of Physical Science?

**John**: Yah, just like I said before, the environment, learners are not exposed to a lot of things. We do not have, start with some of us we do not have enough books and then some of this things, Physical Science is not just a theoretical thing, some are practical. They need to see how these things are. Think technology can play an important role in bridging the gap between the learners and the environment and the world outside there. The use of videos and anything that is related to technology can help in educating the learners and have a very good impact on them

**Researcher**: ok, so do you prefer teaching Physical Science using these technological tools or a chalkboard?

**John**: I prefer the technology.

**Researcher**: ok, alright. During covid 19 pandemic, was teaching and teaching taking place in your school?

**John**: no, it wasn't until when it was open for us to have schools, then we were able to do that but when it was still harsh schools were closed.

**Researcher**: how did that affect the performance of Physical Science?

**John**: we did not perform very well; hence I said Physical Science need to be more practical. Learners need to be doing things almost every day. So, because of that stay-away from school, it has impacted that much on the performance of learners.

**Researcher**: what would you suggest happened to assist with the teaching and learning of Physical Science during that time?

**John**: oh sure, if learners were provided with gadgets for example something that happened in Gauteng were learners were provided with tablets. If learners were having those tablets or even access to cell phones and even data so that we can be able to do the online teaching. We can have zoom meetings; we can have different types of online teaching. This could have closed that gap so that learners do not stay for a long time out of school.

**Researcher**: so now we are heading to section D which is the conclusion. Do you recommend that technology be used in the teaching of Physical Science?

**John**: I do 100%, I wish we could actually move, it might have challenges yes, but it is the right way to move to. We are now in the 4IR so there is no way that we could get stuck in the past. Technology can help us in Physical Science, even in life in general.

**Researcher**: so, what can be done to ensure a smooth operation of technology in the teaching of Physical Science? Like in terms of infrastructure? Specifically in your school.

**John**: if we could be able to have these gadgets to learners, unfortunately sometimes learners also need to be taught responsibility on those. They have cell phones and you find that they are misusing them, maybe because they are not regulated properly. If we could have learners having cell phones and proper connectivity, then we can be able to introduce it gradually to teaching of these learners.

**Researcher**: if I want to clarify any of your answers may I contact you again?

**John**: you are welcome.

**Researcher**: so, now that brings us to the end of the interview.

## APPENDIX I

## KATLEGO INTERVIEW TRANSCRIPT

**Researcher**: we are about to start with the interview, feel free, there are no right or wrong answers. The topic of this study is exploring Physical Science teachers' perspective on the use of technology in the teaching of Physical Science. Do you mind been asked a few questions on how you conduct your Physical Science lessons?

**Katlego**: no! you can ask me.

**Researche**r: ok, your participation in this study is entirely voluntary, any information you will provide will be treated with confidentiality. All your responses ad your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that makes you uncomfortable. The information you will provide will only be used for research purposes. So, before we start do you have any questions or comments?

**Katlego**: mmh! In terms of the questions do I have time in which or say for example you ask me one question do I have limited time to answer the question?

Researcher: no, you can take as much time as you want, you have all the time.

Researcher: ok, we move to the next section, this is about the background. So, question number one, what comes to your mind when we talk about technology or technology use when teaching Physical Science?

**Katlego**: what comes to my mind is or is something that makes the teaching of Physical Science extremely simple or to be more understandable. Technology in terms of Physical Science, makes it more understandable in this regard, in a sense that nowadays when we perform experiments, we can perform them erh! We can perform them using computers without smelling the chemicals that are very much dangerous.

**Researcher**: ok, thank you Katlego. Do you have technological tools for teaching Physical Science?

**Katlego**: At my school?

**Researche**r: yes.

**Katlego**: mmh! No! I don't have at my school. I only use videos.

**Researcher**: ok, the ones that you download using your cellphone or your laptop?

**Katlego**: yes, using my own cell phone.

**Researcher**: ok, do have any skills in using technological tools for teaching Physical Science? Have you acquired any skills for using these technological tools?

**Katlego**: I do have the skills but, it's not simple for me to use them in the classroom situation because of lack of proper facilities. I do I have attended ICT for educators, but the information is there, but the only problem is the facilities at schools, we do not have such kind, but we can interact with learners. Like for instance, the black board, learners do not have the computers to interact with the blackboard.

**Researcher**: so, you're saying that you have the skills but then you are not able to use them in a classroom situation because of lack of facilities? Is that what you are saying?

**Katlego**: Yes, that is what am saying lack of facilities.

Researcher: ok, of which I think you just answered question number 4 which says have you attended any training to help with the necessary skills to advance technology for teaching Physical Science. You said you attended ICT for educators?

