CONSTRAINTS AND OPPORTUNITIES OF USING INFORMATION AND COMMUNICATIONS TECHNOLOGY TO SUPPORT TEACHING AND LEARNING OF PHYSICAL SCIENCES IN SEKHUKHUNE EAST DISTRICT

by

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DECLARATION

I, Manyuku Veronicca Mamphye, declare that:

> *Constraints and Opportunities of Using Information and Communication Technology to Support Teaching and Learning of Physical Sciences in Sekhukhune East District*''

… is my own work and has not been previously submitted for a degree at this or any other university and that all sources that I have consulted or quoted have been clearly indicated and acknowledged by means of complete references.

MAMPHYE V.M Date: 19/12/2023

DEDICATION

I dedicate this dissertation to my beloved late loving, patient and understanding grandmother, Makgalane Makola, who lovingly raised me and empowered me with her wisdom and kindness. Without your teachings, I would be the woman I am today. You will forever hold a place in my heart, and I have immense love for you. May your soul remain at peace. Farewell.

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ABSTRACT

Incorporating technology into teaching and learning allows teachers and learners to enhance their collaboration and performance within the educational setting. ICT limitations can act as a barrier for educators in utilising technology in the classroom and hinder their ability to incorporate additional resources using ICT. Challenges to the implementation of ICT in teaching Physical Sciences prevent teachers and learners from the benefits of online learning and access to learning materials in classrooms. In the modern era, the integration of ICT in the classroom is crucial, as it allows learners to develop skills in navigating, analysing and understanding information through online platforms and collaborative interactions with their peers. The study explored the constraints and opportunities of using technology to support the teaching and learning of Physical Science in Sekhukhune East District Limpopo Province. This qualitative research used observations and semi-structured interviews where the respondents, comprising principals, teachers and learners from sampled secondary schools in Sekhukhune East District participated. Identifying challenges related to using ICT in high school settings can help teachers address barriers in the classroom and ultimately become more proficient in integrating technology into their teaching practices. Utilising a qualitative research approach alongside an interpretative paradigm enabled the study to explore the profound, subjective meanings of participants' experiences. This improved the understanding of the limitations of teaching Physical Sciences with the help of ICT resources. Purposive sampling methods were used to choose participants in order to align with the characteristics of a quantitative research approach. Data were further examined and interpreted using the theoretical framework of Actor Network Theory to better understand it.

Keywords: Information and Communication Technologies, Effective Teaching, Learning, ICT Resources, Rural Schools

LIST OF ACRONYMS AND ABBREVIATIONS

4IR	:	Fourth Industrial Revolution
ANT	:	Actor Network Theory
CD-ROM	:	Compact Disk-Read Only Memory
DBE	:	Department of Basic Education
ELT	:	Emerging Learning Technology
FET	:	Further Education and Training
ICT	:	Information and Communication Technology
ICT LAB	:	Information and Communication Technology Laboratory
ILM	:	Integrated Learning Module
LCD	:	Liquid Crystal Display
PS	:	Physical Sciences
RESSC	:	Research Ethics Social Sciences Committee
SMT	:	School Management Team
TV	:	Television
TV AV	:	Audio-Vidiotape
UHDC	:	University Higher Degree Committee
UNIVEN	:	University of Venda

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CHAPTER ONE

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION

Recent studies have revealed that Information and Communication Technologies (ICTs) are increasingly important in the South African education system for enhancing teaching and learning. Embracing ICT can help prepare the future workforce for the upcoming fourth industrial revolution and enhance global competitiveness in technological advancements. Both developed and developing nations see ICTs as a solution to the challenges in education and a means to revolutionise classroom instruction (Mukhari, 2016).

According to Ndou (2004:24), Brazil is encountering a major hurdle in its ICT implementation efforts due to difficulties in obtaining the necessary tools and limited connectivity in specific regions of the country. Habibu (2012) argues that the challenges faced in utilising ICT for education in Uganda mirror those encountered in many other less-developed countries. Instability in the economy, inadequately developed ICT infrastructure, high costs associated with bandwidth, unreliability in the supply of electricity, and a general lack of resources are central issues in the country's ability to meet a broad spectrum of needs.

South Africa encounters a range of ICT challenges in its classrooms, which may differ in intensity compared to those of other countries. Mukhari (2016) asserts that South Africa recognises the significance of ICT as a key aspect of its society and emphasises the critical role that ICTs play in enhancing the education system. Information and Communication Technology is a powerful tool for keeping learners engaged in educational capabilities and assists them in tackling difficult problems by enhancing their cognitive skills and comprehension. Teachers play a key role in the development and implementation of curricula, as well as overseeing the teaching and learning activities in schools. This implies that teachers should help learners acquire the necessary skills in using ICT and information processing, particularly in the instruction of Physical Sciences. This study explored the factors that limit teachers from

effectively incorporating ICT into the teaching and learning process of Physical Sciences. In addition, the study provided information on the constraints that can help strengthen any training programmes that are already in place.

This study explored the challenges that trained Physical Sciences teachers face in utilising their recently acquired ICT skills during teaching in secondary schools. Teachers are taught various skills such as using Microsoft Word, Excel, and PowerPoint to create lesson plans and examinations using ICT tools. The role of education in society is crucial, and advancements in technology are reshaping the traditional methods of teaching and learning in schools. ICT can improve the ability of schools to manage and administer their operations. Additionally, for the training to be effective, teachers must be provided with support to incorporate technology into their work. This includes creating a space where they can learn from their colleagues, engage in discussions, and evaluate their teaching experiences with ICT. Schools need to take into account various potential obstacles when incorporating ICT resources into Physical Sciences education. These barriers may include limited access to technology and training, insufficient infrastructures, teacher attitudes, and a lack of resources (Khomo, 2018).

1.2 STATEMENT OF THE PROBLEM

The study aimed to explore the constraints of effective use of ICTs to enhance the teaching and learning of Physical Sciences and to also study the opportunities of using ICTs to support teaching and learning of Physical Sciences in Sekhukhune East District, Limpopo province. South African schools face various challenges when incorporating Information and Communication Technology tools in classroom during lessons. Schools recognise the importance of how effective use of ICT tools can improve teaching and learning in classrooms. Transitioning towards a society that prioritises information and knowledge is essential for technological progress in all communities. Examining the limitations and advantages of integrating ICT into educational practices for different educational stakeholders is crucial. The research also suggested delving deeper into teachers' readiness, assurance, drive, and practical implementation through classroom observations and interviews. The results

of the study have implications for educators and those involved in policy-making in South Africa.

Schools are appropriate institutions for providing learners with the essential skills needed to actively engage in the evolving knowledge-based economy. Mukhari (2016) underscores the importance of utilising modern information technologies in developing a society based on knowledge and interconnectedness. Educational institutions are most capable of providing learners with the essential skills they need. Furthermore, South Africa has set goals to equip learners with 21st century skills through the use of ICT in education so that they are better prepared to participate in a knowledge-based society upon completing their education in Further Education and Training (FET) institutions (DBE 2004). Several obstacles, such as inadequate maintenance, a lack of necessary tools, connectivity issues, poor infrastructure, high supply costs, and unreliable electricity, hinder the successful integration of ICT in education. These circumstances pose challenges for educators when incorporating ICT tools for teaching Physical Sciences in classrooms. Another factor that needs attention is determining if high schools have the necessary resources such as ICT tools and Science labs.

The researcher undertook this study because of the understanding the importance of digital literacy to make Physical Sciences understandable. Through integrating technology in the Physical Sciences classroom, teachers are able to navigate digital platforms, use productivity tools, collaborate online, effectively communicate globally using ICT tools to enhance teaching of Physical Sciences. Lack of ICT integration in schools disable teachers and learners to access, organise and analyse information. Classroom technology familiarizes learners with information techniques and prepares them to thrive for the 21st century workplace. Inability of teachers to integrate technology in Physical Sciences classroom will disable teachers with the opportunity to be adaptable and flexible with time and use the new updated teaching methods through ICT to support the teaching and learning of Physical Sciences in the Sekhukhune East district.

1.3 AIM AND OBJECTIVES OF THE STUDY

A research project's scope and expected outcomes must incorporate aims and objectives, which serve as crucial components. Here are the aim and objectives of this study.

1.3.1 Aim of the Study

The study aimed to explore the constraints and opportunities of using information and communication technology to support teaching and learning of Physical Sciences in the Sekhukhune East District.

1.3.2 Objectives of the Study

The objectives of the study were as follows:

- To determine the constraints to effective use of ICT resources in teaching Physical Sciences.
- To affirm the extent to which the use of ICT support learners' academic performance in Physical Sciences subject.
- To explore opportunities/benefits of using ICT tools in the teaching of Physical Sciences subject.
- To determine the experiences of teachers and learners who use ICT resources to enhance the teaching and learning of Physical Sciences.

1.4 RESEARCH QUESTIONS

This investigation was guided by the research questions listed below:

- To what extent do the constraints experienced by teachers prevent the effective use of ICT resources in teaching Physical Sciences?
- To what extent does the use of ICT resources support learners' academic performance in Physical Sciences?
- Which opportunities/benefits are teachers and learners exposed to when teaching and learning Physical Sciences using ICT resources?

- What are the experiences of teachers and learners who use ICT tools to enhance teaching and learning in the teaching of Physical Sciences subject?

1.5 THEORETICAL FRAMEWORK OF THE STUDY

Kivunja (2018) explains that a theoretical framework is composed of theories put forth by experts in the specific field where research is intended to be carried out. A researcher uses these theories to provide a theoretical foundation for their research. This research was grounded in the Actor-Network Theory (ANT). According to Czarniawska (2016), the actor-network theory is a diverse collection of material-semiotic tools, perspectives, and analytical approaches that view all aspects of the social and natural environments as outcomes arising from interconnected relationships in which they exist. According to Law (2009), Actor-Network Theory consists of a range of material semiotic tools, sensibilities, and analysis methods. He added that the Actor-Network Approach, like other material-semiotic methods, explains how a diverse set of actors, including objects, individuals, machines, animals, nature, ideas, organisations, disparities, scale, and geography, interact through a combination of material and discursive relationships. This theoretical model mandates that teachers incorporate ICTs into their teaching responsibilities to cultivate learners with the essential skills needed for the modern era. These abilities will be necessary for upcoming employment opportunities and the economic development of numerous nations.

The ANT is an ideal choice for this research due to the widespread integration of Information and Communication Technology in various aspects of contemporary society, including the field of education. Secondly, this theory is appropriate because the former government of South Africa instituted separate educational systems for its many ethnic groups and the country's rural schools suffered from and continue to experience a lack of teachers with appropriate education and experience to fully utilise ICTs in their teaching. Hence, the use of information and communication technologies can be a valuable tool for enhancing teacher's professional development and equipping them with the necessary knowledge to effectively educate their learners.

ANT is relevant on the constraints to effective use of ICT resources in teaching Physical Sciences because it is important for teachers to use ICTs to effective teaching and learning of Physical Sciences classes but the bluestone walls of the classroom block the transmission signals so that the computers cannot connect to the internet, it is fair to say that human and non-human actors are in a bind together and they need to find a solution which involves all of them. ANT in practice brings to mind the computer imaging of human movement where individual's movements are plotted graphically on a computer to reveal a skeleton of experiments moving mechanically, frame by frame through particular motions which can then be analysed and understood in new and particular ways in the teaching of Physical Sciences to support learner's academic performance and benefit teaching of Physical Sciences while using the ICT tools.

1.6 PRELIMINARY LITERATURE REVIEW

Mahrool (2020) defines a literature review as the examination and evaluation of scholarly articles, books, and other resources related to a particular subject, research area, or theoretical framework, followed by a detailed summary and critique of the findings. Mahrool (2020) also explains that a literature review provides a brief overview of the sources a researcher has explored, showing readers how their research contributes to the broader research within their field. The review of literature offered scientific reasoning for the research enquiries, allowing the researcher to confirm results and juxtapose them with the research of other experts in the technology field (Torres-Carrión, González-González, Aciar & Rodrguez-Morales, 2018). In order to accomplish this goal, an exhaustive and pertinent literature review was carried out to furnish the study with a theoretical framework.

Using technology like information and communication tools in teaching Physical Science helps in collecting scientific data, accessing various resources like images and videos, and encouraging communication and collaboration among students (Khomo, 2018). Drossel, Eickelmann and Gerick (2017) noted that a teachers' proficiency in using ICT for teaching and learning is linked to how often they incorporate it into their instruction.

According to Fernandes, Rodrigues and Ferreira (2018), although computers are more accessible, teachers tend to use CT mainly for academic or administrative tasks like searching for information online, and creating lesson materials, and assessments instead of utilising it to enhance interactive learning experiences. Hinostroza (2018) also notes that the use of Information and Communication Technology in educational activities is becoming increasingly common outside of the traditional classroom environment. This is the case despite the investment that has been made in providing schools with access to the internet and computers.

1.6.1 Constraints to effective use of ICT resources in teaching Physical Sciences.

Khomo (2018) asserts that South Africa faces major obstacles in education regarding the use of Information and Communication Technology in Physical Sciences classrooms, as only 11% of schools have functioning Science laboratories. The utilisation of pictures, films, and computer programmes or applications in educational settings dedicated to the study of Physical Sciences might help students achieve a more profound comprehension of the underlying ideas and principles. The problem related to Information and Communication Technology has emerged as a significant issue causing frustration for both learners and teachers in the field of Physical Sciences within educational institutions. ICT issues have become a major concern and a source of irritation for both students and teachers of Physical Sciences in most schools. These problems also lead to interruptions in the educational process. Teachers are temporarily prevented from using the computer if there is insufficient technical assistance and the device is not repaired (Ghavifekr & Rosdy, 2015).

1.6.1.1 Limited accessibility and network connection

Becta (2004) suggests that the lack of accessibility to Information and Communication Technology resources in schools is not surely due to insufficient hardware, software, or other ICT assets on hand. This outcome may stem from various issues such as insufficient technology resources, subpar hardware, incorrect software, or limited educator access. Becta (2004) argues that "If there is a shortage of technical support accessible in a school, then it is likely that technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns". Furthermore, Becta

(2004), indicates that technical flaws could prevent instructors from adopting ICT in their instruction due to the risk that equipment might break down while they are conducting a class.

1.6.1.2 Users' access to ICT facilities

The effectiveness of incorporating ICT in teaching and learning at educational institutions greatly depends on the presence and ease of access to ICT resources like hardware and software. Having access to specialised apps, software, and hardware is crucial for effectively teaching and learning Physical Sciences through ICT resources. According to Ghavifekr and Rosdy (2015), a major issue facing schools, especially in rural areas, is the lack of suitable Information and Communication Technology tools and access to the internet.

Eligi and Mwantimwa (2017) observe that a lack of specialised Information and Communication Technology facilities "translates into spending a lot of time on learning activities and therefore prevents effective access to a larger range of educational materials". According to Syomwene (2017), obstacles to effectively integrating technology in education may include issues such as limited access to electricity, unreliable internet connections, and outdated or insufficient technological tools.

1.6.1.3 Lack of financial support

Due to the school's limited budget, which serves as a constraint that affects the acquisition and maintenance of ICT facilities and software that support instructional goals, the cost of ICT facilities is a significant challenge. In this study, the researcher identified difficulties faced by teachers as a result of slow internet speeds as a direct consequence of inadequate access, which restricts the availability of materials. Computers and other equipment dependent on computers are not only costly, but they are also prone to crashing if they are inadequately maintained (Alkahtani, 2017).

1.6.1.4 Lack of effective teachers' ICT training

According to Eligi and Mwantimwa (2017), teachers who lack the required skills and expertise to use ICT tools may struggle to effectively enhance learning opportunities for learners. In addition, Eligi and Mwantimwa suggest that training provided for some of the ICT facilities is unproductive because there is a greater demand for ICTs than

there is a real supply. Suarez-Rodriguez Suarez-Rodrguez, Almerich, Orellana and Dáz-Garcá (2018) suggest that teachers should have a strong sense of comfort and assurance in incorporating ICT into their teaching practices. It is important for teachers to carefully consider the technological aspects.

Barakabitze, William-Andey, Ainea, Mkwizu, Maziku, Matofali and Sanga (2019) believe that teachers' insufficient ICT skills and knowledge are a significant obstacle that hinders students from achieving their ICT-related objectives and their ability to learn effectively. The 2017 report from the Department of Basic Education (DBE) highlights the challenges of recruiting and keeping highly qualified and developing qualified teachers in a rural setting due to the poor infrastructure which hampers effective Physical Sciences content delivery due to poor network in the rural areas, there is also a shortage of qualified teachers" (Department of Basic Education, 2017).

1.6.2 The use of ICT to support learners' academic performance

Alkahtani (2017) suggests that ICT can be used to create lessons with interactive real-life examples and appealing visual and auditory elements sourced from various mediums. Furthermore, the use of Information and Communication Technology in education provides advantages, such as saving time through the implementation of innovative methods for generating new documents and storing educational resources. Emails and other social media applications like WhatsApp, Facebook and Microsoft Teams help teachers and students communicate outside of the classroom by facilitating online instruction, facilitating the submission of homework, and enabling teachers and students to share ideas within the platform as well as engage with other teachers and students from other schools. According to Ghavifekr and Rosdy (2015), Microsoft PowerPoint can be utilised to deliver a topic uniquely and imaginatively thus encourages discussion and the sharing of thoughts and viewpoints.

Umar and Jalil (2012) argue that "Teaching and learning activities become more relevant when using ICT since ICT gives an aspect of interactivity that was never conceived of previously". Bidarian and Davoudi (2011) say that ICT could help give some of the educational procedures quickly, such as simulations. This would help revise and deliver materials. Bidarian and Davoudi (2011) also note that with the use

of ICT, information is not difficult to obtain, and this is especially helpful for educational institutions that could be missing resources like laboratories.

Bidarian and Davoudi (2021) state that ICT allows for more variety and shifts. As a result, teaching and learning processes can be streamlined and controlled more effectively, which may result in an enhanced environment for interactive instruction and learning. The educator can collect information for teaching and learning by using a variety of platforms. Utilising ICT allows teachers to introduce a broader range of educational concepts, both theoretical and practical, while offering a fresh perspective on learning. It enables the integration of diverse resources like audio, video, and images in the teaching and learning process. This is an important aspect to consider while focusing on different forms of learning intelligence.

Khomo (2018) discusses the significant benefits of effectively uti1lising Information and Communication Technology in education, stressing that this can greatly enhance the quality of education in schools. Makonye (2017) warns that educational institutions that resist adopting ICT sustainability in the long run as these technologies offer a competitive advantage. Mustafa (2014) also states teachers will acquire vast knowledge of computers beyond only how to utilise ICT if they regularly incorporate Information and Communication Technology in their teaching and educational settings.

1.6.2.1 ICT improves engagement

According to Gilakjani (2015), teachers' level of computer knowledge and skills was the most commonly recognised factor in the literature that influences the use of IT. Furthermore, teachers can expect learners to show increased interest and involvement in the subject matter when incorporating technology into their lessons. The advancement of Information and Communication Technology has created numerous new learning opportunities, which in turn enhance the engagement and appeal of the instructional process. It is reasonable to expect that learners who are actively involved and interested in what they are learning will have a better understanding of the subjects.

1.6.2.2 Encourages individual learning and collaboration

According to Khomo (2018), integrating ICT into Physical Sciences classrooms can help students access scientific information, interact with multimedia resources like photos and videos, and encourage communication and collaboration among peers. Learners' knowledge will expand, and their attitudes towards Physical Sciences will shift, thanks to the contribution that technology may make to the promotion of active involvement in the classroom. Physical Sciences experiments can utilise various technological instruments to help instructors identify the most effective teaching methods for enhancing students' knowledge. Engaging in a range of online activities allows learners to refine their collaboration abilities. Technology can facilitate student collaboration within the same classroom, school, or even across worldwide classrooms, promoting a global learning community. This is especially helpful during challenging times, such as those caused by COVID-19 restrictions, when it can be difficult to communicate face-to-face with one another.

1.6.3 The opportunities/benefits of using ICT tools in the teaching of Physical Sciences

Although there are barriers to the introduction of Information Communication Technology in the educational sector, it has increased the effectiveness of the teaching process (Lawrence & Usman, 2018). It has been scientifically proven that Information Communication Technology can act as a change agent by significantly increasing educational reform, allowing teachers and students to transition from traditional to more creative and successful approaches to teaching and learning (Sebatana & Dudu, 2022). More importantly, academic achievement is commonly explained by elements such as self-efficacy and motivation. It seems that the use of ICTs can increase students' motivation and consequently their overall achievements (Castaño-Muñoz, Duart & Sancho-Vinuesa, 2013).

1.6.3.1 ICT improves knowledge

Learners' knowledge will expand, and their attitudes toward Physical Sciences will shift, thanks to the contribution that technology can make to the promotion of active involvement in the classroom. Physical Sciences experiments can utilise different technological tools to help educators figure out the most effective methods for enhancing students' knowledge. According to Ghavifekr and Rosdy (2015), students

can gain advantages from incorporating ICT into their education by offering a technology-based course that allows them to engage in practical activities rather than being constrained by a fixed curriculum and limited resources, thereby boosting their comprehension of the subject. They say that ICT helps teachers develop their lesson plans in an efficient, innovative, and fascinating manner, which would result in learners' active learning.

1.6.4 The experiences of teachers and learners who use ICT resources to enhance the teaching and learning of Physical Sciences

Analyses of the literature indicate that teachers play a key role in the integration and diffusion of ICT in the classroom; they must have the competence and the right attitude towards technology to improve their teaching methods and contribute to students learning by technological means in a planned and pedagogically sound way (Vernadakis, Antoniou, Giannousi, Zetou & Kioumourtzoglou, 2011; Carle et al., 2009; Brill & Galloway, 2007). Teachers' perceived usefulness of technology seems to have a direct significant effect on their intention to use it (Ma, Andersson & Streith, 2005). Furthermore, positive attitudes have to be paired with appropriate ICT pedagogical use to affect significantly student performance and achievement (Hoffmann & Oreopoulos, 2009).

1.7 DEFINITION OF KEY TERMS

This part of the study explained terms or concepts that were unique to the research and could be be unfamiliar to individuals from different fields.