**Katlego**: Yes, with WITS university.

**Researcher**: Ok, thank you Katlego! Do you have any qualifications in technology related studies?

**Katlego**: Yes, I do. [laughing] most definitely, in fact I have just graduated in ICT for educators, it's a post graduate certificate.

**Researcher**: Thank you Katlego, what is your age range?

**Katlego**: Age range, I'm 33 years.

**Researcher**: ok, now we are moving to section c. this one is about viewpoints. So, question number one, are you willing to use technology for teaching Physical Science?

**Katlego**: excuse me!

**Researcher**: Are you willing to use technology for teaching Physical Science?

**Katlego**: Yes, I am. Does it need me to explain?

**Researcher**: Yes, you can explain if you feel like.

**Katlego:** ooh yes, I would love to and like to use it. It makes learners to understand more. Technology brings in the visual kind of learning for learners other than just learners learning theory. That is another way of tackling teaching in the classroom.

**Researcher**: ehm ok! Thank you Katlego! Do you think technology will improve the teaching of Physical Science?

**Katlego:** Yes, I think so, because ever since we are trying to just in place technology in terms of Physical Science, I think Physical Science as well as mathematics results will improve.

**Researcher**: yes, ok. Do you prefer teaching Physical Science using technological tools or chalk and chalk board?

**Katlego**: yhoo! I can prefer using technological tools, but we don't have facilities because there is no need for me to be there physically at school you know. I can be anywhere and definitely delivering my lessons.

**Researcher**: it makes sense. Ok thank you Katlego. During covid 19 lockdown, was teaching and learning taking place in your school?

**Katlego:** No, it wasn't taking place. The reason been ermh! As simple as learners having smartphones. Learners where not having smartphones and they were not allowed to move to go anywhere. So, a simple technology as a smartphone can restrict a lot so, we are supposed to use WhatsApp videos and all that but since learners didn't have smartphones, teaching and learning was not happening.

**Researcher:** ok, so since you are saying there was no teaching and learning taking place in your school, how did that affect the performance of Physical Science subject?

**Katlego**: the performance of Physical Science subject was negatively affected because learners didn't do all the chapters. We didn't have time anymore and the performance was low, the learners failed. Some went to other Grades without knowing other chapters.

**Researcher**: ok, thank you. Was it important for the teaching of Physical Science to continues even when there was a national lockdown?

**Katlego:** repeat that question again.

**Researcher**: Was it important for the teaching of Physical Science to continues even when there was a national lockdown?

**Katlego:** yes, it was important. [laughing]. It was very much important. I must give you a reason why. It's simply because when we are talking about curriculum, it has a year plan. we didn't really plan that there will be covid, but the curriculum coverage was

there in a sense that we should finish it. So, it was important for us to reach the goal that the department wanted us to reach but it was impossible because of the covid.

**Researcher**: yes, ok, what do you suggest happened to assist with the teaching and learning of Physical Science?

Katlego: more especially with technology?

**Researcher**: yes

**Katlego**: during covid19 or now?

**Researche**r: Anytime.

**Katlego**: right, I think the department should start by making sure that each learner who is doing Physical Science should have the facilities of technology, starting with just a smartphone. A smartphone that would link them to their educator's blackboard. It would make it much easier for the educator to just seat at home, even on Saturday, even learners, they will seat at home, but they will have teaching and learning going on in their own respective place. So, if ever the government could help with the smartphones or the tablets and data because we cannot use technology without data. I will give you an example, this is what is happening at the universities, they give them tablets as well monthly data to interact their educators using the blackboard. When we talk about integrated computer technology, learners are supposed to learn the computers as well, because they will be exposed to these technologies when they get out of the school level. We are teaching learners to go and apply the knowledge in the outside world. I think for better results in Physical Science, we should look at it as an outside world subject not just a subject which is classroom related. This is what I think they can do.

**Researcher:** ok, now we are moving to section D, this is about the conclusion. We are concluding this interview. Do you recommend that technology be used in the teaching of Physical Science?

**Katlego**: yes, I do. Why simply because Physical Science is technology on its own. Like for example if now we are talking about batteries, in Physical Science we are talking about cells. When you give learners examples that they can see and using almost every day for example when we are talking about galvanometer and electrolytic cells where we say another chemical is been converted to electrical. Electrical to chemical, you see those kinds of things. Learners can see if a cellphone battery is flat

and they are able to charge it, they know that another energy is converted to something else.

**Researche**r: ok, what can be done to ensure a smooth operation of technology in teaching Physical Science in terms of infrastructure in your school?

Katlego: Alright yah! For starters, they can build computer labs where of course they will be projectors, to make things easier even for the teachers because mostly teachers go to workshops so, so during my period since learners does not often bring cellphones to school, they can quickly be rash to the computer labs to access me or my videos. Knowing that I will go to a workshop I will prepare a lesson that I will teach them tomorrow today. That will only be possible if there are facilities at school because learners can't always rash home to get their tablets. Such kind of things nowadays computer labs are no longer used in schools.

Researcher: that is understandable. So, If I want to clarify any of your answers can I call you again?

**Katlego**: yes please, you are more that welcome to do that.

Researcher: [laughing] ok Katlego. Would it be best to contact you later? If I want clarity

**Katlego**: yes, you can contact me at any time.

**Researcher**: thank you Katlego. I think we are done with the interview. Thank you for your cooperation it was very helpful, your information is going to be very helpful in this study. One thing you should remember is that your schools' name and your name will remain anonymous in this study.

**Katlego:** thank you very much researcher.

## APPENDIX J

## TEBATSO INTERVIEW TRANSCRIPT

Researcher: we are about to start with the interview, feel free, there are no right or wrong answers. The topic of this study is exploring Physical Science teachers' perspective on the use of technology in the teaching of Physical Science. Do you mind been asked a few questions on how you conduct your Physical Science lessons?

**Tebatso**: NO!

**Researcher**: Ok thank Tebatso, your participation in this study is entirely voluntary. Any information you will provide will be treated with confidentiality. All responses and your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that make you feel uncomfortable. The information you will provide will only be used for research purposes.

**Researcher**: Do you have any questions or comments before we start?

**Tebatso:** So far No!

**Researcher**: ok thank you Tebatso, we are about to get into section B of the interview. This is about basically the background. So, question number one is erh! What do you understand about technology use in the teaching of Physical Science? Or what do you understand when we talk about technology?

**Tebatso**: Erh! The use of technology I think can be or includes erh using the interaction white boards the computers, the overheads projectors and cell phones where possible in order to communicate with learners or in order to teach learners Physical Science.

**Researcher**: ok! Thank you Tebatso! Do you have technological tools to teach Physical Science?

**Tebatso**: Erh! Where am based there are only, ok everyone is given a laptop, or we have the laptops erh! we have the overhead projector sometimes they are connected to share some videos with learners trying to clear up some misconceptions in different aspects or topics.

**Researcher**: ok thank you Tebatso! Do you have any skills in using technological tools for teaching?

**Tebatso**: Erh! Yes, using a projector is not a problem or is not a challenge. If it was possible, I would also like to learn how to use the interacting white board should I get a chance to have one.

**Researcher**: ok! Thank you Tebatso. Have you attended any training to help with the necessary skills to advance in technology for teaching?

**Tebatso:** Erh no! there was no training I attended with respect to advancing the teaching of Physical Science using technology.

**Researcher**: ok thank you Tebatso. Do you have any qualifications in technology related studies?

**Tebatso**: No, I don't have any qualifications in technology related studies.

**Researcher:** ok erh! What is your age range?

**Tebatso:** erh! Age range 24-29.

**Researcher**: ok thank you Tebatso, so we are getting into section c of the interview. This section is about viewpoints. This section is based on your views on the use of technology for teaching for teaching Physical Science. Question number one, are you willing to use technology for teaching Physical Science?

**Tebatso:** yes! Can I provide the reason?

**Researcher**: ok yes you can provide the reason Tebatso!

**Tebatso:** The reason why am willing to use technology is, it makes life easy, life easy I mean if am not using technology am using chalk and a chalk board, the time taken to write on the chalk board and to erase some of the things written on the chalk board and the dust the chalks provide is not good to our health and somehow it takes much of our time that we should be using for teaching Physical Science. But with the use of technology everything will be clear, where there is a need to revise, you simply slide back, and you get to the slide that you need.

**Researcher**: ok thank you Tebatso! Do you think it will improve the teaching of Physical Science, the use of technology?

**Tebatso**: Yes, the use of technology can improve teaching of Physical Science in a sense that immediately learners get to technology things, or they see that everything you are using is technologically related erh! First, that allows them time, or it serves as a motivation that ok! fine It's time for class now, but if every day we are using the

chalk and the chalk board, duster somehow its boring and demotivate some of the learners but when we use technology, they are always encouraged to learn and they are also willing to enjoy the use of technology skills.

**Researcher:** ok! Thank you Tebatso! Do you prefer teaching Physical Science using technology or technological tools or a chalkboard?

**Tebatso:** Erh! I prefer using technological related tools for teaching Physical Science as it makes life easy and say for example we would like to present some experiments and erh wherein we do not have enough apparatus, if we have the technology or the tools that we can use then that will help us a lot as everything can be clearly presented with all colours visible and if it is the experiment learners will be able to see every step of the process, the results, how they came about, the reasons. But when we are using a chalk and a chalk board, duster only, you only highlight things, learners don't have the idea, they only assume what happened without seeing what really takes place.