1.7.1 Information and Communication Technology

Within the educational system, ICT stands for Information Communication and Technology, which involves integrating computer-based communication into everyday classroom teaching methods (Ghavifekr & Rosdy, 2015). Barakabitze et al. (2019) explain that ICT encompasses various technologies like computers, software, networks, and satellite connections that allow individuals to access, analyse, create, share, and utilise data, information, and knowledge in ways that were previously unimaginable. Kristiawan (2017) states that these methods include anything and

everything that can be deployed in the service of accomplishing the meaning and purpose of the endeavour. Mwapwele, Marais, Dlamini and Van Biljon (2019) emphasise that ICT encompasses a range of technological tools that enable the integration and automation of various types of media in diverse sectors like commerce, economics, and education.

1.7.2 Teaching

Transferring new information to students so that it can be integrated with the information they already possess is referred to as teaching. Du Plessis et al. (2007) say that teaching is both the process of assisting learners in their educational pursuits and creating an environment conducive to the learning process is essential for facilitating learning. According to Smith (2018), teaching involves focusing on the needs, experiences, and emotions of individuals and taking action to help them learn and surpass their current knowledge and understanding. Moreover, Smith (2018) adds that interventions often involve various methods such as asking questions, listening, offering information, clarifying concepts, demonstrating skills, assessing comprehension and abilities, and supporting learning through activities like taking notes, engaging in discussions, completing assignments, participating in simulations, and practising.

1.7.3 Learning

According to Du Plessis (2007), the learning process is the accumulation of experiences that cause individual transformation. Learning requires change in an individual in terms of the understanding, actions, outlook, or drive of the person. These changes add information and the ability to accomplish something that learners were unable to perform prior to the imparting of the new knowledge. Building knowledge requires participating in activities such as exploration, observation, and interaction with phenomena, conversing with others, and establishing connections between newly acquired information and information already possessed.

1.7.4 Physical Sciences

Physical Sciences involve the exploration of physical and chemical occurrences using scientific investigation and application of scientific concepts, theories, and principles to understand and forecast occurrences of the world. Science is a method that involves observing and experimenting to define and clarify various concepts.

1.8 RESEARCH DESIGN AND METHODOLOGY

Paradigms are defined as a collection of philosophical beliefs that shape how reality is perceived and the researcher's involvement in creating it. A group of scholars have reached a consensus on these philosophical beliefs (Creamer, 2019). The investigation of a researcher is typically directed by a fundamental set of beliefs or assumptions. Ansre (2017) states that the framework of research is defined by research paradigms, which also guide the framework. Ontology, epistemology, and methodology are the three components that make up a paradigm (Scotland, 2012). Jere (2020) emphasises that ontology explores the essence of reality, epistemology delves into the nature of knowledge, and methodology focuses on the techniques used in data collection and analysis in research. Since this study was situated within the framework of interpretivism, the researcher adopted the interpretative paradigm and used this paradigm as a guiding principle in the qualitative research approach.

Because this study was interested in the challenges that can be faced and the opportunities that can be taken advantage of when using ICT, it was utilised to enhance teaching and learning in Physical Sciences, with a focus on the interpretive paradigm. This approach provided a reference point for comprehending and investigating the viewpoints and ideas of the population on this subject. Alharahsheh and Pius (2020) state that, "The interpretive paradigm enables researchers to consider different factors such as behavioural aspects based on participants' experiences, and this would help to describe reality given the assumptions and beliefs of the interpretive researcher". Researchers using interpretative paradigm are able to take into account various factors, including the behavioural aspects influenced by participants' experiences. Ansre (2017) states that the "constructivism paradigm views knowledge as socially constructed and may change depending on the circumstances". Ansre

(2017) added that constructivists believe that individuals construct their own reality in mind, which leads him to suggest that in-depth reflection is a method for bringing meanings that are buried deeper in the surface.

1.9 RESEARCH DESIGN AND METHODOLOGY

According to Ansre (2017), the methodology of research is a process that describes the methodical and factual demonstration of an attempt to answer a question or search for a way to solve an issue. The study used qualitative research approach to address the study questions and collect data from participants. Mapaya, Litshani and Sinthumule (2021) indicate that the qualitative research approach is utilised to characterise and comprehend the phenomenon from the perspective of the participants. Interviews, document analysis, the examination of artefacts, and observation are all examples of data collection procedures that are used in qualitative research designs. Individuals with extensive information were specifically chosen to provide data. The sample comprised teachers and learners from the Physical Sciences fields. An interpretative research paradigm was used to gain a thorough understanding of the study's context.

1.9.1 Research Design

A research design, according to Ratchel (2017), is an overarching strategy outlining the methods and steps for collecting and analysing essential information. According to Pandey and Pandey (2021), a research design serves as a plan for collecting, measuring, and analysing data. Mukhari (2016) defines research design as a plan that guides the researcher in collecting empirical evidence to address research questions. Ratchel (2017) emphasises that the research design outlines key elements of the study, such as samples, measures, treatments, and their interactions, all aimed at addressing the research questions. The researcher carried out a variety of research methods, including semi-structured interviews and observations.

1.9.2 Research Methods

Research methods are the methods, procedures, or techniques used to gather data or evidence for analysis to gain new insights or enhance understanding of a topic. In this research, data were gathered through diverse approaches such as semi-structured interviews and observational tools.

1.9.2.1 Interviews

Pandey and Pandey (2021) explain that an interview is a social interaction involving two individuals. The psychological aspects of the process require both parties to engage and respond to each other, although the research purpose of the interview may necessitate different responses from each participant. Furthermore, Rossetto (2014) asserts that interviews assist participation in active, supportive listening. This type of listening entails paraphrasing and questioning to create rapport and foster in-depth conversation. A one-on-one semi-structured interviews was chosen as the method for collecting data from participants in low-income schools about the utilisation of resources in their schools in teaching and learning.

1.9.2.2 Observations

According to Wagner, Kawulich and Garner (2012), observation is a commonly used method in social sciences to gather information about individuals, processes, and cultural practices. This technique is frequently employed by teacher researchers in classrooms, social workers in communities, and psychologists studying human behaviour for data collection purposes. A classroom observation sheet was developed to help assess how certain factors, like the use of technology, impact the effectiveness of teaching and learning in Physical Sciences, and ultimately the academic success of learners.

1.9.3 Population

Rahi (2017) states that a collection of people or things that serve as the primary focus of an investigation into a scientific subject is a research population. Similarly, Bhattacherjee (2012) says that a population is all the individuals or things that share the qualities that one intends to investigate. According to Babbie (2010), the term

"population" pertains to a specific group or set of individuals that researchers are focused on making generalisations about. The study involved School Management Team (SMT) members, Physical Sciences teachers, and learners from sampled secondary schools in Sekhukhune East District.

1.9.4 Sampling Procedures

According to Corbetta (2011), sampling involves choosing a smaller group from a population to analyse and make inferences about the entire population based on the results obtained from studying the sample. For Bhattacharjee (2012), sampling is "the statistical process of selecting a subset of the population of interest for the purposes of making observations and statistical inferences about that population". For the current research, the participants were chosen through probability sampling and random sampling, a technique commonly employed in qualitative studies. According to Pandey and Pandey (2021), probability sampling ensures that the sample chosen has a likelihood of accurately representing the entire population. Ramona (2016) asserts that sampling is a crucial element in research processes. Pandey and Pandey (2021) define random sampling as a method where every component of the population is evenly distributed and independent likelihood of being selected for the sample. The researcher utilised a randomisation process to choose purposive sampling, which is also referred to as a simple random sample. The selection process for the teachers and learners of Physical Sciences at secondary schools in Sekhukhune East area used a straightforward random sampling method.

1.9.5 Sample Size

Ratchel (2017) states that a sample size provides a researcher with an easy way to ensure a relevant plan for determining the number of people from the population that the researcher intends to derive from, and the sample must accurately reflect the whole population. It is a portrayal of the demographic group that the researcher aims to make specific conclusions about. There should be adequate people in the population for the researcher to provide advice pertaining to the population. Two distinct schools in Sekhukhune East District contributed one teacher of Physical Sciences, four students and two members of the School Management Team to be part

of the sample size for this qualitative study. Rather than attempting to conduct research on the entire population of teachers who teach Physical Sciences, it is more efficient to select a subset of schools to investigate, as this saves both time and money.

1.10 DATA COLLECTION PROCEDURES

Ratchel (2017) suggests that analysing collected data is essential for comprehending the information and making conclusions based on it. According to Pandey and Pandey (2021), tests play a vital role as instruments guiding researchers in collecting and evaluating data effectively. Researchers who use qualitative methods study the participants' points of view using collaborative research methods. To obtain functional data, research strategies are adaptable and use a variety of various configurations of methods. Qualitative researchers often utilise methods such as extended time in the field, capturing participants' exact words, using specific descriptors, engaging participant researchers, and seeking feedback from participants (McMillan & Schumacher, 2001). Terre Blanche et al. (2001) argue that qualitative research often avoids quantitative measures because social phenomenon is intricately connected to their contexts. This implies that what the researcher is exploring is heavily influenced by the unique situation each individual is in. Throughout the data collection, there are several methodological guidelines that should be adhered to, as outlined in the work of Mouton (2001). The data collection process used thematic analysis and included semi-structured interviews and observations. Qualitative data collected through interviews were analysed using thematic analysis, with the results presented in a narrative format.

1.11 INSTRUMENTATION

In order to collect data, a researcher needs either tools or methods for gathering information. According to Pandey and Pandey (2021), these are tools of measurement which direct the researcher in both the collection of data and the evaluation of it. Different tools vary in complexity, and how they are understood, designed, and managed. Each instrument that is utilised is suited for the collection of

a particular category of information. The researcher employed methodologies such as interviews and observations as instruments of clarifying theory.

Kawulich (2015) states that the act of systematically describing the occurrences, behaviours, and artefacts of a social environment is known as observation. Kawulich asserts that observation is commonly used by teacher-researchers in classrooms, as well as by social workers in community settings and psychologists studying human behaviour. Long-term observation can lead to new insights and understanding that may require a re-evaluation of the research problem, leading to the adoption of alternative methodologies and theoretical perspectives for a more comprehensive investigation. This can be achieved by delving deeper into it. Qualitative research interviews are a method used to gather information, stories, and understandings that are not easily observable, providing insight into people's thoughts, emotions, experiences, and connections (Rossetto, 2014).

1.12 DATA ANALYSIS

Data analysis aims to transform data into solutions for research inquiries. According to Pandey and Pandey (2021), data analysis encompasses a wide variety of tasks, including those that fall under the qualitative and quantitative categories. Mukhari (2016) emphasises the importance of thoroughly examining and analysing data collected through various strategies to gain a comprehensive understanding, describe it effectively, and develop valid conclusions that address the research questions. The researcher must conduct this examination and analysis in order to address the research questions effectively. In his study, Hashemnezhad (2015) provides a definition of data analysis as the act of examining data and making inferences or conclusions as a result of those examinations. The analysis of collected data clarifies the data and generates conclusions from them (Ratchel, 2017). In order to make sense of the findings of this study, the researcher analysed, combined, and summarised the feedback provided by the participants. To analyse data, the researcher compared and interpreted information obtained from interviews, field notes, and data collected through observation. Additionally, the researcher reviewed recorded audio material to observe and describe behaviours of interest during observations.

1.13 TRUSTWORTHINESS OF THE STUDY

This section covers discussions on the trustworthiness of qualitative research and includes assurances of reliability. It explores the four key characteristics- credibility, transferability, dependability, and conformability that are important in establishing trustworthiness. By using these criteria, researchers can assess and validate the quality of qualitative research.

1.13.1 Credibility

According to Guba and Lincoln (1981), the credibility of qualitative data is established when other people can recognise experiences while having merely read about them. On the other hand, there is a compelling argument favouring making more laborious attempts to prove the reliability of the meanings derived from qualitative research. The study suggested the improper utilisation of Information and Communication Technologies and quantitative concepts as metrics of trustworthiness. In addition, because a hazy method made it more challenging to establish the trustworthiness of the meanings, the researchers' best interest is to make it clear what qualitative methodology he or she has employed in his or her investigation. For this study, the researcher was very clear about what procedures and attempts were made to demonstrate the credibility of data analysis.

1.13.2 Dependability

Ramona (2016) states that dependability involves participants verifying the results, interpretations, and recommendations of a study to confirm that they align with the intended meaning and the phenomenon under investigation. Bhattacherjee (2012) states that dependability is the extent to which the measure of a construct can be relied upon to be consistent. Jere (2020) says that the ability of a measuring device to produce consistent results is what is meant by reliability. Ansre (2017) also contends that, "Validity is the degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure". The interview materials, which

included transcripts, written documents, field notes, and audio recordings, were kept for an audit to ensure the reliability of the study.

1.13.3 Confirmability

Confirmability is tied to objectivity and ensures that the data presented truly reflect the information given by participants rather than being influenced or manipulated by the researcher (Elo, Kääriäinen, Kanste, Pölkki, Utriainen & Kyngäs, 2014). Confirmability reflects the extent to which researchers can authenticate the results obtained in a study. This is carried out to ensure that the results truly represent the viewpoints of the participants in the study rather than the potential biases of the researcher (Ramona, 2016). Different data collection methods and analysis strategies were used to reduce the chances of researcher bias and ensure that the conclusions drawn were based on the collected data rather than the researcher's preconceived ideas.

1.13.4 Transferability

The transferability or generalisability of a study refers to how applicable the results are to different settings or populations (Ramona, 2016). Ramona (2016) further observes that transferring the findings in qualitative studies has received a lot of criticism and that the purpose of transferability is to combat this difficulty by presenting analytical generalisations. Korstjens and Moser (2018) mention that transferability refers to the extent to which the results of qualitative research can be relevant or applicable in various contexts or settings involving different participants. Furthermore, offering a comprehensive depiction allows a potential user to assess the applicability of the information. To ensure that the research findings can be applied to diverse situations, populations, times, and settings, the researcher elaborated on the process of transferring this knowledge.

1.13.5 Authenticity

Harvey (2012) indicates that authenticity denotes something that is the real item or something genuine rather than being a reproduction, copy or something

masquerading as something that it is not. The researcher made sure to obtain informed consent, cultivate trusting relationships, maintain transparency in investigation procedures for all participants and observers, and incorporate participant enquirer collaboration throughout the research process. This involved complete consensus on regulations that controlled the investigation, along with ensuring complete transparency and sharing of information.

1.14 SIGNIFICANCE OF THE STUDY

This study served as a database on educational issues and was made available to secondary schools with the required critical information. The project assisted educators in facilitating the supply and exchange of Information and Communication Technology resources, expertise, and advice about current student and school data at any time and from any location. The study assisted teachers in improving their teaching methods and pinpointing the strengths and weaknesses of learners and teachers by analysing the collected data more effectively. This led to increased productivity in the school, higher quality lessons, better collaboration among teachers in creating resources, and easier planning and preparation of lessons and learning materials. The study encouraged teachers and principals embrace ICT to enhance curriculum delivery and school administration. The findings are believed to be beneficial for officials in the Department of Basic Education and policymakers in South Africa to improve training and support for educators.

1.15 DELIMITATION OF THE STUDY

Dimitrios and Antigoni (2019) explain that delimitations are the boundaries or limits that researchers establish for their work to ensure the attainability of the study's goals and objectives. Miles and Scott (2019) emphasise that delimitations are elements that restrict the generalisability of research findings, preventing researchers from claiming universal applicability. Researchers are unable to report findings that are generalisable to the entire population when delimitations are present in the study. Delimitations are restrictions on one's study that one imposes on oneself, in contrast to limitations, which are restrictions on one's methodology that are inherent to the

study (Miles & Scott, 2017). The study was conducted in two public high schools in Sekhukhune East District in Limpopo Province, South Africa.

1.16 ETHICAL CONSIDERATIONS

The researcher promised confidentiality and anonymity to all participants while also explaining in detail how the data would be collected and used. Potential participants were asked to sign consent letters to voluntarily take part in the study.

1.16.1 Permission to Conduct Research

The University Higher Degree Committee takes measures to guarantee that ethical concerns are considered and protects the participants from any potential harm. Consequently, the researchers at the University of Venda sought ethical approval from the University's Research Ethics Committee. Additionally, the researcher requested permission from the Limpopo Provincial Department of Education to carry out their research in schools. After that, the researcher obtained approval to conduct the study from the Department of Education in Sekhukhune East District and subsequently requested permission from the respective school principals.

1.16.2 Informed Consent

Manti and Licari (2018) explain that informed consent involves fully informing prospective research participants about the key elements of a study and the obligations they will undertake by taking part. Information regarding the research must be presented in sufficient detail, and it must be organised and presented in a way that does not merely provide lists of isolated facts but rather makes it easy for the prospective subject or legally authorised representative to understand the reasons why one might or might not want to participate in the research. The study comprised teachers who were eligible to be invited to participate. Because of this, participation was entirely voluntary, and it took place during the teachers' spare time. Participants did not have to give a reason if they decided to exit the study at any time. All participants were asked for their informed permission before the study began. During this study, the researcher drafted consent forms for students and coordinated with the

administrative staff at the school to determine which students would take part in the interviews. The learners brought the consent forms to their parents, who were asked to approve their children's participation in the research interviews after being clearly informed about the study's purpose and their children's involvement.

1.16.3 Confidentiality

Confidentiality means that even though a researcher knows the identity of a research subject, they take steps to ensure that others cannot learn that person's identity (Wiles, Crow, Heath & Charles, 2008). Only the researcher should know who the participants are, and extreme measures were put in place to safeguard their identities from being revealed to anyone else. Every individual who took part in this research had their identities protected to ensure that they freely and accurately answer any questions that may be asked of them. Only individuals who would have been directly participating in the study were allowed access to any of the documents, recordings, or transcripts of the interviews, as well as any communications with the instructors, which were kept confidential.

1.16.4 Anonymity

Kruger (2003) indicates that anonymity requires that no one, not even the researcher, should be able to identify any of the subjects after the study has been completed. For participants in a study to remain anonymous, there must be no way for anybody else to directly identify them. Pseudonyms, rather than the real names of the educators and students, as well as the names of the schools that are taking part, were utilised. This ensured that confidentiality was maintained.

1.17 RESEARCH OUTLINE

In Chapter One, the study's background, problem statement, and objectives are introduced. Chapter Two delves into the theoretical framework and relevant literature related to the research topic, focusing on the challenges and opportunities of using ICT in teaching Physical Sciences. Chapter Three explains the research methodology

used in the study. Chapter Four analyses and interprets the data collected. Finally, Chapter Five offers an overview, synthesising a summary of the major findings and suggesting recommendations.

1.18 CONCLUSION

This section provided an overview of the study, focusing on its basis and the important aspects of conducting such research. The study's aims and objectives were presented to support its purpose. A preliminary review of the literature was then carried out to identify the challenges faced by teachers when using ICT to teach Physical Sciences, as well as the benefits of incorporating ICT into the teaching of Physical Sciences. The following section will delve into the theoretical framework underlying the study and highlight relevant literature.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter aimed to present a summary of the current literature discussing the difficulties and opportunities associated with utilising ICT in the teaching of Physical Sciences. A comprehensive examination of past research and literature was carried out to uncover key themes related to the incorporation of technology in schools in Sekhukhune East District, aiming to achieve a thorough understanding of the subject. The goal of the review of literature on the obstacles and possibilities of integrating ICT in education was to highlight the connections between existing research findings in areas that are relevant to the subject being examined. This section will also discuss the main ideas of the research and the underlying theoretical framework.

2.2 THEORETICAL FRAMEWORK OF THE STUDY

Actor-Network Theory (ANT) provided the framework for the study. Law (2009) emphasises the importance of teachers incorporating information and communication technology into their instruction to prepare students with the essential skills needed for the 21st century, as advocated in Actor Network Theory. Actor-Network Theory applies to this research because of the extensive integration of Information and Communication Technology in various facets of contemporary society, including the field of education.

Secondly, this theory is applicable because the apartheid regime in South Africa implemented segregated educational systems for different ethnic groups. Despite improvements over time, rural schools in the country still struggle with a shortage of qualified teachers who can effectively incorporate Information Communication Technology into their teaching practices. Thus, utilising information and communication technologies can assist in enhancing teachers' professional development and equipping them with the necessary skills to educate learners in ways

that contribute positively towards combating poverty, unemployment, inequality, and crime.

According to ANT, the combination of various connections creates a unique entity known as an actor capable of exerting force. Through ANT connections, a series of actions and objects join to form a lasting network or chain. Teachers can follow the threads of how things connect using an Actor Network Theory. The formation, association, and use of force of various human and nonhuman entities are all tracked by an Actor Network Theory (Kivunja, 2018). Through the process and outcomes of various assemblages coming together, this theory demonstrates how knowledge is produced (Czarniawska, 2016). These connections combined to form a unique entity or assembly that ANT calls an actor capable of exerting force. A chain or network of actions and objects is eventually formed by ANT connect, and these networks have a propensity to last for a long time (Fenwick & Edwards 2010). An Actor Network Theory examines the individual components that make up networks, investigating how these connections were formed and what keeps them functioning.

The researcher draws upon this theory to give a theoretical anchoring for this study. Actor-Network Theory, according to (Czarniawska, 2016), is a diverse set of material-semiotic tools, perspectives, and analytical methods that view all entities in the social and natural realms as constantly produced outcomes of the interconnected networks in which they exist. Law (2009) describes this theory as a set of material-semiotic tools, sensibilities, and analytical methods. Actor- Network Theory, like other theories, involves a range of approaches and perspectives. Furthermore, Actor-network Theory, like other material-semiotic approaches, explains how a diverse range of actors, including objects, individuals, machines, animals, ideas, organisations, inequalities, scale and size, and geographic configurations, interact and evolve through a combination of material and discursive relationships (Kivunja, 2018).

2.2.1 Actors

Actors are defined by the relationships they have, yet precisely because of this, they are severed from their own relational microcosm, which only endures until the actor is replaced by another actor who shares similar traits (Fenwick & Edwards, 2010). way of looking at complexity and challenging the taken for granted status of human actors.

The second part of this theory which reveals itself in the name ANT, is the notion of network. Put simply it refers to the interrelationship of all the actors, or how the 'actors' act on each other.

ANT is relevant to the constraints to effective use of ICT resources in teaching Physical Sciences because it is important for teachers to use ICTs to effective teaching and learning of Physical Sciences classes, but the bluestone walls of the classroom block the transmission signals so that the computers cannot connect to the internet, it is fair to say that human and non-human actors are in a bind together and they need to find a solution which involves all of them. ANT in practice brings to mind the computer imaging of human movement where individual's movements are plotted graphically on a computer to reveal a skeleton of experiments moving mechanically, frame by frame through particular motions which can then be analysed and understood in new and particular ways in the teaching of Physical Sciences to support learner's academic performance.

Adam & Tatnall (2010) argue that in an ANT framework, actors are seen to contest and negotiate with each other in an attempt to influence the final outcome in a direction to their own liking. Department of education, for example, might want ensure that all schools offer a simillar level of education to learners and to ensure outstanding academic performance and effective learning experiences through ICT use. The parents of the learners on the other hand, would want the best for their own children regardless of what is going on in their schools. The technology (both hardware and software) itself acts in the way it was designed, both intentionally and unintentionally, to act (Adam & Tatnall (2010). Furtheremore, they argue that ANT considers associations and interactions between human and non-human actors but its proponents make no claim that this approach can do any more than shed a little light on how a given approach is taken or technology is adopted. The researcher believes that all the factors involved in the adoption of technological tools interaction then it is possible to affect the outcome by assisting favourable interactions and doing one's best to reduce unfavourable interactions and enhances positive ICT experiences of teachrs and learners who use ICT resources in Physical Sciences learning.

2.2.2 Network

It is more important to keep the link patterns steady. Some examples of contexts that are constantly being constructed and modified by overlapping social and material processes are schools, lecture halls, and technological equipment. It is important to understand the network relationships behind these folds and overlaps. As settings play an increasingly important role in educational studies of learning and curriculum development, this network ontology is particularly useful for facilitating in-depth examination of settings (Kivunja, 2018).

Professional learning environments and activities are thought to be the places where it is most deeply embedded. The extensive use of information and communications technologies in all facets of contemporary society, including the educational system, makes an ANT appropriate for this subject. Secondly, this theory makes sense since South Africa's apartheid government established distinct educational systems for each of its numerous ethnic groups and because there are still not enough qualified teachers in the nation's rural schools to effectively use ICTs in the classroom. Information and Communication Technology are therefore a useful tool for teachers' professional development and for arming them with the knowledge needed to instruct students.

This theoretical framework requires teachers to use information and communication technologies in their teaching tasks to produce learners who are well-equipped with skills necessary for 21st century.

Translation 1 happens when an actor goes out of his way and assumes the cause of another as his own. If all human and nonhuman actors are free to act, then why would they give up their interests? Certainly one of the actors must impose his will to form a network around him. For example, when learners will attend a class, they are assuming the cause of a teacher. In this case, the teacher is a more prominent actor who "reassembling" other actors (students, chairs, room, air-conditioning, smartboard.

2.3 IMPORTANCE OF ICT USAGE IN TEACHING AND LEARNING

UNESCO defines ICT as the academic field that incorporates science, technology, engineering, and management practices in the processing of information within the context of societal, economic, and cultural considerations. The technology revolution has had a significant impact on the expectations placed on teachers to assist students in developing 21st century skills like creativity, cooperation, and critical thinking (Shieh, 2012). Educators are required to integrate computer science into the lesson plans in a manner that nurtures these abilities. These skills are honed as individuals grow and mature, with the process beginning in childhood. To ensure that young persons are ready for the industries of today and tomorrow, these skills must be developed beginning in elementary school (O' Neal, Gibson & Cotton, 2017).

When debating the application of ICT in education, it is crucial to look beyond the problems associated with mobile device accessibility and technological choice. Although there are many technology systems available, their significance and efficacy in applications may not always be high (Das, 2019). Thus, it is crucial to examine how this technology is used in terms of organisational, pedagogical, managerial, and other aspects. According to a Mtsi and Maphosa's (2016) poll, information and communication technology strives to provide both the need for mobility and interactivity. Through the help of collaborative learning and constructivism, ICT integrates education (Tsakeni, Munje & Jita, 2021).

Concerns about the poor levels of student performance in particular contexts of South Africa's Science and Mathematics curriculum have been raised (Tsakeni, Munje & Jita, 2021). To address these concerns, further investigation is needed to understand the current difficulties. In South Africa, poor teaching is linked to a lack of resources to provide quality education, particularly in rural areas. Poor or insufficient teacher preparation makes learning more difficult in classrooms. Furthermore, even though they have the power to alter the learning environment, the dearth of Mathematics and Science teachers in poor schools has hindered those institutions' attempts to improve teaching and learning (Kibirige & Tshamago, 2019). Teaching and learning are hampered by their absence, especially in the fields of Science and Mathematics.

Because they are ill-prepared, some teachers find it difficult to incorporate technology into their Science and Mathematics classes (Yieng, 2013).

In this digital age, educators are forced to integrate technology into the classroom. According to Tsakeni, Munje and Jita (2021), the majority of Science teachers in South Africa lack the computer literacy required to use Information Communication Technology. Science instructors can increase their students' motivation, creativity, and self-assurance by utilising ICT resources (Sebatana & Dudu, 2022).
According to Al-Ansi, Garad and Al-Ansi (2021), ICT improves learning in classrooms and for it to be successful, administrators, instructors, parents, students, and all other supporting elements, including suitable infrastructure, must make a conscious effort to collaborate. ICT is used in education as an administrative system, a learning resource, a learning aid, a learning facility, and a competency standard (Hamid, 2016). One option for conducting the learning process virtually is to use Google Classroom, a platform that the company offers. Google Classroom may be used across multiple platforms, including PCs and mobile devices. It is anticipated that learning objectives will be simpler for teachers or educators to handle in order to understand and effectively impart knowledge to students through the Google Classroom application (Hakim, 2016).

It is more convenient for students to actively develop their own knowledge when ICT is used in the classroom. Instructors can also benefit from a number of features included in the Google Classroom programme, including time-saving tools, assignments, grading, communication, mobile apps and privacy. Assessing how the teaching and learning process is being implemented both within and outside of the classroom is made simpler by using Google Classroom for learning. ICT tools are intended to support educators and students in managing their classroom schedules and facilitating communication with students outside of the classroom. Teachers who have the ability to use technology are able to assign tasks to learners and provide feedback and grades to them directly.

2.4 CONSTRAINTS AFFECTING THE USE OF ICT RESOURCES IN TEACHING PHYSICAL SCIENCES

The study's conclusions suggested that Ghana's use of ICT in Physical Sciences education is severely impacted by low computer literacy, a lack of government backing, and a lack of enthusiasm among instructors (Yalley, 2022). According to Toro and Joshi (2012), the main obstacles to ICT integration advancement include low awareness and mindset, a lack of top-level commitment, a methodical approach to ICT deployment, bandwidth costs, and inefficient use of ICT. Furthermore, the biggest challenges include the rapid advancement of ICT tools, the additional time and effort required to integrate them into the classroom, inadequate network connectivity, and incorrect assessment of the integration of ICT tools into the classroom,to mention a few . He adds that for ICT to be successfully used in higher education, these barriers must be removed.

It was predicted that using Information Communication Technology to teach practical skills would improve teaching and learning and provide students with a competitive advantage to handle challenges brought by the Fourth Industrial Revolution and artificial intelligence (Sebatana & Dudu, 2022). However, there is poor academic performance among learners because most schools lack the funding to purchase the necessary tools for practical work (Kibirige & Tshamago, 2019).

Due to misunderstandings about technological systems, teachers' opinions on the use of information, communication, and technology in the classroom vary. Despite the fundamental role played by technological systems in teaching and learning, some teachers are unprepared to provide teaching lessons through technological systems and devices. They feel uncomfortable to use technological systems that do not accommodate their cultural values and norms (Tay, Lim & Lim, 2015).

Research on the use of technology to deliver education in many nations has been done in a number of studies (Dardary, Tridane & Belaaouad, 2018; Lawrence, Tar, 2018; Lisene & Jita, 2018). Because of a number of variables, including cultural stereotypes, beliefs, and attitudes, teachers view the application of technological systems in teaching and learning from diverse points of view.

A situation of this nature might have a detrimental impact on the quality of education that learners will receive because of considerable misinformation towards technological systems and devices. It is undeniable that technology plays a significant role in improving teaching and learning. Problems in how teaching and learning are implemented have a detrimental effect on student results and educational quality.

The application of Information Communication Technology to raise academic achievement in diverse nations is hampered by a number of issues, despite the enormous impact that technology has had on many aspects of life (Ezekwe, 2019). These difficulties include a lack of technological device training, a dearth of technological devices, a shortage of teachers proficient in ICT resources, a shortage of teachers well-equipped to use technological systems in the classroom, and a lack of funding to facilitate the use of ICT in the educational sector so that teaching and learning are simple (Tay, Lim & Lim, 2015). This issue is widespread in developing nations even if it occurs in other nations as well (Jita & Munje, 2020).

This is a serious problem that requires various expertise to make education enjoyable. This initiative will help to produce learners who are well-equipped to apply technological systems to respond to the Fourth Industrial Revolution. A situation of this nature will equip students will the necessary knowledge and skills to contribute to addressing socio-economic problems such as unemployment, poverty, inequality and climate change. This initiative will also equip learners with the necessary skills and knowledge on how to be creative to become entrepreneurs in future. A situation of this nature will help to address the lack of skills needed for the Fourth Industrial Revolution that is worsening because of an outdated educational system in the country.

Since information communication and technologies are important for raising academic achievement, there are a number of obstacles that must be overcome before Information Communication Technology can be successfully implemented in the nation's educational system (Dardary, Tridane & Belaaouad, 2018). These difficulties include inadequate network access, a shortage of teaching supplies, teachers who are hesitant to adopt new technology, and a lack of adequate training and expertise in

using ICT to deliver instruction (Dardary, Tridane & Belaaouad, 2018). Teachers frequently use the internet to develop their knowledge and expand their vocabulary, even if information communication and technology play a big part in the classroom (Lisene & Jita, 2018). Such a scenario is counterproductive to curriculum objectives in education.

A lack of time,a lack of confidence, and resistance to change are some of the issues that impede the use of information communication technology in public schools (Lawrence & Tar, 2018). These obstacles include theft, a shortage of resources like laptops and projectors, and a teacher's lack of information and communication technology competency (Jita & Munje, 2020). Teachers with ICT competency are needed to deliver lessons using technological systems and equipment (Juggernauts & Govender, 2020). This is a significant issue that requires the involvement of many parties in order to establish a supportive atmosphere for instruction. Such an arrangement will incentivise individuals who have dropped out of school to return.

According to Maja (2023), learning is no longer limited to physical spaces and may happen at any time or place thanks to advancements in technology. The main obstacles impeding teachers use technological devices during the past three decades have been identified as extrinsic factors such as inadequate Information Communication and Technology infrastructures, resources and training (Juggernath & Govender, 2020). Those extrinsic factors include poor network connectivity, teachers reluctant to new technology and lack of training to use technological devices. Teachers feel that as the Department of Basic Education employs qualified and experienced teachers, teaching and learning may be improved if ICTs are used as visualisations.

Internet surfing through mobile phones reduces the challenge of a lack technological devices (Lisene & Jita, 2018). The study's findings also showed that teachers' attitudes towards the use of technological tools are growing to be a significant intrinsic barrier, even though all educators are expected to be digitally proficient in Information Communication Technology due to the Fourth Industrial Revolution and the growing significance of artificial intelligence (Juggernath & Govender, 2020).

This demonstrates that while digital cameras, scanners, CDs and DVDs were among the technologies that were infrequently used in schools, mobile phones, the internet and computers were among those that were frequently used (Lisene & Jita, 2018). The other technologies were employed sparingly (Kafyulilo, 2015). Because smartphones and computers have built-in cameras that are more practical to use, digital cameras were probably not extensively used (Lisene & Jita, 2018). Flash drives which are more resilient than CDs and DVDs, probably took the role of those media. This shows that teachers were more likely to use their smartphones to access the internet more frequently than they did their desktops. Given that teachers had greater access to their smartphones than to the school computers, this was to be expected (Lisene & Jita, 2018).

Even though the use of technology to create a favourable atmosphere for teaching and learning is important, there are a number of obstacles that have a negative impact on educational results. It is undeniable that through technological systems in the classroom, learners can easily comprehend and understand complex Physical Sciences concepts. These can improve academic performance. It can be argued that if those barriers are left unattended, a situation of this nature might discourage learners from focusing on their studies. A situation of this nature might also discourage teachers from continuing to perform their duties. These will make it difficult to fill the Physical Sciences post in public schools.

The lack of qualified Physical Sciences teachers is one of the issues affecting the use of ICT to improve students' academic performance in Physical Science courses (Yalley, 2022). The substantial number of teachers quitting the Department of Education due to low pay and other service-related difficulties, such as a lack of opportunities for professional progress in the field of education, is exacerbating the teacher shortage. This is a significant issue that has an impact on the nation's educational standards. This is a common occurrence in emerging nations like South Africa and other African nations.

The use of Information Communication Technology resources in teaching Physical Sciences, particularly in public schools, has been shown to be impacted by two factors: a shortage of new teachers entering the profession as a result of teacher training institutes being rationalised, and ageing teachers who are no longer relevant to the

current Physical Sciences curriculum but are still labelled as active Physical Sciences teachers (Mtsi & Maphosa, 2016). Although there are various interventions from the government through policy development, recruitment of new Mathematics and Physical Sciences teachers, and the provision of resources to public schools in the country also play pivotal roles in the educational sector.

Such a scenario will impede the nation's progress towards national development target number 9, which highlights the importance of creating robust infrastructure, promoting equitable and sustainable industrialisation, and encouraging innovation. This is a serious concern that needs a multidisciplinary approach to take urgent actions to address this problem in order to produce learners who will add significant value in fighting against poverty, unemployment inequality and crime in the country.

Social justice issues surrounding teachers' use of Information Communication and Technology for teaching and learning are still very important in today's technologically advanced world (Mathevula & Uwizeyimana, 2014). Pre-service teachers must gain the requisite knowledge, skills, and learning opportunities during their teaching training programmes in order to become proficient in the use of Information Communication Technology to teach science subjects. In order to support the teaching of material in a variety of disciplines, a new generation of teachers must be equipped with Information Communication Technology abilities, and here is where teacher education programmes come into play (Jita, 2016).

2.4.1 Inadequate Preparation

In some situations, inadequate preparation in lower grades causes students to enter Physical Sciences in higher grades with poor confidence and a negative attitude, which increases student failure rates (Das, 2019). Among the issues affecting the use of ICT to improve learners' academic success in Physical Sciences courses is the shortage of teachers with the required credentials in the field (Yalley, 2022). The substantial number of teachers quitting the Department of Education due to low pay and other service-related concerns, such as a lack of opportunities for professional progress in the field of education, exacerbates the scarcity of qualified teachers.

2.4.2 Extrinsic Factors

The main obstacles impeding teachers' use of ICT during the past three decades have been identified as extrinsic factors such as inadequate ICT infrastructures, resources and training (Juggernath & Govendor, 2020). Furthermore, teachers' opinions about the use of ICT are becoming a significant intrinsic barrier, even though all teachers are expected to be digitally proficient in Information Communication Technology due to the Fourth Industrial Revolution and the growing importance of artificial intelligence (Juggernath & Govendor, 2020). The academic performance of students enrolled in Physical Sciences courses is significantly hampered by extrinsic factors, including inadequate maintenance, network issues, and excessive fees since they are unable to obtain relevant information outside of the classroom.

2.4.3 Aging Teachers

The use of Information Communication Technology resources in teaching Physical Sciences, particularly in public schools, has been shown to be impacted by two factors: a shortage of new teachers entering the profession as a result of teacher training institutes being rationalised, and ageing teachers who are no longer relevant to the current Physical Sciences curriculum but are still labelled as active Physical Sciences teachers (Mtsi & Maphosa, 2016). Many teachers have been in the classroom for more than 30 years, they are not well trained and equipped with skills to apply the latest technological devices and applications to teach Physical Sciences and Mathematics at school. Some Physical Sciences teachers indicate that the working conditions discourage them to continue working in the education sector (Mtsi & Maphosa, 2016).

Although there are various interventions from the government through policy development, recruitment of new Mathematics and Physical Sciences teachers, and the provision of resources to public schools in the country, Physical Sciences is not taught by enough properly qualified teachers.

Such a scenario will impede the nation's progress towards national development target number 9, which highlights the importance of creating robust infrastructure, promoting

equitable and sustainable industrialisation, and encouraging innovation. This is a serious concern that needs a multidisciplinary approach to take urgent actions to address this problem in order to produce learners who will add significant value in fighting against poverty, unemployment inequality and crime in the country.

Social justice issues pertaining to teachers' use of information and communication technology for teaching and learning are still very important in the 20st century, technologically driven world (Mathevula & Uwizeyimana, 2014). Pre-service teachers must gain the requisite knowledge, skills, and learning opportunities during their teaching training programmes in order to become proficient in the use of Information Communication Technology to teach science subjects. In order to support the teaching of material in a variety of disciplines, a new generation of teachers must be equipped with Information Communication Technology abilities, and here is where teacher education programmes come into play (Jita, 2016).

2.4.4 Inadequate Resources

It can be difficult to include ICT in the teaching and learning process. The issue faced by educators worldwide is to develop instructional methodologies that can leverage cutting-edge technology and integrate it into the educational experiences of upcoming generations. Wealthier countries have seen rapid advancements in this. Inadequate resources, however, have slowed down transformation in developing nations (Khurshid, Shah & Reid, 2016). According to Langat (2015), political factors, poor timing and planning, a lack of teachers, a lack of clear digital curriculum, a lack of infrastructure and resources, high implementation costs, communication barriers, corruption, moral dilemmas, and high crime rates are some of the obstacles preventing the adoption of ICTs.

2.4.5 Infrastructure limitations

ICT infrastructure, according to Lomos, Luyten and Tieck (2023), is the availability of computers, internet connectivity, and any other comparable facilities related to the usage of ICT. Teachers must have access to computers, whiteboards, and a working Internet connection as part of their ICT infrastructure; yet, this is not a sufficient

requirement in and of itself (Lomos, et al., 2023). Additionally, it has been shown that the primary obstacle to instructors using ICT for learning and e-learning, especially in many developing educational contexts, is the constraints of the ICT infrastructure. Therefore, in order to improve teaching, instructors must have easy access to ICT infrastructure as well as the time and opportunity to use it in their daily work. It is therefore expected that there will be ICT infrastructure available to facilitate instructors' use of ICT.

2.4.6 Technical Expertise

Technical expertise refers to ICT familiarity, usage proficiency, and overall ICT pedagogical skills. According to Lomos et al. (2023), the Four in Balance model of expertise suggests that instructors' acquaintance with ICT, their proficiency with its usage, and their general pedagogical ICT skills are crucial for its pedagogical application. For their intentions and actual behaviour with ICT to increase, teachers must have first-hand experience with the technology and be hands-on in the classroom (Kim, Long, Zhao, Zhou & Alexander, 2021). According to Asemhe and Ogbeide (2019), teachers' attitudes about the use of contemporary technologies in teaching and learning as well as their availability and competency are key factors in the success of ICT integration in the educational system.

Mahmood, Halim, Rajindra and Ghani (2014) ascribed the low use of ICT in schools to instructors' lack of experience and knowledge in comparison to today's quick-learning and highly computer-literate students. A lack of professional training and ICT abilities is the reason given for some Physical Sciences teachers' lack of confidence.

2.4.6 Accessibility and Inclusivity

According to Das (2019), ICT improves education by making it more accessible to all students. It does this by enabling distance learning, which brings education to the doorsteps of children living in remote rural areas, and it enhances the learning process by making more interactive educational materials available, which boosts student motivation and makes it easier for students to pick up basic skills. Abdullahi (2023) found that teachers' usage of ICTs is hampered when certain ICT components are

unavailable in schools. They added that access points in schools and inadequate search skills are two more things that are said to be preventing instructors from using the Internet. Because schools lack ICT infrastructure, students are forced to use their cell phones to access the internet.

Al-Ansi, Garad and Al-Ansi (2021) discussed a few issues with ICT use in the classroom, including content restrictions, insufficient resources, difficulty accessing resources, difficulty using ICT software and hardware, a lack of technical support, and insufficient time for ICT use. The difficulties of the Fourth Industrial Revolution, such as possible job losses, skill gaps, infrastructure issues, security concerns, and privacy issues, have been studied by Manda and Dhaou (2019). These issues have an effect on how well ICT resources are used in the classroom.

2.4.7 Maintanance and Reliability

Asemhe and Ogbeide (2019), most secondary schools have either insufficient or no ICT tools for the ever-increasing population of students in the school and where they are available, they are by implication a matter of out of bounds to the students. Most educational institutions in developing nations face a number of obstacles when implementing ICT into the curriculum, such as low computer proficiency, ill-equipped classrooms, remote schools that are not connected to the electricity grid, costly and sluggish internet connections, the fact that most schools that have computers do not use them for instruction, and a lack of student-facing e-learning resources (Kettunen & Sampson, 2019). However, there are numerous obstacles to ICT-based teaching and learning in classrooms. Managing and organising classrooms, maintaining technology and software, electrical issues, the cost and speed of the internet, a lack of experience in the field, and infrastructure concerns are a few of these challenges.

2.5 THE EXTENT TO WHICH THE USE OF ICT SUPPORTS LEARNERS' ACADEMIC PERFORMANCE IN PHYSICAL SCIENCES SUBJECT

Mafukata (2016) indicated that a lack of proper complexities background from junior grades, a shortage of qualified teachers in Physical Sciences, teachers' retirements and resignations, and social factors beyond teachers' competence negatively affect

academic performance in Physical Sciences subject. The lack of teachers in-service training programmes and weak curriculum advisers' structure negatively affect academic performance in the Physical Sciences subject in the country (Mafukata, 2016).

Juggernath and Govendor (2020) indicated that the majority of Physical Sciences learners struggle to meet the demands of Physical Sciences and Mathematics grades because they lack a solid junior phase background in the field. Although this problem exists in many different nations around the world, it is prevalent in emerging nations (Das, 2019).

A new set of abilities, attitudes, and pedagogical approaches have to be developed as a result of the use of Information Communication and Technology in teaching, learning, and managing educational institutions. This calls for continuous training programmes to ensure that teachers have the necessary capacity (Tsakeni, Munje & Jita, 2021). Accordingly, effective e-Learning necessitates much more than the simple introduction of hardware in the classroom, especially in developed countries and relatively in urban areas of developing countries, even though the majority of schools now have computers, internet access, and occasionally more advanced equipment like interactive whiteboards (Lamanauskas & Violeta, 2020).

Although Information Communication and Technology have many advantages, there is a significant risk involved since students often waste class time visiting websites that include improper content, such as pornographic material, in an attempt to learn more about the Internet. These leave teachers with no option but to spend time attempting to prevent learners from using websites irrelevant to the learning curriculum (Mathevula & Uwizeyimana, 2014).