**Researcher**: ok thank you Tebatso, so during covid 19 pandemic, was teaching and learning taking place in your school?

**Tebatso**: erh! It was taking place, but it was not that effective as, say for when we were home, I was giving learners activities to per different topics then as you give them activities to conduct while they were at home, you find that erh! In some cases, learners don't have data to access the activities, erh! Sometimes others be having data but the network coverage where they are staying is not well or does not treat them right you find that they miss a lot of work or when they get a chance to do the work, you find that the work is too much and that demotivated them and some of them thought maybe we are punishing them, staff like that.

**Researcher**: ok thank you Tebatso. How did that affect the performance of the Physical Science subject?

**Tebatso**: erh! It was poorly affected as some of the learners when we came back for covid 19, they lack some basic knowledge and that led us to consume a lot of time doing revisions. Revisions I can use the word revision and that word can suit only those that got the chance to do the activities but those that it was their first time erh! It was not the revision with them and as such that consumed our time, we did not manage to finish the whole scope or the syllabus for Physical Science.

**Researcher**: ok Tebatso thank you, was it important for the teaching of Physical Science to continue even when there was a national lockdown?

**Tebatso**: erh! Teaching of Physical Science important to continue, yes, reason been if we do not allow learners to taught continuously erh! That disrupts their learning process and some of them feel demotivated and some of them will loose some important skills that we learned previously. But if we keep on engaging them with skills that are required in Physical Science, then they keep the record of learning, yes.

**Researcher**: ok thanks Tebatso. What would suggest happened to assist with the teaching and learning of Physical Science?

**Tebatso**: erh! If it was possible, the department of education was supposed to allocate the smartphones to every learner doing Physical Science and enough data to access the communication or the activities that the teacher will share with them at that time, so that when they are given activities everyone is given the smartphone, everyone has access to the activities or the work or the lessons that are provided.

**Researcher**: ok thank you Tebatso. Now we are heading to section D of the interview. This is just a conclusion. Erh! This section gives you as a participant a chance to give recommendations on whether technology can be used or not in the teaching of Physical Science. Question number one, do you recommend that technology be used in the teaching of Physical Science?

**Tebatso**: yes, technology must be used in the teaching of Physical Science, as it makes everything easy. Everything can be well observed, everything can be clearly presented to learners and that will help in alleviating some misconceptions as far as other topics are concerned.

**Researcher**: ok, thank you Tebatso. What can be done to ensure a smooth operation of technology in the teaching of Physical Science? Maybe in terms of infrastructure? What can be done to ensure that those technological tools you mentioned earlier run smoothly in your school?

**Tebatso**: erh! First, the infrastructure is a challenge, so it must be fixed first. Fixed in a way that new buildings should be built wherein the interacting white boards can be installed and every classroom can be clean and allows for electricity to be used meaning every classroom should have electricity in it so that when we connect the technological tools they are well and that should not be a problem and that every

learners must be given a chance to learn computer basic skills so that they know how do we open the files, how do we read the files, how do we create the files, how do we communicate using technology, staff like that.

**Researcher:** ok thank you Tebatso. If I want to clarify any of your answers, may I contact you again?

**Tebatso**: yes please!

**Researcher**: ok thank you, would it be best to contact you later?

**Tebatso**: yes, should anything arise.

**Researcher:** ok thank you Tebatso. This brings us to the end of the interview. I thank you for your participation, it will really help a lot in the research, erh! Remember just to emphasize this answers that you have provided or the information you have provided will only be used for research purposes. And then yes, your name and your school's name will remain anonymous. All the information will be kept of treated with confidentiality. So, they are no worries when it comes to the information you have provided. So, thank you so much. This will bring us to the end of the interview.

**Tebatso:** thank you for having me and you are welcome.

## APPENDIX K

## THABO INTERVIEW TRANSCRIPT

**Researcher**: the theme of this interview is exploring Physical Science teachers' perspectives on the use of technology. We are conducting this research to find out how Physical Science teachers perceive the use of technology in their classrooms. Do you mind been asked a few questions about how you conduct your Physical Science lessons?

**Thabo:** No, I don't mind

**Researcher**: ok, your participation in this study is entirely voluntary, any information you will provide will be treated with confidentiality. All your responses ad your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that makes you uncomfortable. The information you will provide will only be used for research purposes. Now we are getting into section A of the interview. Any questions or comments before we start?

**Thabo**: no, I don't have a question.

**Researcher:** alright, then we are heading to section B, this is about the background information of the participants. So, number one, what do you understand about technology use in the teaching of Physical Science?

**Thabo:** I think technology use is the use of technological devices in teaching of Physical Science.

**Researcher:** ok, do you have technological tools for teaching Physical Science?

**Thabo**: yes, we do have.

**Researcher**: maybe mention what you have in your school.

**Thabo**: we have overhead projector; we also have smartboard as well as iPads for learners that they normally use to login.