There is evidence that properly developed, and developmentally appropriate digital tools can ensure students learning when they are thoughtfully incorporated into worthwhile learning activities. Students are accustomed to and regularly use electronic gadgets because they are growing up in a technologically advanced environment. This provides another justification for utilising Information Communication Technology in education. Similar changes in educational settings

have been brought about by the creation and widespread use of small mobile devices. Through the use of tablets and related programmes (apps), innovative learning is now implemented in primary and secondary schools.

Numerous countries have made investments in ICT to boost educational quality and academic productivity (Hinostroza, 2018). Information Communication Technology is defined as technology that enables people to manage and communicate information electronically. It includes hardware such as computers, printers, scanners, video recorders, televisions, radios, and digital cameras, as well as software and communication systems such as the internet and email. The impact of information communication and technology on students' academic progress is critical to education (Ghavifekr & Rosdy, 2015).

Through the use of these technological systems, it is possible to simplify the educational subject and make it more understandable and enjoyable (Lamanauskas & Violeta, 2020). The use of Information Communication Technology in teaching and learning, as well as in educational institution management, necessitates the emergence of a new set of skills, attitudes, and pedagogical approaches, necessitating ongoing training programmes to develop adequate capacity among teachers (Tsakeni, Munje & Jita, 2021). This means that, while most schools now have computers, Internet access, and, on occasion, more advanced equipment such as interactive whiteboards, effective e-Learning requires much more than simply introducing hardware into the classroom, particularly in developed countries and, to a lesser extent, in developing countries' urban areas (Lamanauskas & Violeta, 2020).

These present security concerns, albeit not for physical security, are for access to information security. Without instructor supervision, learners are likely to use technology incorrectly and spend less time learning and studying (Mtsi & Maphosa, 2016).

2.6 OPPORTUNITIES OF USING ICT TOOLS IN TEACHING PHYSICAL SCIENCE SUBJECT

Although there are barriers to the introduction of Information Communication Technology in the educational sector, it has increased the effectiveness of the teaching process (Lawrence & Usman, 2018). It has been scientifically proven that Information Communication Technology can act as a change agent by significantly increasing educational reform, allowing teachers and students to transition from traditional to more creative and successful approaches to teaching and learning (Sebatana & Dudu, 2022).

Teachers must have a variety of pedagogical skills in order to effectively use technology in the classroom, including the ability to use technology productively to teach content and understand how technology can be used to expand on prior knowledge and create new epistemologies (Yalley 2022; Sharima, Sharima & Sharima, 2017). In other words, incorporating technology into teaching entails more than simply bringing it into the classroom. A shortage of resources limits opportunities to teach and learn science and mathematics. This includes human, physical, and technological resources (Yalley, 2022).

The deployment of ICTs in secondary schools and teacher training in ICT use are likely to benefit the impoverished in South Africa, where there are great discrepancies between income and status (Mathevula & Uwizeyimana, 2014). According to scientific research, ICT improved instruction and learning, aided in the integration of a range of subjects and the use of the most recent resources, and encouraged the development of critical thinking abilities (O'Neal, Gibson & Cotton, 2017). The use of ICT in education makes learning more accessible, memorable, and interesting for students. It also encourages students to participate more actively and reduces stress by viewing learning as a game (Sebatana & Dudu, 2022).

ICT for teaching and learning, according to Das (2019) and Mafukata (2016), has a number of benefits, including promoting collaborative learning and facilitating the sharing of learning resources and learning environments. According to Yieng (2013), ICT has the ability to enable teachers and students to use video systems to transmit

information and television shows throughout a school and even between schools in the same district. Additionally, sharing educational resources can lower costs and raise the standard of instruction, especially in remote schools (Mathevula & Uwizeyimana, 2014).

The issue of overcrowding and teacher scarcity could be greatly mitigated by sharing learning spaces (Mathevula & Uwizeyimana, 2014). According to Tsakeni, Munje and Jita (2021), a lot of learning that is currently thought to be individual will change and become collaborative thanks to the usage of ICT. ICT-based learning offers numerous benefits and elements, including high-quality content, an interactive learning environment, convenience of use, and educational assessment (Binyamin, Rutter & Smith, 2019). However, the use of electronic devices like computers, mobile phones, and tablets in the classroom and the accessibility of these resources for educators and students improves the quality of instruction.

Mafukata (2016) claims that the economic case for ICT in education is based on the possibility of increased efficacy and efficiency in educational tasks, which will save labour costs. Students who get computer-assisted instruction in mathematics, the natural sciences, and the social sciences perform better on tests in these subjects, according to a study by Mtsi and Maphosa (Mtsi & Maphosa, 2016). Science students who utilised Information Communication Technology also performed better. It has been scientifically proven that learners who use technological devices to read get higher grades (Mathevula & Uwizeyimana, 2014).

Through the implementation of Information Communication Technology in the educational systems, learners can benefit through virtual experimental labs and quick information searches (Lawrence & Usman, 2018). However, it is undeniable that some teachers, particularly in public schools, struggle with the idea of using just one tablet in a classroom with many students. Some of the opportunities include the following:

2.6.1 Access to Vast Resources

When used in the Physical Sciences, ICT gives students access to a wealth of resources, including virtual libraries. Students benefit greatly from virtual libraries since

they can save money by not having to purchase pricey textbooks, periodicals, and reference materials (Toro & Joshi, 2012). Additionally, there are online resources accessible to help educators and learners handle writing tasks so that plagiarism and copyright infringement can be identified and avoided. ICT enhances both the quantity and quality of education generally, and the availability of these materials demonstrates the critical role that ICT integration plays in the teaching and learning of Physical Sciences. According to Talebian, Mohammadi and Rezvanfar (2014), the advantages could include a variety of modes depending on the type of learning, such as availability in terms of time and location, equity, improving collaboration between students and educators, direct access to a variety of resources, the capacity to improve education dimensions globally, and the capacity to assess the rate of progress in educational courses.

2.6.2 Promotes Active Learning and Engagement

According to Das (2019), ICT facilitates the learner's access to the learning programme at any time and from any location. Additionally, ICT enhances the learning process by making more interactive educational resources available, which boosts student engagement and makes it easier for learners to pick up fundamental skills (Das, 2019). The use of ICT influences how knowledge is taught and how well students learn since learning will only be effective if the tactics are learner-driven rather than teacher-driven. It helps to give education anytime and from anywhere. ICT can be used in a variety of ways to build effective learning environments (Bindu, 2016). Additionally, it can access a wealth of information from a variety of sources to improve teaching and learning. However, there are several advantages to using ICT in the Physical Sciences classroom, including increased student engagement and retention, a boost to individual learning and teamwork, and flexible scheduling for learning. ICT can provide a pedagogical skill that enables learners to become effective independent learners, for example, computer games and other assessment software are available that can adjust themselves to the level of competency of the learners and move to the next level as they improve their learning skills in Physical Sciences. Information and communication technologies (ICTs) have a significant impact on education in general and Physical Sciences education in particular, with greater access to various open learning sources, learners' interaction through online and social networking across the

world and the availability of a variety of teaching and learning tools leading to an increased academic performance of Physical Sciences learning. It seems that the use of ICTs can increase students' motivation and consequently their overall achievements (Castaño-Muñoz, Duart & Sancho-Vinuesa, 2013).

2.6.3 Real-word Connections

According to Matthew et al. (2015), ICTs have the power to improve instruction and support school reform while also accelerating, enriching, and deepening students' skills, motivating and engaging them, and assisting in the connection between the classroom and the workplace. The use of computers in Physical Sciences education is crucial in this ever-changing environment so that students can retrieve and apply knowledge in a given setting. For example, when teaching simulations and generators in Physical sciences, the teacher will find useful simulations, videos, models and diagrams to show and explain theoretical knowledge on the projected screen or smartboard. By conducting simulation based experiments online, learners in the computer lab are able to develop and maintain knowledge, skills, and competencies as they are able to see experiments performed, so this will help the learners understand. ICT will expand in South African schools as a result of technologically advanced classrooms. This has the potential to enhance average subject performance, information interpretation, and the production of qualified ICT experts who can handle IT issues both domestically and internationally.

2.7 THE EXPERIENCES OF TEACHERS AND LEARNERS WHO USE ICT RESOURCES TO ENHANCE TEACHING AND LEARNING OF PHYSICAL SCIENCES

Even though using information, communication, and technology in schools has many advantages, some schools struggle with integrating technology because of inadequate internet access and poor resource maintenance (Juggernath & Govendor, 2020).

2.7.1 Experience for Learners

Learners who use ICT tools to learn Physical Sciences can have a variety of positive experiences that enhance their understanding and engagement with the subject matter.

2.7.1.1 Increased engagement

According to Zweekhorst and Maas (2015), ICT tools let students communicate and interact with one another as well as with professors on a higher level. As a result, students will regularly give professors who use the tool higher marks on the "engaging" item. The majority of students find that using ICT resources makes them feel more engaged in the teaching and learning process. ICTs make it easier for people to communicate with each other and access a wide range of information, which suggests that teaching methods need to evolve and that both instructors and students must get used to using these tools (Zweekhorst & Maas, 2015). High interactivity of resources allows learners in an active, pictorial and almost tangible way to familiarize themselves with the presented content, which is often too abstract for them. ICT usage helps the teacher to discuss content in a dialogical way where learners actively participate, which help teachers lessen the burden and use their time more resourcefully.

2.7.1.2 Enhanced comprehension

ICTs have extended pupils' attention spans (Khan, 2015). In the last few years, ICTs have revolutionised education and completely altered its scope. It has been demonstrated that integrating ICTs into Physical Sciences education significantly improves students' academic achievement. ICTs help students study with improved comprehension. Ishaq, Azan, Zin, Rosdi, Abid and Ijaz (2020) emphasise that students' academic performance is greatly impacted by their use of ICTs. Additionally, ICTs help them to improve instructional quality, strengthen the integration of education into the increasingly virtual workplace, and obtain more education.

2.7.1.3 Self-centred learning

According to Toro and Joshi (2012), ICT offers a tool that can support and encourage the shift in educational practices from being a teacher-directed endeavour to one that is student-centred. The effect of technology to enhance students' academic

endeavours will grow as more students use computers as information sources and cognitive tools (Toro & Joshi, 2012). The use of ICT in Physical Sciences fosters critical thinking, self-learning, problem-solving skills, teamwork, and the exploration and simulation of abstract topics.

According to Sharma, Gandhar, Sharma and Seema (2011), ICT enables self-paced learning through various tools such as assignments, and computers. As a result of this, the teaching-learning enterprise has become more productive and meaningful. Sharma et al. (2011) argue that ICT helps facilitate the transaction between producers and users by keeping the students updated and enhancing teachers' capacity and ability to foster a live contact between the teacher and the student through e-mail, chalk sessions, e-learning, and web-based learning, including internet, intranet, extranet, CD-ROM, and TV audio-videotape.

2.7.1.4 Collaboration and peer learning

An audio-visual impact that uses multimedia computer software can be utilised to pique students' interest and involve them in the learning process (Bindu, 2016). Studies demonstrate that learners who use ICTs for instruction are actively involved in the process of learning. He adds that ICT-integrated learning facilitates improved concept understanding and longer-term memory retention in kids. Because they are actively involved in the learning process, ICT also assists students in developing a good attitude about learning. According to Noor-Ul-Amin (2013), new scenarios that support both individual and collaborative learning are replacing outdated communication models and teacher-used teaching and learning techniques.

2.7.1.5 Access to diverse resources

Course outlines, digitally recorded lectures, discussion boards, lab manuals, lab assignments, lecture notes, live lectures for later viewing and rewatching, links to course-specific websites, online tutorials, additional readings, and virtual office hours for teacher-student consultations are just a few of the student support services that ICT offers (Toro & Joshi, 2012). ICTs significantly improve knowledge acquisition and absorption, providing developing nations with hitherto unheard-of chances to better educational institutions, formulate and implement policies more effectively, and expand prospects for the impoverished and businesses. ICT should give students

access to extra resources to support resource-based learning, according to Das (2019).

2.7.1.7 Real-world applications

Toro and Joshi (2012) highlight that educational institutions can provide programmes remotely with the aid of ICT. The use of ICT facilitates anytime learning since it allows students to pursue their education at any time, place, or anywhere. ICT helps students get ready for their future careers and social lives in addition to preparing them to use their knowledge in the real classroom. According to Das (2019), educators should skilfully rethink classroom settings to enable students to use their newly acquired ICT abilities to other apps in an environment rich in ICT.

ICTs can generate financial capability for future personnel, improve, deepen, and originate abilities; they can also interact and encourage students, allowing them to use their skills in practical fields; and they can improve teaching and learning experiences (Ekpo & Okoro, 2016).

2.7.1.6 Negative experience for learners

Learning on a computer has harmful side effects like vision problems (Kibirige & Tshamago, 2019). Learners and teachers are likely to suffer from visual problems as a result of using computers. There may be instances when learners have less time to work on their speech and handwriting skills. Because they may find it difficult to work independently and may need more teacher supervision, certain kids may find using ICT difficult (Yalley, 2022). However, while Jita (2016) discovered a link between computer use and school performance, other researchers, such as Uwizeyimana (2014), found mounting evidence that using ICTs may be the only practical and financially sound solution.

2.7.2 Experience for Teachers

Teachers who incorporate ICT tools into their instruction of Physical Sciences can benefit greatly by improving their teaching strategies and student learning outcomes. Typical positive examples may include:

2.7.2.1 Collaboration and professional development

According to Lomos et al. (2023), teachers need to undergo initial professional development in order to effectively integrate ICT into their teaching practices. This will help them change their beliefs about ICT and clarify the steps needed for successful ICT implementation. According to findings, Physical Sciences teachers who have greater familiarity with ICT, along with higher levels of initial technological knowledge and confidence in using ICT, are more likely to incorporate it into their teaching practices to enhance student performance in the subject. It also contributes to the enhancement of professional development and educational management, improving active learning for teacher trainees. Matthew et al. (2015) also suggest that technology can improve professional development and educational management, as well as facilitate active learning for teacher trainees. They also point out that technology helps students become more familiar with how they interact and connect with one another.

Collaboration and leadership, as contextual characteristics, refer to teachers' collaboration, their support through professional development within schools, and a joint agreement about ICT priorities in the school. According to Lomos et al. (2023), collaboration and leadership in a school setting involve teachers working together, receiving professional development support, and reaching a common agreement on ICT policies. Research has demonstrated that effective collaborative professional development can enhance teacher's utilisation of technology in teaching, particularly through collaborative learning approaches (Thoma, Hutchison, Johnson, Johnson & Stromer, 2017). The researcher anticipates that teachers who experience high levels of collaboration, support, and a clear focus on using technology in their school will also use technology more in their Physical Sciences classes.

Kurtz (2014) suggests that using social networking tools to facilitate collaborative learning can empower students to take ownership of their learning and encourage them to engage in discussions with their peers about academic challenges. In a study conducted by Huang (2017), the significance of collaborative learning in reducing the time spent on tasks such as sending emails, saving, revising, and editing materials was emphasised. This not only saves time for both students and educators but also

enhances their productivity. Utilising social media platforms to share a wide range of information can greatly enhance student's comprehension of challenging subjects and enable them to express and exchange their thoughts effectively (Erturk, 2016). Furthermore, teleconferencing tools like Zoom, Microsoft Teams, and Google Classroom have become essential for facilitating remote learning. These platforms allow students to engage with their teachers at any location and time, helping to address difficulties students may encounter while studying Physical Sciences.

2.7.2.2 Access to updated content

According to Sharma et al. (2011), it is important for teachers to stay current with the latest digital tools and resources in order to assist students in meeting academic goals. The use of open-source software has allowed for the creation of content and learning management systems like the Integrated Learning Module (ILM). ILM offers courses with a strong thematic focus that are mainly taught online. The effective use of ICT has the potential to revolutionise the way teaching and learning occur, improving the delivery of content and teaching methods in educational settings. By integrating ICT, education can become more accessible and cost-effective, ultimately enhancing the quality of educational services for all learners, including those in remote areas.

2.7.2.3 Improved student-teacher communication and relationships

Duong, Pullmann, Buntain-Ricklefs, Lee, Benjamin, Nguyen and Cook (2019) investigate the impact of a professional development programme on middle school teachers using the Establish-Maintain-Restore (EMR) approach. EMR can help improve teachers 'abilities to build connections with students through a short 3-hour training session and continuous support during implementation. Establishing positive relationships between students and teachers can greatly influence student involvement, behaviour, and academic achievements in both the short and long term. Positive student-teacher relationships impact student engagement and behaviour and predict both short- and long-term academic success (Pianta, Hamre & Allen, 2012). ICT improves communication between teachers and students, facilitating efficient information delivery and fostering a learning environment that mirrors real-world conditions. Additionally, ICT enables teachers to effectively identify and nurture the creativity of students with diverse learning styles to achieve desired educational outcomes.

According to Alarcia and del Arco Bravo (2012), virtual tutoring involves various forms of communication between students and instructors, such as one one-on-one interactions through email, group discussions on forums, peer support, and announcements from instructors in a virtual classroom setting.

2.7.2.4 Improved assessment and feedback

Sharma et al. (2011) advocate the view that ICT helps facilitate the transaction between producers and users by keeping the students updated and enhancing the teacher's capacity and ability fostering a live contact between the teacher and the student through e-mail and chat sessions. Bindu (2016) points out that ICT promotes opportunities to modify the learning material and activities to the requirements and capabilities of every individual learner, particularly by giving personalised feedback. This will enable Physical Sciences learners to share ideas, do online discussions and also personalise their own feedback. For example, multimedia and interactive materials can be used online as the basis for assessment tasks such as quizzes, tests and projects. Learners record their responses and send via a computer and receive feedback online from teachers. Automated assessment computer provides immediate feedback to learners that supports better academic performance and improved learning. Frequent feedback should be provided while using test material from the computer because this will increase motivation and improve performance of the learners in the same test material online. Given the fact that ICT based assessment provides the opportunity for both teacher and learners to get quick feedback of strengths and weaknesses of teaching and learning.

2.7.2.5 Enhanced instructional delivery

The impact of ICT on teaching and learning process has become pertinent as it facilitates the teaching and learning process, creates a conducive learning environment, and helps learners develop creative thinking and self-confidence (Bindu, 2016). ICT helps teachers to motivate learners and develop interest while learning. ICT has the potential for wider accessibility to educational resources. Furthermore, it enhances flexibility, so that, learners can have access to different learning materials irrespective of time or geographical limitations. ICT can also have an impact on the way learners are taught in the classroom and the way they learn. Moreover, ICT helps

to motivate learners by creating a rich learning environment by providing new opportunities for both teachers and students. These opportunities can have a significant influence on students' academic performance and educational achievement.

ICT usage in learning has many opportunities in teaching Physical Sciences, including saving more time and expenses, adoption of more technologies for learning, learning new skills and availability of learning materials online all the time while studying/teaching. Opportunities for ICT in teaching and learning enhance the abilities and competencies of learners and educators and also facilitate the learning process (Al Ansi & Al-Ansi, 2020).

2.9 CONCLUSION

Information Communication and Technology play significant roles in different aspects of life. Through the application of ICT tools in teaching Physical Sciences subject, learners can comprehend and understand complex Physical Sciences concepts. This can also improve academic performance, particularly in significant subjects such as Physical Sciences. Despite the significant impact of ICT in teaching Physical Sciences, there are challenges that need a multidisciplinary approach to create a conducive environment for teaching and learning.

The next chapter discussed the research methodology. The details of how participants of this research study were selected were presented in detail. It further discusses the data collection techniques and the ethical issues involved in the research study that involves human participation.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodological approach that was used to carry out this study. Chashi (2022) looked at methodology as the scheme plan that is used to generate the needed responses to research questions. The chapter further includes a description of the research design, the targeted population from where the sample size was drawn as well as the sampling procedures and research instruments. The research methodology serves as a guide that directs the researcher towards reaching the intended goals or arriving at the expected conclusions. In addition, this chapter describes the data collection procedures which were employed and how the data collected were analysed in order to answer the research questions. The research technique also provides the basis for defining the ethical considerations that the researcher followed in order to make sure the research is ethically sound.

3.2 RESEARCH DESIGN

Research design has been defined as a master plan that describes the research methods and procedures for gathering and analysing the necessary information (Ratchel, 2017). Pandey and Pandey (2021) define research design as a blueprint for gathering, measuring, and analysing data. A research design is defined as the "set up to decide on, among other issues, how to collect further data, analyse and interpret them, and finally, to provide an answer to the question" (Rezigalla, 2020). Research design is characterised by exploring all factors contributing to the problem that is being investigated data(Creswell, 2013). According to Turhan (2019), there are three types of research designs. They are explained below.

3.2.1 Phenomelogical research design

Turhan (2019) asserts that Phenomelogical design aims to examinethe presence of a specific phenomenon through the data collected. He further stated that "Phenomenology is a type of research that focuses on phenomena that we aware of

in our daily lives but do not have detailed information about". The purpose of phenomelogical study design is to investigate the significance of lived events and how people interpret them. It aims to comprehend people's viewpoints, feelings, and actions in certain contexts. According to Turhan (2019), the statements used as data in phenomenology research are not "new information"; however, they might be important and informative data for scientific research in order to come up with effective solutions. Without making any assumptions or forcing any previous notions on their subjects, the primary goal of this design is to unearth the essence of the human experience. Interviews are the main method of gathering data in phenomenology because the discipline seeks to explain phenomena via the perspectives of those who experienced them.

3.2.2 Grounded Theory research design

Grounded theory discover a new theory by analyzing the available data. The key point in this design is to discover embedded categories with the help of data so that they can be meaningful, and it is possible to form theories that explain study-specific behaviors (Turhan, 2019). It helps to explain social situations or processes through data. Grounded theory ivolves many alternative data collection methods like participant observation, interview and literature review.

3.2.3 Ethnographic research design

Ethnography is appropriate when the goal is to describe how a cultural group works or explore shared lived experiences of the group (Creswell & Poth, 2018). Ethnography relies heavily on researcher observational skills, which may include participant observation (Glesne, 2016). Studying a group of people's culture, which includes their social interaction, behavior, beliefs, language, and thought processes, is the main goal of ethnography. Ethnography is appropriate when the goal is to describe how a cultural group works or explore shared lived experiences of the group (Creswell & Poth, 2018).

3.2.4 Case study Design

Case studies investigate a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident (Yin, 2017). Moreover, case studies address the full complexity of

a research problem by incorporating multiple sources and types of evidence (Yin, 2017). A case study can be an independent research effort that looks at a specific program, community, or organization.

This study was guided by an Phenomenology research design. Phenomenology asks questions about life experiences. It aims to define a specific phenomenon rather than making generalizations. Determining and analyzing a phenomenon's existence as well as explaining experiences and the meanings attached to them are the goals of phenomenological inquiry. This study aimed to explore teacher's constraints and opportunities of using ICT to effectively teach Physical Sciences in the Sekhukhune East district. The researcher interviewed the participants and observed their daily interactions in the classroom during Physical Sciences class. The researcher used Phenomelology design to ensure that the collected data to answer the initial research questions as clearly as possible without generalising phenomena and it helped the researcher to understand participant's life experiences.

The study explored the constraints and opportunities of using information and communication technology to support teaching and learning of Physical Sciences in Sekhukhune East District. The primary objective of a research design is to ensure that the collected data allow the researcher to answer the initial questions as clearly as possible.

Chashi (2022) further asserts that qualitative research is a means of exploring and understanding the individual or group attributed to a social human problem. This means that an individual or a group such as a school becomes the centre point of the study. Ndhlovu (2012) states that qualitative research is a system of collecting, analysing and interpreting the given data to enhance the description and accounts of social events and objectives of research while upholding the natural environment. It is important to note that this study did not impact the participants' natural surroundings, instead, the researchers conducted the study in its original state and then reported the results.

3.3 RESEARCH APPROACH

According to Mohajan (2020), research approach is a procedure that gives the direstion of conducting research efficiently. According to Flick, (2018)there are three types of research approaches namely qualitative, quantitative and mied methods. These are explained below.

3.3.1 Qualitative research approach

Chashi (2022) asserts that qualitative research is a means of exploring and understanding the individual or group attributed to a social human problem. This means that an individual or a group such as a school becomes the centre point of the study. Ndhlovu (2012) states that qualitative research is a system of collecting, analysing and interpreting the given data to enhance the description and accounts of social events and objectives of research while upholding the natural environment. It is important to note that this study did not impact the participants' natural surroundings, instead, the researchers conducted the study in its original state and then reported the results.

Qualitative research draws from interpretivist and constructivist paradigms, seeking to deeply understand a research subject rather than predict outcomes, as in the positivist paradigm (Denzin & Lincoln, 2011). Interpretivism seeks to build knowledge from understanding individuals' unique viewpoints and the meaning attached to those viewpoints (Creswell & Poth, 2018).

3.3.2 Quantitative research approach

Flick (2018) asserts that the data collected through quantitative research approach depend on the experience of the researchers involved in the research process. Mixed-methods designs are only comparisons possible in this approach to research if the statistical data are required (Schoonenboom & Johnson, 2017).

3.3.3 Mixed methods approach

Clark & Ivankova (2015) argue that a mixed-methods research design is a process of research in which researchers integrate quantitative and qualitative methods of data collection and analysis to best understand research purpose. It uses philosophical presumptions as a methodology to give instructions for gathering and analyzing data from several sources in a single study. A mixed-methods design offers a number of

benefits to approaching complex research issues as it integrates philosophical frameworks of both post-positivism and interpretivism (Fetters, 2016)

The study was guided by a qualitative research approach. The researcher opted for a qualitative research approach as she believed it provided a solid basis for a deep understanding of the phenomenon. Furthermore, the researcher opted to use qualitative research approach as it addresses the " how" and " why" research questions and enables deeper understanding of experiences of teachers and learners in using ICT in Physical Sciences classroom effectively. This reseach approach is relevant for this study as it allowed the researcher to ask questions that cannot easily put into numbers to understand human experience. The qualitative research approach involves gathering that through the analysis of documents, observing behaviour, and conducting interviews with participants (Creswell, 2013). Moreover, Hammarberg, Kirkman and de Lacey (2016), emphasise the importance of incorporating a qualitative research method when exploring subjects that involve the perspectives, context, and viewpoints of participants. The researcher adopted qualitative research approach because she wanted to collect non-numerical data and use non-statistical software to analyse the collected data.

3.4 JUSTIFICATION OF QUALITATIVE APPROACH

The study utilises a qualitative study approach, which allows the researcher to gain a deeper understanding of the problem at hand (Hammarberg et al., 2016). Sampson and Johannessen (2020) indicated that qualitative research approach provides a basis so that people can have an in-depth understanding of the problem.

3.5 STUDY SETTING

A study setting refers to a place where the study will be conducted (Creswell, 2013). The study was conducted in Sekhukhune East District. Sekhukhune East District is amongst the rural districts of Limpopo Province. The district is characterised by subsistence farming and mining companies. The majority of the people in the district depend on social grants for survival. Most schools in the district are Quintile One. Quintile One schools are the poor schools where no school fee is paid, no adequate

infrastructure, no maintenance of school property, no financial resources and sometimes not enough human resources and is dominated by public teachers.

3.6 TARGET POPULATION

The target population refers to a specific group of individuals who have similar characteristics like location and values. It is the group from which samples are selected for research purposes. It is important to ensure that all members or groups expected to be part of the study are included in the target population. The population of the study consisted of selected school principals, teachers and learners of Physical Sciences in Sekhukhune East District. The senior education specialists (curriculum advisors) of Mathematics and Sciences departments were also targeted.

3.7 SAMPLING

The process of choosing a subset of the population to represent the complete population is known as sampling (Creswell, 2013). Sampling is the act, procedure, or method of choosing a representative sample or portion of a population in order to ascertain the parameters or features of the entire population. According to Etikan, Musa and Alkassim (2016), sampling is the statistical process of choosing a subset of an interest population in order to observe and draw conclusions about that population. A sampling technique, according to Kasonde (2013), is a research plan that specifies how study participants will be chosen from the general population. It is also a procedure that will aid in the researcher's choice of subjects, locations, or other study subjects.

The study adopted a nonprobability purposive sampling method to select a certain portion of the population to form part of the study. Nonprobability sampling procedures are those in which the probability of selection cannot be precisely determined or in which some units of the population have no chance of being selected. The hallmark of purposeful sampling is the meticulous selection of subjects the researcher wants to include in the sample according to the criteria (Creswell, 2013). A simple random sampling method was used to select the four learners, with the belief

that they could provide valuable insights into the challenges and opportunities of using ICT resources in learning Physical Sciences.

The target population's features were closely examined by the researcher, who then identified the traits that mattered most. A predetermined list of characteristics was used by the researcher to deliberately choose the participants she wanted to include in the sample. Purposive sampling is used to ensure that the participants chosen for the study align with the specific characteristics of the target population (Creswell 2013). In this particular research project, the researcher utilised purposive sampling to select professional teachers specialising in teaching Physical Sciences. This method was deemed appropriate for the study.

3.8 SAMPLE SIZE

The researcher selected a total of 10 participants, including four teachers, four learners, two principals A simple random sampling method was used to select the four learners, with the belief that they could provide valuable insights into the challenges and opportunities of using ICT resources in learning Physical Sciences. Nonetheless, it is important to carefully and thoughtfully choose this smaller group to ensure that it is a representative sample of the entire population with similar characteristics. Each individual in the sample is commonly referred to as a respondent or participant.

There were a total of 10 participants in the study in the study, including 4 teachers (2 from each secondary school), 2 school principals (one from each secondary school), 4 learners (two from each school). The small sample size was chosen because the research was qualitative rather than quantitative. The breakdown of the study sample is shown in the table.

Table 3.1: Sampled Participants

Position of Participants	Total Number of Participants
School principals	2
Teachers of Physical Sciences	4
Learners	4
TOTAL	10

3.9 RESEARCH INSTRUMENTS

3.9.1 Interview Guide

An interview guide is a document that outlines the questions and subjects that will be discussed during the interview (Jordan, Clarke & Coates, 2021). In this study, interviews were carried out using a semi-structured guide. This type of interview guide provides clear directions to interviewers and can help produce reliable qualitative data (Jordan et al., 2021). Van Schalkwyk and Dewinter (2020) suggest that using semi-structured interviews in conjunction with formal interviewing, observation, and structured interviewing can give researchers a comprehensive understanding of the subject for generalising relevant and insightful quasi-questions. The researcher was able to gather information and opinions from participants about specific events or questions.

The interview guide was developed, and probing questions were asked to seek clarity on issues that were raised during interview sessions. The interview guides comprised two sections. Section A had biographical information about the participants while Section B had interview questions which probed the constraints experienced by different categories of participants, see Appendices C, D, E and F. The reasons which prevent the effective use of ICT resources in teaching Physical Sciences were also probed. In addition, the opportunities and benefits of learning and teaching Physical

Sciences using ICT resources were also asked. The participants were also asked to share their experiences of using ICT tools to enhance teaching and learning. Furthermore, an observation sheet was developed which tapped on the availability of ICT resources and the ability of teachers to use ICT tools in the classrooms.

3.9.2 Observation Sheet

An observations tool was developed. Observation, as described by Kabir (2016), is crucial for researchers to understand their environment. However, it is more than just watching and listening. Data is collected by directly observing events, behaviours, interactions, and processes to grasp various (Taherdoost, 2021). The main focus of these observations was on the learners' participation in learning activities and their ability to consistently engage in self-study. The main focus of these observations was to explore the experience of teachers and learners when using ICT resources to enhance and participate in the teaching and learning activities of Physical Sciences.

An observation form was created and utilised to evaluate the presence of ICT resources in the Physical Sciences classroom and computer labs, the ease of access to these resources for both teachers and learners, how often teachers utilise ICT resources during lessons, and to verify internet connectivity.

3.10 DATA COLLECTION

Data collection is an important aspect of research, serving as a crucial step to ensure the quality of results by minimising errors that may arise during the project. Therefore, along with a well-designed study, it is essential to dedicate sufficient time to gathering data in order to obtain accurate findings. Using semi-structured interview guide was a method chosen for data collection in this study (Kabir, 2016).

It is important to note that conducting thorough interviews can provide valuable insights and allow the researcher to uncover the true narrative from individuals who have a deep understanding of the issue, such as the participants (Aupers, Schaap & De Wildt, 2017). This suggests that the basis for in-depth knowledge is provided by in-depth interviews. In addition, through an in-depth interview and on a one-on-one

basis, participants are more inclined to open up hence providing the premise for disclosure (Aupers et al., 2017). Interviewers with experience can react to enquiries and probe for further information hence enabling the collection of quality data and if necessary, questions can be added or changed in real time (Aupers et al., 2017).

Additionally, data can be collected in a short period because in-depth interviews typically allow for faster collection of data than other research methods (Wollum, Makleff & Baum, 2021). It is important to understand that this method of collecting data has some drawbacks. For example, analysis can be challenging and time-consuming, which can lead to qualitative data being confusing and complicating interpretation, especially for new analysts (Wollum et al., 2021). According to Chakuzira and Kadyamatimba (2020), there are specific procedures that must be followed while conducting in-depth interviews, including creating a sample strategy, creating an interview guide, and performing the interviews.

To allow each participant the freedom to choose whether or not to participate in the study, the researcher fully disclosed all study-related facts to them. Prior to the interview, participants who agreed to participate in the study were asked to provide verbal or written agreement. The study's participants were made aware that their participation was entirely voluntary and that there would be no repercussions if they chose to end it.

Participants were informed by the researcher that the information they provided would only be shared with those immediately involved in the study and that their personal information would not be utilised when reporting. Permission to record the interviews was sought from the participants. The interviews were recorded using an audio cassette recorder. It took five to ten minutes for the interview to ensure that all questions about clarity were addressed.

The settings for the in-depth interviews were chosen to ensure participant comfort. To help the participants feel more at ease, the researcher established a strong connection with the respondent. To collect data from participants who were willing to engage in the study, appointments were set up at times that worked for them. The investigator conducted in-person interviews and participant observations. The learners, the head

of the Mathematics and Science department, and the chosen Physical Sciences teacher were visited in their various offices and schools. Using an interview schedule, in-person interviews were subsequently held with each of the chosen participants.

3.11 DATA ANALYSIS

A digital voice recorder was used to record the in-depth interviews. The content on the tapes was attentively and frequently listened to, then verbatim transcribed. After identifying the similarities and differences, similar data were organised into themes and sub-themes. The transcripts were provided to an independent coder for independent data analysis in order to identify themes and subthemes before the data analysis was finished. The researcher discussed the themes and subthemes they had developed in order to come to a consensus. The findings were evaluated after the themes and subthemes had been coded. Data collected was analysed using qualitative methods. Content analysis methods were applied to the examination of qualitative data. Information was categorised using a content analysis method. In light of the study's findings, pertinent recommendations and conclusions were drawn. Tables and pictures were among the numerous methods used to display the data.

3.12 TRUSTWORTHINESS OF THE STUDY

This research ensured trustworthiness by incorporating four key elements: credibility, confirmability, transferability, and dependability. The study delved into each element in depth and demonstrated how they were implemented throughout the research.

3.12.1 Credibility

Credibility is the condition of ensuring that the data is being gathered from the appropriate sources who are knowledgeable about the topic being studied; methods for establishing credibility include extended interaction with the participants, steadfast observation, and member checks (Creswell, 2013). Credibility in research is crucial as it determines whether the findings accurately reflect the participants' original data and interpretations. By using the right sampling technique to find and choose individuals who match the inclusion requirements, credibility was ensured. This

includes deciding on the best technique for gathering and analysing data. As a result, themes were categorised, and extraneous themes awee removed before being presented to participants to see if their opinions were accurately and effectively portrayed.

3.12.2 Confirmability

Kyngäs, Kääriäinen and Elo (2020) explain that confirmability refers to how impartial a study's findings are, showing the perspectives and experiences of the participants rather than being influenced by the researchers' biases, motivations, or personal interests. Anney (2014) explains that confirmability is the extent to which other researchers can verify or support the results of a study. Confirmability focuses on ensuring that the data and conclusions are grounded in the data rather than the researcher's biases or assumptions (Tobin & Begley, 2004; Anney, 2014). The researcher ensured confirmability by transcribing information recorded during the data collection process without alterations. The researcher also performed an extensive examination of the literature to compare, pinpoint parallels and differences, and confirm whether the findings were corroborated by the literature. In order to guarantee that the data being presented was an accurate representation of the collected information, an audio recording device was used.

3.12.3 Transferability

According to Ghafouri and Ofoghi (2016), transferability suggests that the results of the current study will be applicable to similar situations in the future, ensuring the findings are relevant and can be utilised beyond the immediate research context. Transferability in qualitative research means how well the findings can be applied to different situations or groups beyond the original study participants, similar to the idea of generalisability. In this study, the researcher thoroughly described how the research was conducted, including the methodology, design, setting, target population, criteria for inclusion, method of sampling, and procedures. In order to ensure that other researchers can replicate and validate the study's findings in the future, a detailed description of the research method was provided (Creswell, 2013).

3.12.4 Dependability

According to Cohen, Manion and Morrison (2011) and Anney (2014), dependability refers to how participants assess and confirm that the study's results, analysis, and suggestions are all backed up by the information provided by the study's participants. The thesis was sent to external examiners and experts for assessment of the limitations and potential benefits of utilising Information and Communication Technology in aiding the teaching and learning of Physical Sciences.

3.13 ETHICAL CONSIDERATIONS

Research ethics are established guidelines that dictate how research should be carried out. They are in place to safeguard the rights of both the participants and the researcher. The study strictly followed the ethical principles without any deviation. from start to finish.

3.13.1 University Protocols to Ensure Ethical Principles

The School of Education in the Faculty of Humanities, Social Sciences, and Education received the research proposal. The Higher Degree Committee reviewed and approved the proposal before it was submitted to the University Higher Degree Committee for final approval. The Univen Research Ethics Committee office granted approval for the study to proceed, followed by obtaining a research permit from the Limpopo Provincial Department of Education. The principals and teachers in selected schools were then contacted to request their participation in conducting a research study.

3.13.2 Permission to Conduct the Research

The University Higher Degrees Commitee ensures ethical considerations are taken into account and safeguards participants from potential harm. As a consequence, the researcher submitted a request for ethical approval to the University's Research Ethics Committee and Ethical clearance certificate was granted with ethical clearance number FHSSE/23/CSEM/01/2606. Next, the researcher requested approval from

the Limpopo Provincial Department of Education to conduct the study at the school premises. Following that, the researcher also obtained authorisation from the Department of Education in Sekhukhune East District and sought permission from the appropriate circuit managers and school principals.

3.13.3 Informed Consent

According to Manti and Licari (2018), obtaining informed consent involves educating prospective research participants about the main features of the study and the obligations that accompany their involvement. Participants in the recruitment phase were briefed about the purpose, importance, and methodology of the study, including the data collection technique. The study participants were informed of the potential risks associated with their participation. In addition, participants were made aware that they might stop taking part in the study at any time and that they would noit be asked to provide a justification for doing so. The learners brought the consent forms to their parents so that the parents could give permission for their children to take part in the research interviews. The form provided parents with detailed information about the study and requested their children's involvement. A written participant's consent document was provided for individuals capable of reading to aid in making informed choices before providing consent. Participants who wished to participate in the study were asked to provide their consent either verbally or by signing the consent.

3.13.4 Confidentiality

Confidentiality is when a researcher knows the identity of a research subject but makes sure to protect that person's identity from being uncovered by others (Wiles, Crow & Charles, 2008). Data collected during the study were shared only with individuals directly involved in the research, and the records were securely stored to prevent unauthorised access. Data and information gathered during the study were shared with actively participating in the research. Documentation collected during the data collection phase was securely stored, ensuring that only authorised personnel had access to it. Each participant in the study ensured the confidentiality of their identity in order to feel comfortable and be able to provide honest answers to all enquiries. Only individuals who were directly part of the study could access the

documents, recordings, or transcripts of interviews, as well as any confidential communication with the instructors.

3.13.5 Anonymity

Kruger (2003) indicates that anonymity requires that no one, not even the researcher, should be able to identify any of the subjects after the study has been completed. The researcher assigned codes to participants instead of using their real names such as Learner A (LA), Learner B 'LB' and so on. The codes were used to promote anonymity and confidentiality.

3.14 CONCLUSION

In this chapter, the study's methodology was detailed, covering the procedures for collecting, organising, and analysing data. The methodology section covered various factors such as research design, target population, sample size, sampling techniques, research instruments, data quality assurance, data collection procedure, data analysis, and ethical considerations. After discussing the sections mentioned earlier, the next chapter will reveal the study's findings from the two secondary schools that were included in the sample and further analysis.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This chapter gives a presentation of the data collected during the research. The study targeted four categories of participants, namely; members of the school management team, Physical Sciences teachers, learners and curriculum advisors. An interview schedule was administered to collect data from the sampled schools. The biographical data were presented in statical forms. The purpose of this study was to investigate the constraints and opportunities of using ICT to support the teaching and learning of Physical Sciences in Sekhukhune East District, Limpopo Province. An interview guide and an observation checklist were used in data collection. The study aimed at answering the following questions:

- To what extent do the constraints experienced by teachers prevent the effective use of ICT resources in teaching Physical Sciences?
- To what extent does the use of ICT resources support learners' academic performance in Physical Sciences?
- Which opportunities/benefits are teachers and learners exposed to when teaching and learning Physical Sciences using ICT resources?
- What are the experiences of teachers and learners who use ICT tools to enhance teaching and learning in the teaching of Physical Sciences subject?

4.2 DEMOGRAPHIC INFORMATION ABOUT THE RESPONDENTS

To give the study findings presented in this chapter a logical context, this part provides a demographic description of the respondents. The study had four main participant groups: curriculum advisors, teachers, learners, and SMT members. The demographic data of the participants is displayed based on their gender, educational background, and work experience.

4.2.1 Gender of Participants

Table 4.1 below presents the gender information of the participants. A total of 10 participants participated in the study out of whom 7(54%) were males while 6(46%) were females. Their distribution was as shown in the table below:

Table 4.1: Distribution of Participants by Gender

Gender	Frequency	Percentage
Male	6	60%
Female	4	40%

4.2.2 Categories of Participants

Table 4.2 below shows that out of all the school principals which took part in the study, 2(50%) were all females . A vast majority of the teachers who were interviewed were male, that is 3(75%) compared to 1(25%) of their females. Of the majority of the learners who were interviewed, 3(38%) were male compared to 6(62%) of their female counterparts.

Table 4.2: Categories of Respondents/Participants

Categories	Frequency	Percentage
Principals	2	20
Teachers	4	40
Learners	4	40

Two public secondary schools participated in the study. The schools were coded SA and SB. Two learners was interviewed from each school. The learners were coded LA, LB, LC and LD. The principals of the two schools were interviewed and coded PRA and PRB for school A and school B respectively. Four teachers of the two

schools were interviewed and coded TA and TB for school A and TC and TD for school B respectively.

4.3 CONSTRAINTS AFFECTING THE USE OF ICT RESOURCES IN PHYSICAL SCIENCES CLASS

The researcher was interested in exploring constraints to effective use of ICT resources in teaching Physical Sciences. The study is a framework of how ICT tools can be vital tools that will assist them in their teaching, and interaction between teachers and learners and provide learners with meaningful feedback and excellent teaching and learning experiences to sharpen their technological skills in order to prepare them for the 4IR. Below is an analysis of data from participants' interviews.

4.3.1 Theme 1: Challenges Affecting Teachers on the Use of ICT

When asked to state the challenges that teachers faced in the teaching and learning of Physical Sciences when using ICT in schools, teachers had their unique views. Although they appreciated the benefits of ICT usage in schools, teachers also identified a number of challenges as highlighted in this study.

4.3.1.1 Lack of enough ICT materials

This study revealed that the main problems affecting schools to effectively use ICT resources in teaching and learning include the high cost of purchasing and installing the computer equipment, operating, limited access to the internet, inadequate electricity supply, computer maintenance and a lack of technical support to teachers and learners. According to Ghavifekr and Rosdy (2015), one of the most significant challenges that schools, particularly those in rural areas, are currently confronted with is a scarcity of appropriate Information and Communication Technology equipment as well as internet connectivity.

ICT tools for teaching and learning involve digital infrastructure such as printers, computers, laptops, tablets and software tools such as Google Meet, Google Spreadsheet, Google Classroom and many more.

To support this statement, TA remarked the following:

> *The unavailability of ICT resources in the school is a serious problem. ICT tools such as projectors, internet connectivity, software, smartboards and computers are not available. These are hindrances towards teachers using ICT to achieve teaching objectives as it is not easy.*

Syomwene (2017) points out that some of the hurdles that can hinder the successful incorporation of technology in the instructional process include a lack of electricity, an unstable internet connection, and outdated or non-existent technological resources. The study revealed that schools are facing difficulties in implementing the use of information and communication technology. ICT challenges include an inadequate number of projectors, computers, laptops, internet services for learners, internet connection and functional computer laboratories. The schools are experiencing financial challenges where it is difficult to maintain available ICT tools and a computer laboratory. A high rate of theft was also discovered to be a barrier to the effective use of ICT resources in teaching and learning of Physical Sciences.