**Researcher**: ok so, do you have any skills in using these technological tools? Have you acquired skills or attended a workshop?

**Thabo:** I haven't yet acquired skills; I only attended a visual training but for me was not adequate.

**Researcher:** so, we can say for you to be able to use these technological tools was kind of self-taught thing or method?

**Thabo**: it's self-taught and help of other teachers who understand how this thing works.

**Researcher**: alright, so you are saying that you haven't attended any training or you only attended one training which was a visual one.

**Thabo**: yah.

**Researcher**: do have any qualifications in technology related studies?

**Thabo**: qualifications like computer certificates?

**Researcher:** yes.

**Thabo:** yah I do.

**Researcher:** ok! You have acquired it during the university times?

**Thabo**: yah.

**Researcher**: ok, and then what is your age range?

**Thabo:** what are the ranges you have?

**Researcher**: I have, let's start with 20-29, 30-39, 40-49 like that.

**Thabo**: 30-39.

**Researcher**: ok, fine now we are getting to section C which is about the viewpoints. Are you willing to use technology for teaching Physical Science?

**Thabo:** yes, I am willing to use it.

**Researcher**: ok, do you think it will improve the teaching of Physical Science?

**Thabo**: it can improve; however, I think it has both positive and negative side of it.

**Researcher:** ok, do you care to explain to explain the positive and the negative side of it so that I understand better?

**Thabo**: the positive side of using technology is that it is time efficient and its very effective. You can be able to complete a topic in a very short period of time, you know Physical Science has got a lot of content, so you can cover pacesetter or ATP within a given period of time. That is the advantage of it. The other thing is that most learners they like going to the science lab or media center where they will be able to use these tools, like login and checking information on the internet and all these things. This is

one of the advantages that we have. Disadvantage for me is that even if technology is there to be used, I still believe it cannot replace the old way of teaching the manual teaching because some of the concepts in Physical Science needs the teacher to be there, writing down the equations and writing their meanings and 1,2,3..so, technology will help with visualizations like if maybe, you are projecting something that needs learners to see how is done, maybe let's just talk about example of the topic in Grade 11 of ideal gas laws. For example, when you talk about vibrations or movement of particles in space or in a vacuum, these learners they don't understand what you are talking about but if you are using technology, you are able to project something that they will be able to see gas particles moving in a container. Talking about then moving in a container, in random motion, they are able to see this was happening and you will be able to indicate to then that when you reduce the volume, what happens to the pressure and then the collision theory as well as how that affect the maybe affect the rate if it's a reaction. That's where technology will be very positive in teaching.

**Researcher:** mmh well said. So, do you prefer teaching Physical Science using these technological tools? Or a chalkboard?

**Thabo:** I prefer using both of them, depending on the topic as I mentioned. There are those topics that needs an overview projector, you project. There are those that needs you to go and teach but majority of the time myself am using a chalkboard or whiteboard instead of technology.

**Researcher:** ok, so during the covid 19 pandemic was teaching and learning taking place in your school?

**Thabo:** during covid 19 I was teaching somewhere not here, and the school did not have this kind of technologies we have here. The ones we had was stolen on that very same year, but then during covid 19 I was teaching online using WhatsApp platform. I was talking to the learners that we will be discussing this in this time and at that time we login and introduce the topic and ask them questions, some will respond either at the time or they will record voice note and I will b projecting some other things and explaining to them what they mean.

**Researcher**: so, you were using a WhatsApp?

**Thabo**: yah.

**Researcher**: alright, so according to you, was it important for teaching and learning of Physical Science to continue during the national lockdown?

**Thabo**: obviously it was very important, because Physical Science is a continuous learning subject, you cannot stop somewhere because once you stop you forget and if learners for example now that they were not taught during that time, they experience problems when they go to other Grades. Since most topics are integrated as you move from Grade 10-12 so, that content barrier will have a negative impact in understanding of some questions especially high-level questions that require previous knowledge especially in Grade 12. If you want me to mention topics I can.

**Researcher:** ok, you can do that.

**Thabo:** for example, we can talk about the concept of electrostatics, there are always questions around electrostatics in Grade 12 which requires Grade 10 knowledge of conservation of charge as well as quantization of charge. They always ask learners to calculate the number of electrons to calculate the charge after the speres were allowed to tough and then separate. That is the knowledge of Grade 10 under conducting spheres. If learners did not do that in Grade 10, even now they are struggling to understand these things.

**Researcher**: yes, because of this lockdown.

**Thabo**: and learners for example again, during this trial examination, they failed decimally in the last question of paper 1 under optical phenomena and properties of material, which obviously is because they never done that topic and Grade 10 and 11. It is difficult for the to understand. When we talk about energy of a photon is like you are talking a Greek language.