This was indicated by the response of PRB from school B who stated that:

> *Teachers are facing an inadequate number of projectors for use and the laptops are limited for teachers and learners. We once got tablets donations but later lost them due to burglary as they were stolen. Internet connectivity is not accessible. This is caused mostly by the fact that the school is on the mountainside. The school cannot easily connect to the internet, and this affects both teachers and learners as they are unable to access useful teaching material online.*

Eligi and Mwantimwa (2017) observe that a lack of specialised information and communications technology facilities "translates into spending a lot of time on learning activities and therefore prevents effective access to a larger range of educational materials". The study further revealed that the available ICT resources are not enough. ICT implementation in schools is challenging because there are not enough useful tools to support teachers in delivering meaningful lessons.

To support this statement, PRB further was quoted saying that*:*

> *As the school, we only have two laptops used by the principal and the school administrator. We have one projector, so it becomes*

> *difficult if there are a number of educators who want to use it all at the same time as periods are running concurrently.*

Information and Communication Technology challenges include a lack of training to use technological devices, a lack of technological devices, a lack of competent in ICT resources and a few teachers who are well equipped to use technological systems in the educational sector (Tay, Lim & Lim, 2015). Information and Communication Technology usage constraints make it difficult for learners to take notes or write down everything as the teacher is teaching. This means learners will miss much during the unlike when ICT tools are used. ICT resources enable teachers to display slides detailing all the information so the learners can capture full information which will not be easier for them to forget. Based on the transcript of the interview with a school manager of school A, the study found that since ICT materials are unavailable in Physical Sciences class, sometimes teachers expose learners to the learning centre (computer laboratory) available in school.

PRA from school A added that:

> *We expose learners to the Learning Centre (computer laboratory) so that they can be able to access more information whenever they need it. The Learning Cenre is always available for both teachers and learners because there is an unlimited internet connection.*

Information Communication and Technology play a significant role in improving academic performance, as such, there are various challenges affecting the smooth implementation of Information Communication Technology in the educational sector in the country. These challenges include a poor network connectivity, a lack of learner equipment, teachers reluctant to use new technology and a lack of appropriate skills and knowledge on how to provide educational lessons through ICT systems (Dardary, Tridane & Belaaouad, 2018). Based on the challenges that affect the implementation and usage of ICT resources to teach Physical Sciences, it was revealed that schools make use of other alternative methods to ensure teaching and learning is not affected.

PRB mentioned that:

> *The school is under-resourced, and we sometimes ask for the assistance of projectors from neighbouring schools. In Physical Sciences, some experiments need chemicals to be completed. Since we have a budget constraint and are expensive, teachers make use*

> *of YouTube where they play videos so learners can see when these experiments are performed*.

Technology has greatly progressed in recent years, powering devices such as drones, virtual assistants and self-driving cars (Schwab, 2016). Based on these findings, it is evident that we live in 4IR and teaching and learning. The 4th Industrial Revolution brings the ability of allowing learners to close the gap that they experience when it comes to vast amounts of information access. Learners must be well advanced in terms of moving with the changing world. They need to also be prepared possibly in the future for when they reach institutions of higher learning.

To support this statement, PRB:

> *Our learners are not yet skilled to use ICT resources when learning Physical Sciences. We are unable to equip them with ICT skills as we have a limited number of resources. This becomes more challenging as it affects learners' academic performance negatively, hence our Physical Sciences results are poor.*

The availability, accessibility, and utilisation of ICT resources in secondary schools for the teaching and learning of Physical Sciences were found to be extremely low. This study looked at the availability of ICT resources in sampled secondary schools in Sekhukhune East schools, Limpopo, South Africa. In support of these assertions, Nisar and Munir (2012) assert that the use and accessibility of information and communication technologies (ICT) are critical to enhancing students' educational efficacy because these tools are now a necessary part of life for postsecondary students (Aguilar, 2012; Floreto & Quinito, 2019).

The majority of respondents stated that the schools under investigation did not have access to ICT resources. Teachers and students only use ICT resources for teaching and learning if they are made available in the schools (Onwuagboke, Singh, & Onwuagboke, 2014).

The study findings showed that most of the ICT resources required for teaching Physical Sciences in both sampled schools were unavailable in schools and those that were available were inadequate. The study also revealed that the available ICT resources were utilised to a very low extent by Physical Sciences teachers and

learners. The study also found that low power supplies, a lack of resources, a fear of technology, a lack of interest, a lack of ICT skills, higher ICT costs, and inadequate physical infrastructure were among the barriers to ICT usage in the sampled schools (Mavellas, Wellington & Samuel, 2015).

4.3.1.2 Lack of technical support and maintenance

According to Buabeng-Andoh (2012), when a computer breaks down, there are disruptions. If technical support is unavailable, it is possible that routine computer repairs will not get done, which will prevent teachers from using computers in the classroom. Instructors may be dissuaded from utilising ICT resources because of concern that their equipment may malfunction and that they will have no one to turn to for technical assistance should an issue arise. Additionally, Yilmatz (2011) noted that in addition to hardware and internet connections, it is critical to offer technical help to schools with upkeep and repairs to ensure that ICT is used in the classroom.

The study findings show that most teachers are not making use of technology for teaching and learning Physical Sciences. The majority of science teachers in South Africa lack the computer literacy needed to use Information Communication Technology. Computers and other equipment dependent on computers are not only costly, but they are also prone to crashing if they are inadequately maintained (Alkahtani, 2017). All the participants from school B were not using any form of communication with learners through technology. Government schools are still behind ; they rely on the old ways of teaching that do not involve the use of technology, especially schools in an environment where the is a deep lack of network connectivity in all forms. The study revealed that it is very difficult for the teachers to communicate with their learners using emails, and social media and very difficult for the learners to access learning material online to improve their understanding of the Physical Sciences subject.

4.3.1.3 Accessibility and Inclusivity

ICT integration in education requires that students have access to ICT resources and infrastructure in their schools (Buabeng-Andoh, 2012). In addition to having access to hardware and software, it is critical to use the right tools and programmes to enhance teaching and learning. The availability and accessibility of ICT resources, such as software and hardware, are critical to the successful deployment and integration of ICT into teaching in schools. It goes without saying that educators and students cannot use ICT resources for teaching and learning activities if they are not able to access them.

To support this statement, TB made the following remarks:

> *There are no computers to assist learners when doing research. Learners cannot access some study material. Since the resources are not available for me as a teacher, it affects them as well.*

The affordances and restrictions of technological tools must be carefully evaluated when incorporating them into lessons when there is access to appropriate technology (Chen, 2010). Despite finding it challenging to use, this response demonstrates that teachers are aware of the benefits of integrating technology into the classroom. As long as there is network access, the availability of technology resources will allow them to conduct courses whenever and wherever they choose. Learners will be able to access information anywhere anytime although the majority of them highlighted that this is very challenging. They pointed out that they are unable to use applications such as Microsoft PowerPoint to prepare slides and use the projector to conduct their lessons.

TB further commented that:

> *We still have teachers who always ask for help in terms of connecting the computer to the internet, connecting the projector to the computer, and preparing slides, which consumes too much time.*

4.3.1.4 Lack of technical expertise

Technical expertise refers to ICT familiarity, usage proficiency, and overall ICT pedagogical skills. According to Lomos et al. (2023), the Four in Balance Model of expertise suggests that instructors' acquaintance with ICT, their proficiency with its usage, and their general pedagogical ICT skills are crucial for its pedagogical

application. For their intent and actual behaviour with ICT to increase, teachers must possess a personal technical understanding of the technology and be hands-on in the classroom (Kim et al., 2021). Some students are unaware of the potential effects that technology can have on their education, and teachers are also unaware of these effects since they lack the technological know-how. Asemhe and Ogbeide (2019) assert that the successful integration of ICT in the school system depends largely on the availability and competence and the attitude of teachers towards the role of modern technologies in teaching and learning.

The study revealed that teacher pieces of training on how to use ICT resources effectively to support the teaching and learning of Physical Sciences is needed. Moreover, learners must be also trained to adopt to ICT approach from early grades. This training will also help educators who are unable to use ICT tools and expose more ways to make teaching and learning more interesting.

In light of this statement, TB teacher from school B states that:

> *It would be much better to give educators the skills and knowledge on how we can take advantage of online teaching to successfully deliver content. If laptops can be provided, we will be able to project something on the smartboard so learners are able to take notes.*

More computer-savvy educators are more assured of their capacity to use them successfully. Research indicates that the majority of educators who expressed disapproval towards the use of ICT in the classroom lacked the information and abilities necessary to make wise decisions (Bordbar, 2010). Teachers cannot use ICT resources due to a lack of knowledge, especially the older generation. There are no skills training workshops for older teachers to teach them how to best utilise ICT resources.

This study revealed that ICT tools such as projectors, internet connectivity, software, smartboards and computers were unavailable in school B. These are hindrances to teachers using ICT to achieve teaching objectives. It is also difficult for educators to do preparations thoroughly because of the limited information provided by textbooks used. Lesson preparations are done manually which is time consuming also. Learners find adoption of the ICT approach challenging since most subjects use a

teaching approach where not much ICT learning is taking place. Learners will not be able to investigate the contents of the subject.

To support these remarks, TB added that:

> *Learners have limited information from the textbooks. The information they get from us teachers is limited as we rely most on textbooks. The textbooks are not updated compared to the Internet where new information and updated books are posted on a daily basis.*

4.2.2. Theme 2: Challenges Learners Encounter when Using ICT Resources

Even though the use of technology to create a favourable atmosphere for teaching and learning is important, there are a number of obstacles that have a negative impact on educational results. It is indisputable that learners are better able to comprehend and grasp difficult subjects in Physical Sciences when they use technology in the classroom. When asked if there were difficulties in teaching and learning Physical Sciences in schools using ICT resources, students gave varying answers.

To encourage learner-centred technology learning, it is necessary that learners have access to quality technological resources. For instructors to use ICT, there must be an ICT infrastructure comprising computers, whiteboards, and a working internet connection (Lomos et al., 2023). According to Das (2019), ICT improves education by making it more accessible to all students. It does this by enabling distance learning, which brings education to the doorsteps of children living in remote rural areas, and it enhances the learning process by making more interactive educational materials available, which boosts student motivation and makes it easier for students to pick up basic skills. Abdullahi (2023) found that teachers' usage of ICTs is hampered when certain ICT components are unavailable in schools.

On the question of challenges that learners encounter when using ICT resources when learning Physical Sciences, TA stated that:

> *Challenges that learners encounter when using technological resources include limited access to information from them as a result*

> *of shortages of these resources. The biggest problem is availability in Physical Sciences classroom.*

The above findings reveal that learners experience difficulties when using ICT resources to access study materials just like teachers are also struggling to implement the use of ICT. Although in some schools, ICT resources are available, in some instances, resources are unavailable in Physical Sciences classrooms and this consequently affects learners' academic performance and technical knowledge. Although there are challenges affecting the implementation of Information Communication Technology in the educational sector, Information Communication Technology improved the effectiveness of the teaching process (Lawrence & Usman, 2018). ICT knowledge and skills help teachers motivate learners grow interest in learning. It helps teachers to communicate properly with their learners, parents and other stakeholders. Teachers need to be trained in how to utilise ICT tools. This will help them to be exposed to different software that can help them deliver content in a more meaningful way.

PRA was quoted saying that:

> *I believe this is the time for the Department of Education to organise workshops for educators. The training workshops will help teachers get skills and knowledge to utilise the tools in the classrooms and outside the learning environment.*

In order to effectively use technology in the classroom, teachers must possess a variety of pedagogical skills, including the ability to use technology in productive ways to teach content and understand how technology can be used to expand on prior knowledge and create new epistemologies (Yalley, 2022; Sharima et al., 2017). Incorporating technology into teaching calls for more than just incorporating it into the classroom. Opportunities for teaching and learning Science and Mathematics are hampered by a lack of resources. This includes human resources, physical resources and technological resources (Yalley, 2022). The computer lab assistant provides technical assistance by helping install and use software programmes, printing documents and assisting with hardware issues. Learners are unable to utilise ICT resources; they find it difficult to understand while using them.

PRA emphasised that:

> *We should have an ICT lab assistant to help learners who experience challenges; they can be assisted so that they can be able to use these ICT resources on their own. Some learners have never seen or used a computer before, so it sometimes comes as a challenge for them to utilize ICT tools.*

From the above statement, it can be inferred that some learners are not in possession of any mobile devices to help them access e-learning materials since cell phones are not allowed in schools. All the participants highlighted that there is limited access to information by learners through ICT usage, as schools have shortages of the resources and in some instances, there are none available whatsoever.

To add to this statement, TC mentioned that:

> *There are no computers to assist learners when doing research or accessing more study material online. They are unable to thoroughly prepare for their lessons.*

Champa, Rochsantiningsih and Kristiana (2021) argued that traditional educational environments do not seem to be suitable for preparing learners to function or be productive in the workplaces of today's society. This is because participants agree that schools are still using the old traditional method of content delivery without ICT resources. Through the use of these technological systems, it is possible to simplify the educational subject and make it more understandable and enjoyable (Lamanauskas & Violeta, 2020). A new set of abilities, attitudes, and pedagogical approaches have to be developed as a result of the use of Information and Communication Technology in teaching, learning, and managing educational institutions. This calls for continual training programmes to ensure that teachers have the necessary capacity (Tsakeni, Munje & Jita, 2021).

TC claimed that:

> *ICT approach is not much different from theory so there is no consolidation of understanding. Lack of knowledge in terms of how to operate devices/tools hinders effective learning. There are no computers to assist learners when doing research or accessing more study material. They are not able to perform certain tasks and cannot do thorough preparation for the class. Since the resources are not available for me as a teacher, it affects them as well.*

The study revealed that ICT usage in teaching and learning increased teachers' and learners' participation and knowledge in academic research. Teachers are able to endeavour into the search and voyage of information by applying ICT skills in research which makes them well-informed and vested with the knowledge of the subject.

In this regard, TB made the following remarks:

> *ICT will enable learners to investigate the contents of the subject. They have limited information from the textbooks. The information they get from us teachers is limited as we rely most on textbooks. The textbooks are not updated compared to the internet where new information and updated books are posted on a daily basis.*

The above statement emphasises that ICT can enable learners to understand the content subject matter more easily and effectively. Teachers are not able to offer more detailed lessons during content delivery as a result of having limited resources and limited time. Although the use of ICT cannot replace the traditional way of teaching and learning, the study agrees that it can make teaching and learning more effective and understandable.

4.2.2.1 Lack of digital devices

According to Langat (2015), political factors, poor timing and planning, a lack of teachers, a lack of clear digital curriculum, a lack of infrastructure and resources, high implementation costs, communication barriers, corruption, moral dilemmas, and high crime rates are some of the obstacles preventing the adoption of ICTs. There are differences in the way that students learn since not all of them have equal access to technology and the internet. Technical difficulties can also prevent students from running into hardware or software issues that interfere with their education. The volume of information available online can be daunting, making it difficult to choose reliable sources due to information overload.

To support this statement, LA made the following remarks:

> *Lack of computer hardware is a serious problem in our school. Sometimes you find in a class of 30 learners with only a few computers. There is also a slow speed communication problem with the internet, poor condition of commuters and load shedding.*

Based on these findings, it is clear that the lack of equitable access to digital devices and information deprives learners of online learning experiences and can limit their learning opportunities and potential to do research. National Council for Technology in Education (NCTE) (2008-2013) found out that about 85,3% of schools reported technical support and maintenance as a high priority and claimed that it should be an important element of the school ICT environment with proper technical support being made available to maintain hardware and infrastructure. Teachers may be limited to dealing with many learners with less time and costs in teaching them. It also means that teachers cannot be able to demonstrate the practical aspects of theories to learners with the assistance of digital tools.

To support this statement TC added that:

> *The lack of computer devices does not only affect teachers, but learners are facing a dire consequence, especially in the world that we live in today. This shows that learners are experiencing difficulties in accessing information and other learning media on the internet which can hinder their ability to gather knowledge and engage in effective Physical Sciences learning.*

4.2.2.3 Lack of internet connection and limited accessibility

There are always challenges while using the internet because it is far from flawless. Even though having access to the internet has become crucial for students to learn, many students in schools lack internet connection. Due to a lack of internet access, many underprivileged or rural populations are now losing out on important education, as schools have moved to online and remote learning (Bahinting, Ardiente, Endona, Herapat, Lambo, Librea, Librano, Libron, Petaluna, Ygot & Taneo, 2022).

The study revealed that ICT challenges facing Physical Sciences learners include inadequate internet connection.

To support the above statement, LC from school A made the following remarks:

> *We experience low access to the Learning Centre, therefore, we cannot get more information to access desired learning outcomes. The ICT challenges that we experience affect our progress very badly because we are left behind academically and end up failing the subject because we cannot access more useful information.*

Wang (2013) argued that students from rural schools score lower on all the internet inequality indicators and are therefore more disadvantaged in internet usage status than their urban peers. Learners experience low access to the available computer laboratory as it is mostly used by learners doing Computer Application Technology (CAT), therefore accessibility is limited. Learners are only allowed to use the computer laboratory in the afternoon as it is only accessible then, but they still experience challenges in using it as there is no lab assistant to help them do research or access more study online material. Constraints of ICT usage hinder learners' academic progress by limiting access causing technical issues and raising concerns about distractiveness and privacy. Learners from both participating schools believe that learners are unable to access some information as a result of a lack of power and a lack of ICT resources.

To support this finding, LB further added that:

> *We have signal problems in the computer laboratory, the internet is slow, the computers virus thread, poor working condition of the computers.*

4.2.2.4 Poor academic performance

Students' academic performance is significantly impacted by the internet and its services (Emeka & Nyeche, 2016). By providing simple access to the information world and facilitating communication within the academic community, the internet enables students to expand their knowledge beyond the classroom (Bodhi & Kaur, 2017). Academic performance is affected more negatively as teachers sometimes do not explain further. They are unable to answer questions in the examination or during lessons as those topics were not fully covered but they were given only a summary. Academic results are poor as more information is unknown as theybwere unable to access more updated information.

To support this statement, LA suggested the following:

> *As learners, we need the internet in order to communicate with teachers outside the learning environment. Without ICT resources, teachers do not have enough time to cover all the content prepared. One period lasts only 30 minutes therefore time plays a significant role in limiting the information we get from teachers. There is no detailed information from the approved Physics textbooks thus why we need an internet connection to search for more learning materials.*

The statement elaborated that the purpose of the internet connection is to provide great help to learners, especially in their classrooms. Real-time discussions and meetings are possible without face-to-face setting due to the internet. Like in traditional classrooms, teachers still make sure that learners can share their ideas and meaningful ideas during discussions.

To support this statement, LC added that:

> *The school must provide us with more computer hardware, tablets, and whiteboard interactions for learners and also provide hardware and devices for learners with disabilities. We need to easily access the internet everywhere around the school.*

4.3 THEME 3: EXTENT OF USING ICT RESOURCES SUPPORT LEARNERS' ACADEMIC PERFORMANCE IN PHYSICAL SCIENCES

4.3.1 The Use of ICT to Support Physical Sciences Learning

Mafukata (2016) indicated that the lack of proper complexities background from junior grades, a shortage of qualified teachers in Physical Sciences, teachers' retirements and resignations, and social factors beyond teachers' competence negatively affect academic performance in Physical Sciences. The lack of teachers in-service training programmes and weak curriculum advisers structure negatively affect academic performance in Physical Science in the country (Mafukata, 2016). Engagement is maintained by clear and transparent assessment instructions, challenging tasks, and providing immediate and real-life feedback. Learners must be identified and given attention when they are having difficulties in order for them to re-engage successfully in the learning process.

In support of this statement, TC commented that:

> *Teachers need the labs and classrooms to be installed with projectors in order to make teaching much easier. ICT resources will enable us to do simulations (practical) so it will make life easy.*

The findings of this study revealed that training among teachers on how to utilise ICT in their teaching is needed. The Department of Education must develop academic

programmes to train and equip them with the skills and necessary knowledge to integrate ICT into their teaching.

Information, Communication and Technology play a critical role in education by helping students attain academic success (Ghavifekr & Rosdy, 2015). Valtonen, Makitalo-Siegl, Kontkanen, Pontinen and Vartiainen (2012) state that continual professional development seems to be a critical component in supporting teachers' innovation. Since many teachers are unfamiliar with ICT resources and teaching tactics, it is crucial to provide them with continuing support in their classrooms as well as high-quality professional development courses to help them hone their skills. According to the report, educators need to have several entrance points into ICT use and learner-centred teaching methods.

In light of this statement, TA added that:

> *Educators need skill and knowledge on how they take advantage of online teaching to successfully deliver content. If laptops can be provided, we will be able to project PowerPoint lessons on the smartboard, so learners are able to take notes. This training will also help educators who are not able to use ICT tools and expose more ways to make teaching and learning more interesting. We still have teachers who always ask for help in terms of connecting the computer to the internet, connecting the projector to the computer, and preparing slides, which consumes too much time*.

The results show that both learners and teachers have positive experiences.

To support the above statement, LA commented that:

> *It promotes self-efficiency as I can study on my own through visual lessons conducted online, Physical Sciences lessons conducted on television, Physical Sciences applications to access more and be able to assess myself. ICT is helpful as it makes it easier for us to understand and sharpen our scientific knowledge. We are able to study through seeing things like experiments being performed online.*

Computer self-efficiency, according to Baubeng-Andoh (2012), is computer confidence in competency. The study found that one of the most important factors in the successful usage of ICT instruction is instructors' proficiency with computers. According to Zweekhorst and Maas (2015), ICT tools let students communicate and interact with one another as well as with professors on a higher level. Toro and Joshi

(2012) state that as more students use computers as information sources and cognitive tools, technology's influence on assisting students in their academic endeavours will grow. The use of ICT in the Physical Sciences fosters critical thinking, self-learning, problem-solving skills, teamwork, and the exploration and simulation of abstract topics. The study also shows that as students are the ones who directly benefit from physical scientific instruction and learning in schools, it was crucial to engage with them and get their perspectives on how Physical Sciences is taught and learned using ICT.

4.3.2 ICT Resources Promote Collaboration

Students can be engaged in the learning process and maintain interest by using multimedia computer software to produce an audio-visual effect (Bindu, 2016). According to Noor-Ul-Amin (2013), new scenarios that support both individual and collaborative learning are replacing outdated communication models and teacher-used teaching and learning techniques. According to this study, ICT encourages teamwork in Physical Sciences classes. Because of the constraints placed on ICT resources, students can collaborate in groups. Students spend a lot of time cooperating and developing a collaborative mindset. Even those without access to ICT can nonetheless learn from one another.

To support this statement, LB added that:

> *The school must provide unlimited access to the internet so we can supplement missing information from textbooks with new and updated information or learning materials uploaded daily online. This will also enable us to download study guides that have more detailed information because the school sometimes has no money to buy study guides for all of us. The school must buy tablets so we can download eBooks, study guides and previous question papers. A WI-FI connection must be installed or be available in the classroom.*

Collaboration and leadership, as contextual characteristics, refer to teachers' collaboration, their support through professional development within schools, and a joint agreement about ICT priorities in the school (Lomos et al., 2023). Collaborative learning fosters collaboration and communication among learners through online platforms and tools promoting peer learning, problem solving and blended learning.

Creating collaboration and promoting a mix of traditional and digital learning methods help create a well-rounded educational experience. This means that collaborative learning helps learners to capitalise on one's resources and skills. The study highlights that collaborative learning enables learners to develop high level thinking and increase student retention, self-esteem and responsibility.

On the question of how ICT resources promote collaboration in class, it was discovered that ICT usage in learning helps learners share study materials, and allows for online group discussions and afterschool interaction among teachers and learners anytime anywhere.

LA added that:

> *ICT learning promotes collaboration in class because learners are able to share hardware and software. They are able to share study materials online and discuss topics they did not understand in class. ICT resources will help form a WhatsApp group chats where we will work together you start working together on that particular topic. ICT promotes collaboration in Physical Sciences class because as learners, we are able to share most things with each other. The availability of ICT resources will help us share study materials online and have discussions whenever we want.*

It is believed that teachers must undergo initial professional development before they can learn how to effectively incorporate ICT into their professional practices. This will enable them to modify their attitudes towards ICT usage and clarify the optimal course of action for ICT implementation (Lomos et al., 2023). The study revealed that ICT resources helped and enhanced teachers‟ interactions with learners and improved on methods of teaching. On methods of teaching, the study highlights that ICT usage promoted learner-centred methods of teaching which allowed more to be done by learners through independent exploration and teamwork.

In tandem with the above, TB had this to say:

> *ICT promotes collaboration in Physical Sciences class. Due to the limitations of ICT resources, learners work in groups. Learners spend time working together and adapting the spirit of collaboration and working together. Learners who are not exposed to ICT can learn from others.*

Furthermore, the study discovered that ICT usage in Physical Sciences stimulated learner's curiosity and promoted collaboration in learning among learners in schools. Joshi (2012) argues that ICT provides a technology that has the capacity to promote and encourage the transformation of education from a teacher teacher-directed enterprise towards student-centred models. Teachers stated that this worked well for schools that had enough ICT tools due to large classes and differences in individual learning strategies. To support this, TA made the following remarks:

> *ICT stimulates learner's curiosity in the subject matter. it provides classrooms with engaginfg and and interactive learning experiences. ICT usage promotes deeper understanding and retention of concepts.*

During the data collection period, the researcher discovered that working in groups will help learners understand better and also learn from one another who experience challenges and struggle to understand.

Online tools such as apps, e-books and computers can be used as lesson plans, lectures, textbooks, assignments, software, quizzes, tests, resources, audio and video, digital, and social networking platforms such as Twitter, YouTube, and Facebook (Watling, 2012). The study discovered that personalised learning helps promote students' motivation, enhances the efficiency of Physical Sciences learning, and enables learning to be tailored to suit learners' interests. The study also revealed that some content in Physical Sciences tends to be very difficult for teachers to explain or instruct to learners thus why they believe ICT usage makes teaching easier and more effective.

In light of this statement, TC explained that:

> *If ICT resources were available in the Physical Sciences classroom, it would make teaching much easier. Some content is difficult to explain as they are too abstract. Teachers can easily show using the slides and this will make teaching much easier and the learning information(material) more meaningful and understandable.*

According to Tong, Uyen and Ngan (2022), face-to-face collaboration encourages students to participate in learning activities together in the classroom. On the question

of the kind of support teachers need to efficiently use ICT resources in the classroom, TA stated that:

> *Face-to-face collaboration encourages learners to participate in learning activities together in the classroom. Furthermore, the teaching process is accomplished online with the teacher's assessment of the learning progress and interactions throughout the learning process.*

The study emphasises that online teaching platforms encourage learners to participate in learning activities online and allow learners to study at their own pace, with flexible time and space.

In line with this statement, TC asserted that:

> *ICT resources must be available in the classrooms so that learners can access them during their free time. It will enable them to work on their own and they can do research or check learning materials that they did not understand in class. Since resources are unavailable, teaching and learning are compromised somehow because more information is not easily accessible and is difficult to instruct learners.*

Teachers from both schools believe that this will promote collaboration among learners and be beneficial to learning goals and objectives. Teachers can use decoys to capture students' attention by making them curious and sparking their interest in making meaningful connections. Additionally, they can accomplish this goal by showing students that they are an important part of the class and the subject by participating in class actively and on time.

Huang (2017) discussed the importance of the collaborative learning role in saving time for students and educators in sending emails, saving, revising and editing materials and other activities, which leads to improved productivity. Learners being the direct beneficiaries of the teaching and learning of Physical Sciences using ICT tools in schools, it was imperative to interact with them in this study gathering their experiences in the teaching and learning of Physical Sciences through ICT tools. The study found that the learning was done with the help of textbooks as stipulated in the school syllabus content. Furthermore, the learners reported having a positive experience of learning Physical Sciences through ICT resources.

To support this, LA made the following remarks:

> *Positive experience as it helps me get two steps ahead of the teacher. It promotes self-efficiency as I can study on my own through visual lessons conducted online, Physical Sciences lessons conducted on television, and Physical Sciences applications to access previous question papers and be able to assess by myself anytime.*

Learners who use ICT resources to learn Physical Sciences understand better. They use updated and improved methods of learning, and they have a deeper understanding of Physical Sciences as they have unlimited sources of information. Learners use these resources because learners are exposed to proper diagrams and good accuracy.

4.4 THEME 4: OPPORTUNITIES THAT TEACHERS AND LEARNERS ARE EXPOSED TO WHEN USING ICT

Information Communication and Technology play a significant role in improving academic performance, as such, there are various challenges affecting the smooth implementation of Information Communication Technology in the educational sector in the country (Dardary, Tridane & Belaaouad, 2018). Teachers can adopt various ICT approaches to match different learners' needs and learning styles. Teachers can also train learners to adapt to utilising the ICT approach. A range of different teaching strategies should be explore the e-Learning so that learners can understand and be exposed to more information outside the classroom environment. ICT provide significant opportunities for exploring new teaching methods and learning styles suitable for all study types. The study reveals that ICT also benefits learners as they are able to see real things.

TB added that:

> *For example, in Physical Sciences, if we are working with momentum, maybe say two cars are colliding, and the learners will be able to see the collision taking place on their own unlike just demonstrating it. The learners will be able to time the collision took place. ICT benefits learners as they will see videos of someone demonstrating the practical part, experimenting live and this will help them to remember.*

Traditional digital tools include digital video support, aerial video projectors, interactive materials, digital assemblies containing interactive resources, and reference content such as lecture notes and dictionaries (Lazar et al., 2020). It saves time for educators. After all, they will not have to prepare the worksheet because they will display everything on the projector. Teachers need to do practical with the learners so that they can understand, and it will get them to be interested in the lesson. Teachers who use these resources are able to use different teaching methods that help learners understand better and are able to present excellent content delivery. It saves time and it makes learning more efficient.

To support this statement, PRA added that:

> *The school must make available ICT resources for learners to utilise them. They need to select topics which require an ICT approach to enable understanding and not shift from traditional teaching methods. If we use videos to teach, it will make the learners more interested and engaged during lessons.*

4.4.1 Benefits of Using ICT Resources in a Physical Sciences Class

The impact of ICT on the teaching and learning process has become pertinent as it facilitates the teaching and learning process, creates a conducive learning environment, and helps learners develop creative thinking and self-confidence (Bindu, 2016). The benefits of ICT in a Physical Sciences class include enhanced engagement, access to rich information from a global perspective, collaborative learning, data analysis and instant feedback to learners. The study revealed that ICT usage has excellent effects on learning, especially because it enhances unlimited access to information. ICT usage is important as it allows learners to learn through seeing experiments performed online as schools have no resources to perform live Physical Sciences experiments.

To support this statement, LB highlighted that:

> *The benefits of ICT include unlimited access to information easily and fast as learners can search for whatever they don't understand anytime and anywhere. This is more beneficial to teachers as they will not have to spend much time teaching the same topic. It promotes collaboration among the learners it improves the concentration of learners because they'll be able to see what the*

> *teachers are explaining. In Physical Sciences, there are topics that you cannot understand unless you see the experiment done live, and because our school is under-resourced, we have no necessary equipment and chemicals to perform experiments, it is better to watch experiments being performed on YouTube videos.*

The researcher took time to interact with the participants through interviews and discussion so as to appreciate their personal experiences in the teaching and learning of Physical Sciences. The presentation of the question of what the experiences of teachers and learners who use ICT resources when learning Physical Sciences begins by addressing teachers experiences and thereafter learners.

Bindu (2016) points out that ICT promotes opportunities to modify the learning material and activities to the requirements and capabilities of every individual learner, particularly by giving personalised feedback. A disadvantage of the traditional teaching approach is that it reduces the opportunities for solving problems through applications and acquiring knowledge. However, combining lessons with images, videos, and other learning content in the classroom will make these lessons more effective for learners. Additionally, ICT help learners feel more engaged and encourage active participation in acquiring knowledge during lessons.

4.5.1 Experiences of Teachers Who Use ICT Resources

The study revealed that in Physical Sciences, abstract topics are challenging to explain. Teachers find it difficult to explain certain contexts to learners. Both teachers who participated in this study believe that learners learn best through seeing. They believe that topics that are too complex can be understood better on the videos and learners will be able to understand and remember more easily.

TB highlighted that:

> *ICT resources (access to internet) make any topic that is so difficult to explain easier when you teach it. For example, when teaching simulations on abstract topics like electrodynamics, generators, motors and so forth, learners can easily see them on the screen through the availability of ICT materials.*

Opportunities for ICT in teaching and learning enhance the abilities and competencies of learners and educators and also facilitate the learning process (Al Ansi & Al-Ansi, 2020). ICT promote better information presentation. They enable better record keeping of class registers, and lesson plan development is more effective. ICT can instil motivation into learners as they will be able to know that these things are not difficult simply because they will be seeing what will be happening there unlike just imagining things.

To support this statement PRB:

> *It stimulates learners' curiosity in the subject matter. ICT provides classrooms with engaging and interactive learning experiences. ICT usage promotes deeper understanding and retention of concepts.*

Alarcia and del Arco Bravo (2012) maintain tutoring through the virtual classroom such as personal communication between students and lecturers via e-mail, public communication between students and lecturers via forums, tutoring and inter-student support, unidirectional tutoring from lecturers to students via a 'notice board 'type of tool for the virtual classroom. The study revealed that ICT could stimulate, motivate and spark learners' appetites for learning and help create a culture of success. It was discovered that technology is increasingly an important part of today's generation. When teachers incorporate technology in their Physical Sciences lessons, they show learners that learning can take place anywhere, including the digital spaces they interact with daily.nto support this statement, TB went further to state that:

> *ICT usage has a way of motivating learners. ICT can instil motivation in learners, as they will be able to know that this subject is not difficult as they will be seeing what's happening there unlike just imagining things.*

Teachers being the implementers of educational programmes through the teaching and learning process were significant participants in this study. This was because they play a key role in facilitating the teaching and learning of Physical Sciences than learners in schools and gathering the views over their experiences in teaching of Physical Sciences was exceptionally important. In line with this, teachers were asked

to state their positive experiences of utilising ICT tools to teach Physical Sciences at the two participating schools.

Teachers were further asked to explain the type of ICT resources they are using in the school. The study found that ICT tools were available in schools but still limited. Teachers reported that there are few functional tools that they are able to access and use to present lessons. In their explanations, they added that computer teaching using ICT tools was very interesting and captivating.

To support this, TB from school B made the following remarks:

> *Despite having a lot of shortcomings, ICT usage instils motivation into learners as they will be able to know that Physical Sciences is not difficult because they are seeing experiments performed live on Videos unlike just imagining things.*

Based on this statement, it is clear that teachers have experienced ICT usage in Physics through experiments as the school has no funds to buy chemicals to perform experiments. Teachers stated that the experiment part is sometimes conducted from a computer laboratory available in the school as the Science lab is not well equipped.

Bindu (2016) states that ICT has the potential to create powerful learning environments in various ways. It also has the potential to access numerous information using various sources to enhance learning and teaching. The study found that ICT usage in teaching and learning of Physical Sciences encourages engaging and interactive learning amongst learners and teachers.

Shedding more light on this, TA had this to say:

> *ICT usage stimulates learners' curiosity in the subject matter. ICT provides classrooms with engaging and interactive learning experiences. ICT usage promotes a deeper understanding and retention of concepts.*

According to Matthew et al. (2015), ICTs have the potential to accelerate, enrich, and deepen skills, motivate and engage students, help relate school experiences to work practices, and create economic viability for tomorrow's workers, as well as strengthen teaching and help schools change. It was discovered that ICT tools usage

encourages critical thinking, exposes learners to be flexible and improves their level of concentration. ICT resources make it easier for communication between teachers and learners to take place anytime.

It also stimulates motivation and allows learners' exposure to different learning styles suitable to learners' uniqueness.

LC stated that:

> *ICT help us a lot since some learners are unable to ask questions in class to get more knowledge about certain topics. ICT accessibility will enable us to be exposed to more informationas we will be able to download PDF files, previous question papers, and memoranda with more information about the content matter and we will be able to access these study materials whenever we want unlike in the classroom where if we forget, we won't be able to recall what was said by the teacher.*

ICTs have the ability to boost, improve, and deepen abilities, encourage and interact with students so that they can utilise their skills in practical fields, generate financial capability for future use and enhance the teaching and learning experiences (Ekpo & Okoro, 2016). Teachers in schools, especially those who were involved in the teaching and learning of Physical Sciences, were asked to state the benefits of teaching and learning of Physical Sciences using ICT resources. As regards the perceived benefits that the study unearthed from teachers, it showed that Physical Science' teaching through ICT usage equipped teachers with prestigious administrative knowledge. Furthermore, the teachers revealed that ICT usage in teaching and learning empowered them with the knowledge and skills for writing correspondences, and reports, and setting examination papers and lesson planning.

Furthermore, TA stated that:

> *ICT brings some concepts to life. Some concepts can be demonstrated. Learners' understanding is enhanced because through ICT, learners can rewind and fast forward unlike in the case of teacher explanation.*

The study also found that ICT resources enhanced the communication skills of teachers. With respect to this, they stated that the component of information entrenched in computers gave them a skill to enhance information collection,

processing and dissemination which made them competent and good communicators in giving instructions to learners in schools. ICT usage in teaching reduces teachers' busy schedules as it improves methods of teaching. It promotes learner-centredness which is full of self-regulating exploration, and innovation learning and encourages the spirit of cooperation and collaboration among the learners as they share different experiences, views and competences on assessments.

It has been scientifically proven that Information Communication Technology can operate as a change agent by greatly increasing educational reform that enables teachers and students to switch from conventional to more creative and successful approaches to teaching and learning (Sebatana & Dudu, 2022). Professional development is needed to offer teachers ongoing training to help them effectively incorporate technology into their teaching methods so learners can benefit more.

Learners were also asked to give out their point of view on the perceived benefits of learning Physical Sciences using ICT resources in schools as they were the recipients of the teaching and learning process. As regards to their perceived benefits, learners reported that ICT tools benefitted them in so many ways.

LC stated that:

> *As learners, we need more computers and if we can be provided with hardware like CPUs and generators to help during power failure and load shedding, we can have undisrupted internet connectivity.*

The study revealed that in school A, they have Learning Management Systems (LMS) such as Google Classroom and online forums such as group chats.

LA was quoted saying that:

> *Based on the subject we're doing, we have groups on WhatsApp where we share work and papers so we can study and practice for the exams. We also use Microsoft Office, Google Workplace Docs and Adobe Spark by creating documents that could help us in the exams. Our Physical Sciences educators are mostly likely to use these types of tools to help them teach. Besides teaching the old traditional way, this will help also educators to find out more technology systems rather than treating teaching traditionally and also by engaging in the type of form activities and learning systems.*

Sharma et al. (2011) further add that the availability of open-source software has enabled the development of content management systems and learning management systems such as the Integrated Learning Modules (ILM). ILM is thematically focused classes, delivered primarily over the internet. The appropriate use of ICT can transform the whole teaching-learning processes leading to excellent content delivery and teaching methodology in the learning environment. ICT resources available in school include access to a computer laboratory, overhead projectors for teachers to project notes, printers and Wi-Fi. The ICT resources available at school include computers, projectors, printers, and Microsoft Word spreadsheets. There are no ICT tools available in Physical sciences class. There are no ICT instruments to help us understand what they are teaching because some topics are difficult to understand without a demonstration of what is being explained.

4.7 DATA COLLECTED THROUGH OBSERVATION

The researcher conducted observation during the data collection, therefore observations in this study were restricted to one visit to two sampled schools and one classroom observation and the teachers were teaching in their normal classrooms. Observation allowed the researcher to brilliantly describe and explain the classroom context and what was happening as no computers were being used during those visits. The observation method was “the most direct way of getting data not what people have written on a topic, or what they have said but what they actually do” (Gunzo, 2020).

The researcher observed two lessons in two distinct schools I in Sekhukhune East District. The teachers taught Physical Sciences and Mathematics and the lessons observed were on Physical Sciences.

The observations were useful in that they assisted the researcher in clarifying what she was looking for during the classroom and computer laboratory observation. The observation guide was designed to record the following: 1. Availability of ICT resources in the Physical Sciences classroom, where the researcher checked whether the ICT resources were available in the school and the status of the ICT resources. 2 Accessibility of the ICT resources and facilities, where the researcher checked who has accessibility among teachers and learners. 3 Use of ICT resources to check

whether teachers are using ICT tools to prepare lessons and how they present lessons using ICT resources.

4.7.1 Availability of ICT Resources

It was observed the available computers in the schools were mainly used for teaching ICT as a subject. One sampled school had computer laboratory (ICT lab) laptops, and both schools had projectors (overhead and LCD projectors). One of the schools had Television (TV), and digital devices like CDs, DVDs, and VCDs. Video players were available in both schools. Both sampled schools had printers and photocopiers. The digital content of Physical Sciences was unavailable in sampled schools. Internet services were not introduced in the schools, and resources like tablets, smartphones and educational games were inattentive in both schools.

Furthermore, to support the above findings, the researcher observed the lessons in both schools' where Physical Sciences was offered. The thrust was to check how learners interact with teachers during lessons using ICT resources. A visit to a computer lab was also done to check how learners were using the ICT tools to benefit them.

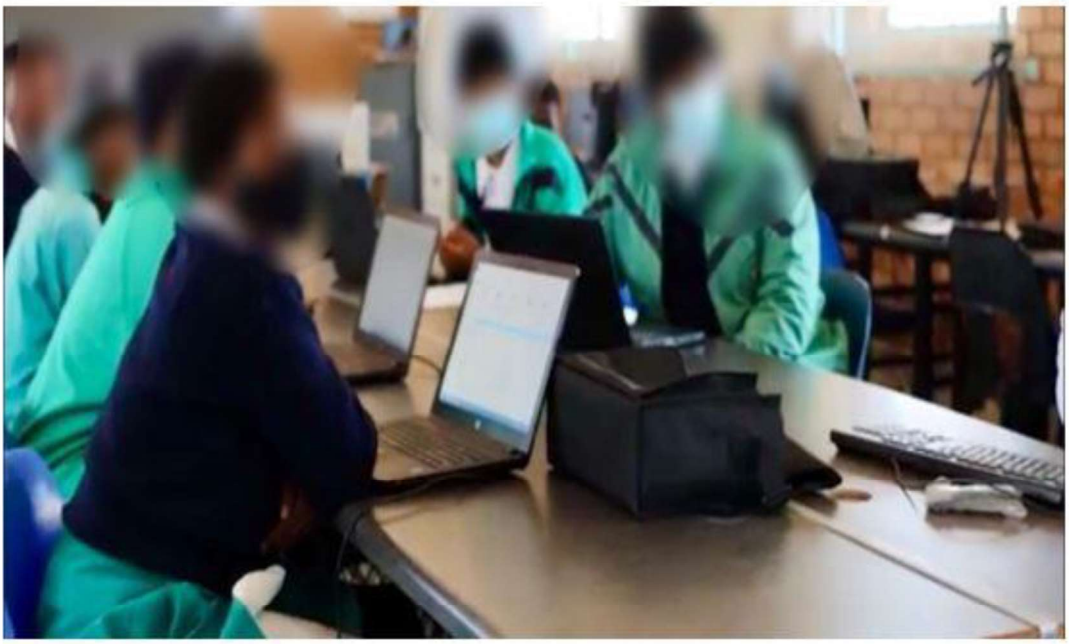

Figure 4.1: Availability of ICT Internet Access

With respect to the above Physical Sciences classes, learners at the two participating schools reported that limited internet access in Physical Sciences classrooms and the unavailability of learners' tablets made it difficult for them to learn Physics through ICT tools. They added that the limited ICT resources in their classroom made teaching and learning of the subject difficult leading to poor performance in the subject.

These resources are very few and inadequate for teaching and learning of Physical Sciences. This finding was in line with Agyei (2013). There were no ICT resources available in the classroom except the teacher's personal gadgets.