**Researcher:** its understandable. It means that this national lockdown really impacted teaching and learning of Physical Science as you are explaining.

**Thabo:** negatively so.

**Researcher**: yes, it created knowledge gaps and other things. So, in your view what do you suggest happened to improve the teaching and learning of Physical Science during that time?

**Thabo:** I think the department should have ensured that the schools are assisted with this type of teaching aids or tools maybe they can give teachers laptops or tablets and ensure that learners also have something like that so that teaching and learning must

continue especially for the Grade 12s. I think if they have done that maybe we wouldn't in this kind of the problem we are in right now.

**Researcher**: yes, therefore it is essential for learners to have these tools also because if the teacher is the one which is having the tools, it won't be that effective, especially during the observations I saw that the learners, even though you as the teacher you were using the projector to project the concepts on the whiteboard, the learners were just coping the notes. They were not that active, so it is more like we have just improved the chalkboard. So, it means if the learners had these laptops or iPads in their hands, they wouldn't be coping the notes instead they would just scroll as you scroll, instead they focus on you as you explain the concepts. It means the learners must have these tools as well as the teacher.

**Thabo**: yes.

**Researcher**: so, we will head to section D which is the conclusion. Do you recommend that technology be used in the teaching of Physical Science?

**Thabo**: yes, it must be used.

**Researcher:** what can be done to ensure a smooth operation of this technology in the teaching of Physical Science? In terms of infrastructure? Anything that can make it easy to use this technological tool.

**Thabo:** I think all schools especially in our province Limpopo, most schools they do have these things. All schools must be equipped with these tools. At least they must have one room that have a smartboard. They must have a wall or a room with projectors to project somethings and you continue with teaching and learning. The other thing is that teachers and learners, teachers must be provided with laptops and learners with iPad or tablets to be able to see what the teacher is talking about like we said. If we can do that as the department or the province, we can improve the pass rate of this subject.

**Researcher:** ok if I want to clarify any of your answers may I contact you gain?

**Thabo**: ok, this brings us to the end of the interview. Thank you so much

## APPENDIX L

## LEBO INTERVIEW TRANSCRIPT

**Researcher:** the theme of this interview is exploring Physical Science teachers' perspectives on the use of technology. We are conducting this research to find out how Physical Science teachers perceive the use of technology in their classrooms. Do you mind been asked a few questions about how you conduct your Physical Science lessons?

**Lebo**: NO.

**Researcher**: ok, your participation in this study is entirely voluntary, any information you will provide will be treated with confidentiality. All your responses ad your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that makes you uncomfortable. The information you will provide will only be used for research purposes. So, before we start do you have any questions or comments?

**Lebo**: No, no question.

**Researcher**: ok, now we are getting into section B of the interview, this is about the background. Question number one, what do you understand about technology use in the teaching of Physical Science?

**Lebo**: ok, how do I answer it, should I give examples of the equipment's they use or what?

**Researcher**: Any how you want to answer it, or you understand it.

**Lebo**: ok, repeat the question.

**Researcher:** what do you understand about technology use in the teaching of Physical Science?

**Lebo**: ok, technology is very important now, we have seen during covid 19, it has really helped us to communicate with learners through online platforms and WhatsApp groups. So, technology is very important plus some of the schools are very poor, we don't have laboratories and staff like that. We are just downloading videos and showing them to learners so, things are much easier now compared to that time we were relying on a textbook.

**Researcher:** ok, do you have technological tools for teaching Physical Science in your school?

**Lebo:** its only a laptop and a computer.

**Researcher:** ok, do you have any skills in using technological tools for teaching?

**Lebo**: yes, I did this other certificate of teaching with technology, so yah I acquired a bit of knowledge in terms of technology.

**Researcher**: ok, so this one answer question number 4, that says have you attended any training to help with the necessary skills to help to advance in technology for teaching, so you already indicated that there is this certificate that you have acquired?

**Lebo**: yes.

**Researcher:** ok, do you have any qualifications in technology related studies?

**Lebo**: yes, I have done a short course on data science, programming with python.

**Researcher**: what is your age range?

**Lebo**: Age range, I'm choosing from what to what?

**Researcher**: Like, are you between 20-29, 30-39 like that.

**Lebo**: ok, 30-39.

**Researcher:** ok, this one was section B now we're heading to section C. this is about your viewpoints. Are you willing to use technology for teaching Physical Science?

**Lebo**: yes.

**Researcher**: do you think it will improve the teaching of Physical Science?

**Lebo**: yes.

**Researcher**: do you mind at least elaborating on how it will improve?

**Lebo**: like I mentioned before, some of the schools does not have equipment for practical. So, we download videos and show them to learners and besides learners nowadays learn more when they see things through videos other than just talking verbally.

**Researcher**: ok, do you prefer teaching Physical Science using technological tools a chalk board?

**Lebo**: for now, we are using chalk board, but I would prefer to use technological tools if we had them.

**Researcher:** ok, emmh. During covid 19 lockdown was teaching and learning taking place in your school?

**Lebo**: No, it was not.

**Researcher**: how did that affect the performance of the Physical Science subject?

**Lebo**: For lower Grades, Grade 10 & 11, it has affected them badly because we went back to school and focused only on Grade 12. So, for 10 & 11, we are suffering the consequences, because they don't have that basic knowledge, they have missed some things during that lockdown.

**Researcher**: it means if you had the tools, it wasn't going to be the case.

**Lebo**: technological tools, during lockdown we were communicating with learners through cell phones, you find that most learners of the does not have cellphones. So didn't bother doing online lessons because most of the learners did not have cell phones and data or Wi-Fi.

**Researcher**: ok, was it important for teaching and learning of Physical Science to continue even when there was a national lockdown?

**Lebo:** yes, it was important.

**Researcher:** like you mentioned that…

**Lebo**: now we are suffering because of that time.

**Researcher:** mmh. What would you suggest happened to assist with the teaching and learning of Physical Science?

**Lebo**: technological tools are very important, let's say if each learner has a tablet, and teachers have laptops and projectors to project information. Tablets for learners and access to Wi-Fi, so that we can communicate with learners wherever they are, during weekends for extra classes.

**Researcher**: ok, now we are heading to section D which is based on the conclusion, do you recommend that technology be used in the teaching and learning of Physical Science?

**Lebo**: yes, I highly recommend that.

**Researcher**: ok. What can be done to ensure a smooth operation of technology in teaching Physical Science especially in terms of infrastructure in your school? What can be done so that can work perfectly in your school?

**Lebo:** like I mentioned before each learner must have a cellphone or a tablet. A tablet that we can download school related staff for all the subject not only Physical Science. They must have access to Wi-Fi. Our schools should be equipped with projectors and laptops so that we can do our work.

**Researcher**: if I want to clarify any of your answers may I contact you again?

**Lebo**: yes, no problem.

**Researcher:** it meas it would be best to contact you later?

**Lebo:** like through zoom meeting or what?

**Researcher**: even telephonically, in case if I need a clarity on the information you have provided. Like I will call you so that you can clarify me.

**Lebo**: No problem.

**Researcher**: that brings us to the end of the interview

## APPENDIX M

## PETER INTERVIEW TRANSCRIPT

**Researcher**: the theme of this interview is exploring Physical Science teachers' perspectives on the use of technology. We are conducting this research to find out how Physical Science teachers perceive the use of technology in their classrooms. Do you mind been asked a few questions about how you conduct your Physical Science lessons?

**Peter**: yes, you can ask me.

**Researcher:** ok, your participation in this study is entirely voluntary, any information you will provide will be treated with confidentiality. All your responses ad your school will remain anonymous. You can withdraw from the interview at any time, and you will not be penalized. You can refuse to answer any questions that makes you uncomfortable. The information you will provide will only be used for research purposes. Now we are getting into section A of the interview. Any questions or comments?

**Peter**: erh! No question.

**Researcher**: erh! Now we are heading to section B of the interview, this is about the background. Question number 1, what do you understand about technology use in the teaching of Physical Science? When we talk about technology use what do we mean according to you?

**Peter**: we talk about something that can simplify the teaching and learning in the classrooms.

**Researcher**: such as…

**Peter**: for example, laptops, using videos for the learners if you don't have apparatus for performing experiments. You can use U-tube videos just to help you to make learners understand.

**Researcher**: ok, so do you have technological tools for teaching Physical Science in your school?

**Peter**: The laptops

**Researcher:** you as the teacher, or even the learners have the laptops?

**Peter**: Myself as the teacher, they sometimes use these cellphones.

**Researcher:** ok, so do you use your laptop for teaching?

**Peter**: yes, yes sometimes

**Researcher:** ok, so do you have any skills in using technological tools for teaching? Have you acquired some certain skills?

**Peter**: aah...no! No! but I've just learned myself. I didn't go any further about this.

**Researcher**: it means you haven't attended any training?

**Peter:** yes, yes. But I am willing to learn. If I don't know something I ask other people, how do we do this.

**Researcher:** so, do you have any qualifications in technology related studies?

**Peter:** no! no! it was just a one-day course for this summer, talking about how to use these computers. It was only for one day.

**Researcher:** so, it was a workshop?

**Peter**: yes, it was only a workshop.

**Researcher:** so, ok what is your age range?

**Peter**: 50-59

**Researcher**: ok, now we are heading to section C, it's about your viewpoints. Are you willing to use technology for teaching Physical Science?

**Peter:** yes, yes.

**Researcher:** why do you say so?

**Peter**: because technology is used every day, without technology, you will never know anything?

**Researcher**, so do you think it will improve the teaching of Physical Science?

**Peter:** yes, the world is changing every day.

**Researcher:** do you prefer teaching Physical Science using technological tools or chalk and chalkboard?

**Peter**: technological tools

**Researcher:** you prefer using technological tools?

**Peter:** yes, yes.

**Researcher:** ok, during covid 19 lockdown, was teaching and learning taking place in your school?

**Peter**: yes, I was sometimes using technology talking to the learners at home using cell phones.

**Researcher:** through WhatsApp?

**Peter**: yes, through WhatsApp.

**Researcher:** so you were sending some work through WhatsApp?

**Peter:** yes, yes. So even when learners needed clarity, I was able to give them through WhatsApp.

**Researcher**: it's understandable. Was it important for teaching and learning of Physical Science to continue even when there was a national lockdown?

**Peter:** yes, it was very important, because this world is changing every day. Even the learners must know what is happening around them especially during the national lockdown through this technology.

**Researcher**: ok, what would you suggest happened to assist with the teaching and learning of Physical Science?

**Peter**: firstly, learners must have tablets and Wi-Fi, so that they can do their own researches. It will simplify learning.

**Researcher:** alright, I think we are heading the end of the interview. Do you recommend that technology be used in the teaching of Physical Science.

**Peter**: yes, it is very important.

**Researcher**: so, you do recommend that it should be used?

**Peter:** it should be used.

**Researcher**: so according to your school infrastructure, what do you think should be done to improve or to ensure that these technological tools should be used.

**Peter**: firstly, WI-FI must be installed at school, even the laboratory must be built in the school to simplify these things, even the security must be available for that equipment. Electricity must be provided the buildings must be electrified.

**Researcher:** before heading to conclusion, do you think using technology will improve the teaching of Physical Science?

**Peter:** yes, it will improve, it will also save time.

**Researcher**: Do you prefer using technological tools or chalkboard?

**Peter**: technological tools.

**Researcher**: I have skipped these two questions and they are important. So, in case I want to clarify some of the answers you have provided, can I call you again.

**Peter:** yes.

**Researcher:** Thank you. This brings us to the end of the interview

**APPENDIX N**

**TURNITIN REPORT**

final thesis draft revision

ORIGINALITY REPORT

| 17% | 15% | 11% | 5% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | uir.unisa.ac.za<br>Internet Source | 3% |
| 2 | repository.up.ac.za<br>Internet Source | 1% |
| 3 | researchspace.ukzn.ac.za<br>Internet Source | 1% |
| 4 | Submitted to University of Pretoria<br>Student Paper | 1% |
| 5 | vital.seals.ac.za:8080<br>Internet Source | 1% |
| 6 | hdl.handle.net<br>Internet Source | 1% |
| 7 | purehost.bath.ac.uk<br>Internet Source | <1% |
| 8 | Submitted to Midlands State University<br>Student Paper | <1% |
| 9 | Grasia Chisango, Newlin Marongwe, Nomxolisi Mtsi, Thembisile E. Matyedi. | <1% |

# APPENDIX O

# LANGUAGE EDITING CERTIFICATE


25 February 2024

TO WHOM IT MAY CONCERN

Dear Sir/Madam

Re: Editorial Certificate

This letter proves that the thesis listed below was language edited for proper English, grammar, punctuation, and spelling, as well as the overall layout and style by myself, proprietor of Neurogenesis (Pty) Ltd.

**Thesis Title: EXPLORING THE PERSPECTIVES OF PHYSICAL SCIENCE TEACHERS ON TECHNOLOGY UTILISATION: A CASE STUDY IN MAKHUTSWE CIRCUIT**

**Author: MOHALE THABISO MELVAR**

The research content or the author's intentions were not altered during the editing process. However, the author can accept or reject my suggestions and changes. I, the editor can guarantee the quality of my editing and mentorship abilities, however, I cannot guarantee that the examination board will accept the thesis with a pass. This will depend on the hard work, persistence and amount of effort put in by the mentee.

Should you have any questions or concerns about the edited document, I can be contacted at the listed telephone numbers or email addresses.

Yours truly,
Dr Eden Padayachee
(Proprietor/ PhD. Medicinal Biochemistry)

Dr. Eden Rebecca Padayachee
PhD Medicinal Biochemistry (Specialized Field: Neuroscience)
Website Link: https://neurogenesisconsulting.com/
Email: eden@neurogenesisconsulting.com
University of Cape Town
Department of Integrative Biomedical Sciences
Institute of Diagnostic Medicine
Observatory, Cape Town