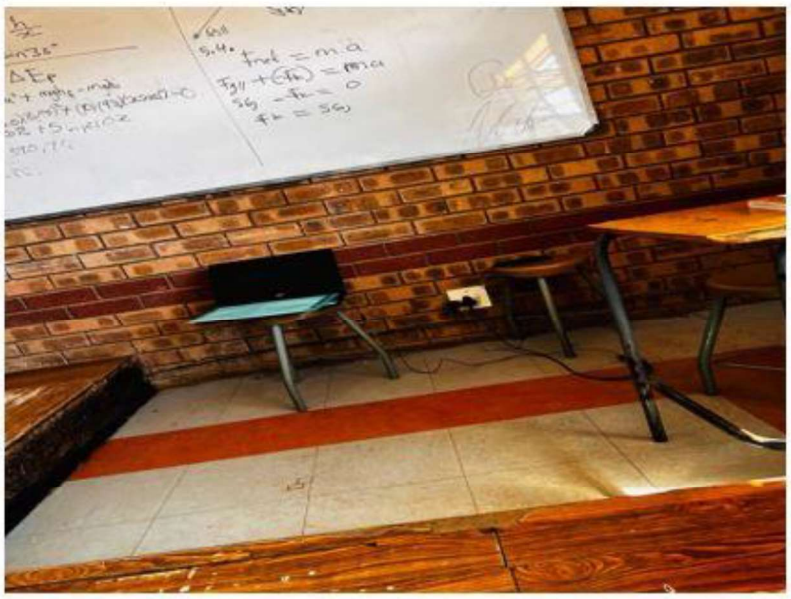

Figure 4.2: Availability of ICT Resources

One laptop was available for the teacher to prepare study materials for the learners such as question papers, class activities and lesson plans. A printer wasalso available to help the teacher print activities for the learners and lesson plans. In school B, there were no ICT tools available in the Physical Sciences classroom. Some learners had cell phones, but they were not connected to the internet. The school had no computer facility where learners could access more information and assistance using any CT tools.

4.7.2 Status of the ICT Resources

The status of the TV screen in the classroom was very bad as it was broken and not in good condition. The printer available was functional. Overhead projectors were available in the classroom but not in good condition. In school B, overhead projectors were not functional and were disconnected. No ICT resources available in the school for both teachers and learners. The study also discovered that there were broken old computers in the Physical Sciences classroom. This proved that ICT usage teaching and learning of Physical Sciences was not taking place in School B.

Figure 4.3: Poor State of ICT Resources

4.7.3 Accessibility of the ICT Resources and Facilities

Information and communication technology resources provide learners with many learning opportunities allowing them to apply critical thinking, sharpen scientific knowledge, and apply theoretical concepts in practical settings. Learners can experiment with software applications, explore the internet and assess themselves anytime anywhere. The use of ICT in education lends itself to more student-centred learning settings and further improves the educational quality of the student, revolutionising the way information is obtained.

Learners were unable to easily access ICT resources as cell phones are not allowed in the school. There was a computer facility available that learners were allowed to access anytime in school A, provided that the computer facility was not occupied by CAT learners and teachers conducting lessons there. Learners had no access to a computer facility or any resources in the school B as they were unavailable. Based on the observer's findings, the picture below shows Physical Sciences learners sitting in the classroom waiting for the teacher to teach. Learners had no form of ICT tool in their possession. The classroom had no computer screen, overhead projector, no internet connection and some had no textbooks.

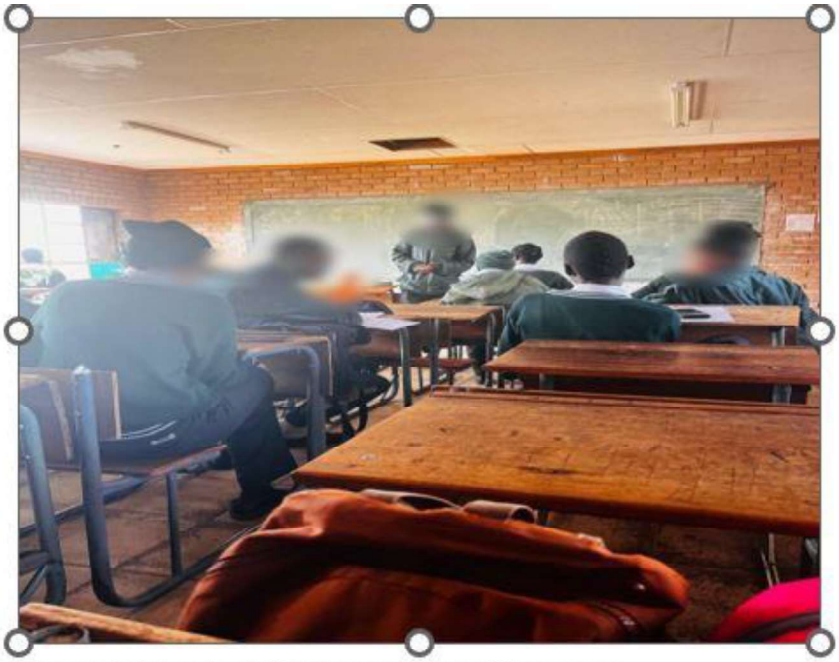

Figure 4.4: Lack of ICT Resources in Classroom

Teachers could access the school computer facility to prepare their lessons and to conduct lessons in the computer laboratory available. Teachers had access to a projector, however, was not easily accessible as it was the only one in the school and all teachers were using it. Teachers had access to school laptops to prepare lessons and learning activities in school B. Iwas discovered that teachers had unlimited access to a computer laboratory in school A. This helped them research and conduct lessons if available although it was always occupied and used by CAT teachers and

learners but unavailable for Physical Sciences teachers and learners unless during weekends or in the afternoon.

Figure 4.5: Effective use of ICT Resources

4.7.4 Usage of ICT resources

Lesson planning and presentation and learners' assessment and feedback and Interest of learners learning using ICT resources

Information and Communication Technology allows teachers to plan their lessons more effectively while saving their time to focus more on delivering accurate lessons and improving learner growth and engagement. Teachers and learners are expected to get benefits from lesson plans such that the learning process is inspiring, efficient, motivating, challenging, interactive and so forth (Ahmad, 2020:63). The study observation revealed that teachers in sampled secondary schools constructed lesson plans electronically.

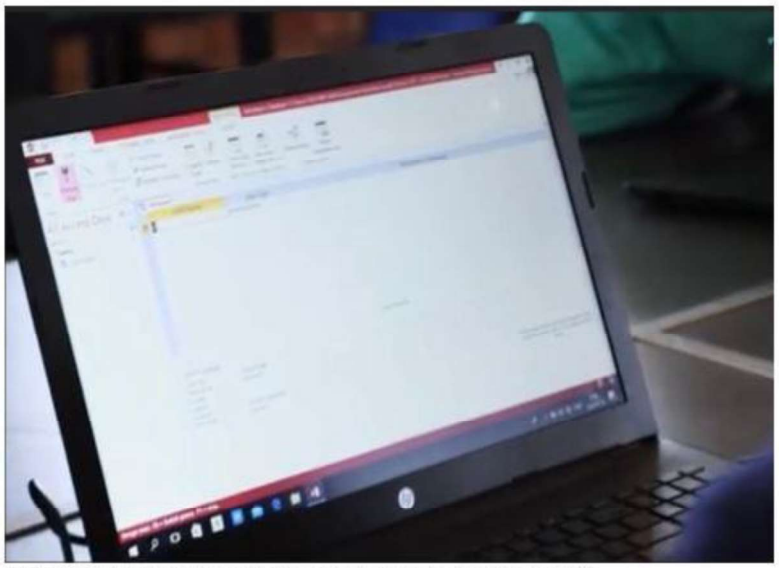

Figure 4.6: ICT Benefits in Preparations of Lessons

Lesson plans are done electronically, however, lessons were presented without ICT usage. Learners were assessed manually, and feedback was given in class without the usage of tools. Learner assessments were well-typed and printed for all the learners. Learners were not interested in the lesson as the teacher was just explaining without showing anything on the whiteboard. Some learners were asleep during the lesson. However, learners showed outstanding interest in the computer laboratory as they were given a chance to go and research. They were interacting with one another and discussing their findings together.

ICT is not used to plan lessons, and none were used to present lessons. Learners were assessed without using ICT tools during the lesson. Feedback was given by the teacher in class without using any tools. Learners were less interested in the entire lesson. They looked bored and tired as they were just listening to the presentations.

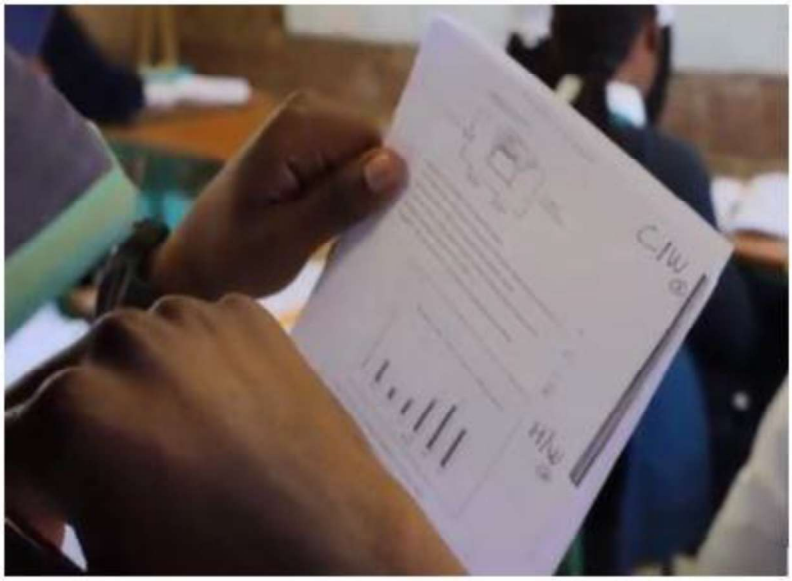

Figure 4.7: Benefits of ICT on Learning Assessments

ICT resources make it easier for teachers to prepare learning assessments and help provide feedback on time. It was discovered that these resources enable learners to access various study materials online such as study parks for Physical Sciences. Study packs are a package of previous question papers available online and various activities which can be accesed by learners anytime anywhere. ICT resources make teaching and learning enjoyable and keep learners focused.

4.7.5 Internet Connectivity

Internet connectivity was unstable in the computer laboratory. Internet connection was negatively affected by load shedding, therefore computers had no internet connection. There wasa no internet connectivity available in the classroom. Teachers and learners wanted to use a computer facility available and were with ICT tools.

There was no internet connectivity in the whole school. The school is always experiencing network connection problems as it is on the mountainside, so connectivity is affected. The school also had budget constraints that they were unable to pay for Wi-Fi. The power supply in schools is fundamental in the use of ICT resources in teaching and learning of Physical Sciences (Manu, 2014). Research

findings revealed that challenges facing ICT usage were inadequate infrastructures like electricity and telecommunication services.

4.5 CONCLUSION

This chapter presented the findings of the study in line with the study questions. The study found that the constraints affecting teaching and learning played a major role in the academic performance of learners. The teaching and learning experiences of using Information and Communication Technology to support teaching and learning of Physical Sciences, despite some difficulties, was good and interesting. The opportunities of teaching and learning Physical Sciences through ICT usage in secondary schools improve methods of teaching and learning. In the next chapter, conclusions and recommendations will be discussed in relation to the reviewed relevant literature.

CHAPTER FIVE

OVERVIEW, SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter presented the findings, analysis and interpretation of the study. The present chapter discusses the overview, summary, conclusion and recommendation of the study. The discussion will be done under the following sub-headings which have been derived from the research objectives:

The objectives of the study were as follows:

- To determine the constraints to effective use of ICT resources in teaching Physical Sciences.
- To affirm the extent to which the use of ICT support learners' academic performance in Physical Sciences subject.
- To explore opportunities/benefits of using ICT tools in the teaching of Physical Sciences subject.
- To determine the experiences of teachers and learners who use ICT resources to enhance the teaching and learning of Physical Sciences.

5.2 OVERVIEW OF THE STUDY

Chapter One presented introduction and background of the study, Chapter Two explored literature review of the study, Chapter Three discussed research methodology, Chapter Four explored data presentation, analysis and interpretation and finally, Chapter Five presented an overview, summary, conclusions and recommendations.

5.3 SUMMARY OF MAJOR FINDINGS

5.3.1 Constraints Affecting the use of ICT Resources in Physical Science

The are several constraints affecting the use of ICT resources in Physical Science in public schools. Despite the significant benefits brought by the application of Information Communication Technology to improve academic performance in schools, there are challenges affecting the implementation of Information Communication Technology. On certain occasions, criminal activities have a negative impact on implementing Information and Communication Technology to teach Mathematics and Physical Sciences subjects. A situation of this nature has a negative impact on the educational sector because the Fourth Industrial Revolution is a powerful system that has the potential to improve the quality of education and contribute positively to the economy. When there are several challenges hindering the implementation of the 4th Industrial Revolution in public schools, these will affect the quality of education, delay the implementation of policies to boost the economy and create employment since South Africa experiences one of the highest rate of unemployment, poverty, inequality, gender-based violence and crime in the world.

Not all learners have equal access to technology and the internet thus creating disparities in the learning experiences. Technical issues also serve as barriers for learners to encounter software or hardware problems that disrupt their learning. Information overloads the abundance of online information and it can be overwhelming making it challenging to use relevant sources. It is important to work with non-profit organisations, government institutions, private institutions and faith-based organisations to improve the quality of education in South Africa. A situation of this nature will help improve the academic results and contribute positively to the economy of the country.

5.3.2 Extent of Using ICT Resources Support Learners' Academic Performance in Physical Sciences

The application of Information and Communication Technology in teaching Physical Sciences has the potential to improve the academic performance and create direct

and indirect employment which can contribute positively to the economy. Information and Communication Technology promote collaboration in Physical Sciences classes. Learners spend time working together and adapting the spirit of collaboration. Learners who are not exposed to ICT can learn from others. Collaborative learning fosters collaboration and communication among learners through online platforms and tools promoting peer learning and problem solving and blended learning. Creating collaboration and promoting a mix of traditional and digital learning methods helps create a well-rounded educational experience. This means that collaborative learning helps learners to capitalise on one's resources and skills

5.3.3 To Determine the Experiences of Teachers and Learners who use ICT Resources to Enhance Teaching and Learning of Physical Sciences

The results showed that teachers and learners experienced the teaching and learning of Physical Sciences through ICT resources positively, as it empowered them with technological skills such as browsing, typing and researching on the internet. Such skills would make the learners attain progress in their educational journey and influences critical thinking. This was because they were able to make use of the knowledge and skills acquired from ICT usage to solve their Mathematics and Sciences problems and apply the solutions to their activities in a meaningful manner. On the other hand, ICT usage was not experienced by all sampled schools. They had no computer laboratories and other ICT resources to enhance the teaching and learning of Physical Sciences. ICT usage allowed stimulated learners' critical reasoning and a sense of creativity among them because much of the learning was undertaken by the learners themselves. Thus, teacher-learner interaction in classrooms was positive in that it yielded the intended results and promoted among learners' collaboration.

5.3.4 The opportunities/benefits of using ICT tools in the teaching of Physical Sciences subject

The study results showed that despite having a lot of challenges in implementing the usage of ICT inteaching and learning of Physical Sciences, ICT usage instils motivation into teachers and learners as they will be able to solve Science problems and be able to link those problems with everyday life. The results further proved that

ICT in teaching also that ICTs have the potential to accelerate, enrich, and deepen skills, motivate and engage learners, relate learning experiences and create economic viability for future employees, as well as strengthen the quality of teaching and learning. It was discovered that ICT tools usage encourages critical thinking, exposes learners to be flexible and improves their level of concentration. ICT resources have a potential to make it easier for communication between teachers and learners to take place anytime.

5.4 LIMITATIONS OF THE STUDY

The study aimed at collecting data among principals, teachers and learners a from two selected schools and one curriculum advisor in Sekhukhune East District in Limpopo Province, South Africa. However, only school principals, teachers and learners were only used. The curriculum advisor could not be accessible due to load of work at the District Department of Education, and he kept postponing the appointments and this affected the sample size as the researcher could not be able to collect data from him. Despite these limitations, the findings are still reliable and valid, as the researcher managed to collect data from ten participants instead of eleven participants. As a result, the findings cannot be generalised to the entire population of principals, teachers and learners in Limpopo Province in South Africa but rather be recommended.

5.5 CONCLUSION

In conclusion, the perception of teachers regarding using ICT in teaching and learning that teachers face many constraints from content development through to delivery, and also in enhancing the online learning opportunities of their learners. Learner collaboration and self-learning is reported to be poor due to the limited availability of ICT resources in schools and sometimes at home.

It is essential for the teachers to revise teaching strategies and to initiate certain steps to enhance teaching and learning of Physical Sciences. It was revealed that schools that achieve NSC 100% pass rate in Physical Sciences have enough resources and their learners have access to internet services anytime anywhere, so it makes it easier to access many study materials and enable them to sharpen their problem solving skills (NCS Results, 2023).

Schools must start to utilise Zoom and Google Classroom in delivering lessons from school premises and to equip classrooms with Wi-Fi, camera, screens, overhead projectors and microphone systems in order to provide a more realistic and familiar classroom environment to leaners.

5.6 RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

- The government, school stakeholders, community leaders and business people should assist in the provision of ICT facilities for the academic excellence of secondary schools that offer Physical Sciences in order to enhance effective teaching and learning.

- The school principals, teachers and learners need to be trained and be equipped with ICT knowledge and skills on how they can incorporate ICT in the effective teaching and learning of Physical Sciences. This can be done through organised departmental seminars and workshops where principals and teachers are exposed to the techniques or modern ICT-led teaching strategies and to support the usage of ICT resources in Physical Sciences classrooms.

- The government through the relevant agencies should provide schools with uninterrupted internet access, learners' tablets, enough projectors, teachers' laptops, software' and ICT personnel to help in cases of network breakdown or computer breakdown during lessons. Education must strive to improve the ICT infrastructures available in schools and hold school managers accountable if they do not properly maintain them.

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APPENDICES

APPENDIX A LIMPOPO DEPARTMENT OF EDUCATION APPROVAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

CONFIDENTIAL

Ref: 2/2/2 Enq: Makola MC Tel No: 015 290 9448 E-mail:MakolaMC@edu.limpopo.gov.za

Mamphye VM
P.O BOX 220
Vaalwater
0530

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.

2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"Constraints and opportunities of using information and communication technology to support teaching and learning of Physical Sciences in the Sekhukhune East District."**

3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the School concerned.

3.3 The conduct of research should not in anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.

12/07/2023

Mashaba KM
DDG: CORPORATE SERVICES

Date

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

APPENDIX B: CONSENT FORM

RESEARCH ETHICS

Informed Consent

Appendix B

PATICIPANT LETTER OF INFORMATION

Title of the Research Study : Constraints and opportunities of using information and communication technology to support teaching and learning of Physical sciences in Sekhukhune East District.

Principal Investigator/s/ researcher : (*Veronicca Manyuku Mamphye, Master of Education in Curriculum studies*)

Co-Investigator/s/supervisor/s : (*Dr Dzivhonele Albert Sinthumule (DEd) and Dr TL Tshikota (PhD*)

Brief Introduction and Purpose of the Study: **Introduction**

Recent research has shown that information and communication technologies, sometimes known as ICTs, are an essential tool that may be utilised in the South African education system for teaching and learning. The next generation of workers can be better prepared for the fourth industrial revolution through Information and Communication Technology (ICT). This can also make countries competitive globally in terms of new technological inventions. ICTs are hailed as a panacea in both developed and developing countries to the problems that are experienced in education systems.

Purpose of the Study

To help find solutions to ICT problem arising in the classrooms when teaching Physical Sciences in schools.

Outline of the Procedures: Participants are requested to answer the questions as honest as possible and feel free to ask any clarity seeking question.
Should there be any, interviews will take place during their free time at their respective schools. Interviews will be audio recorded. Interviews will take about 10 minutes for each participant and participants will be randomly selected.

Risks or Discomforts to the Participant: There will not be any risks or discomforts to the participants. Participants are free to withdraw from the interviews anytime if they feel uncomfortable during interviews.

Benefits

The study will contribute towards the advancement of Information and Communication Technology usage in the classrooms and provide more knowledge to teachers and schools in general about the importance of implementing ICT in their teaching. The study will improve the learner's engagement during Physical Sciences lessons and improve engagement. The study will also encourage individual learning and collaborations. The study will help the Department of Education to make informed decisions about making available the ICT tools in all schools to ensure effective teaching of Physical Sciences.

:

Reason/s why the Participant Maybe Withdrawn from the Study: There will be no adverse consequences for the participant should they choose to withdraw. Participants will be free to leave should they decide to withdraw from participating during data collection.

Remuneration: The participants cannot receive any monetary or other types of remuneration for taking part in the study.

Costs of the Study: The participants will not be expected to cover any costs towards the study.

Confidentiality: The researcher will be the only person aware of the identities of participants, and stringent precautions will be taken to ensure that the identities of the participants are not disclosed to any other individuals. All subjects who take part in this research will have their identity protected to ensure that they freely and accurately answer any questions that may be asked of them. No one other than those who would have been directly involved in the study will have access to any of the documents, recordings, or transcripts of the interviews and any communication conducted with the instructors in a confidential manner.

Research-related Injury: Precautionary measures will be taken to ensure that no individual suffers any injuries during data collection. No compensation will be provided since all the participants will take part in this research willingly.

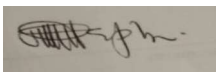
CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, **(*MAMPHYE VERONICCA MANYUKU*),** about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: **FHSSE/23/CSEM/01/2606**,
- I have also received, read and understood the above written information (*Participant Letter of Information*) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

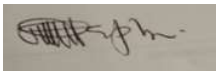
| --- | --- | --- | --- |
| Full Name of Participant | Date | Time | Signature |

I, Mamphye Veronicca Manyuku 23/12/2022 15h30



herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher

Veronicca Manyuku Mamphye Date **: 23/07/2023** Signature . 

Full Name of Witness (If applicable)

…… Date ……

Signature……..

Full Name of Legal Guardian (If applicable)

…… Date……

Signature……..

APPENDIX C: INTERVIEW SCHEDULE FOR TEACHERS

Constraints and opportunities of using Information and Communication Technology to support teaching and learning of Physical Sciences in Sekhukhune East District.

SECTION A: DEMOGRAPHIC INFORMATION

What biographical information would you collect from your participants?

1. Age_____
2. Gender _____
3. Grade taught_____
4. Highest Qualification_____
5. Subject specialisation_____
6. Number of years teaching Physical Sciences_____
7. Post level as Physical Sciences teacher_____

SECTION B: INTERVIEW QUESTIONS

1. Constraints affecting the use of ICT resources in PS class

1.1 What are the constraints teachers encounter when utilising ICT resources when teaching PS?

1.2 What challenges do learners encounter when using ICT resources when learning PS?

1.3 How do the constraints hinder the progress of PS learners?

2. The use of ICT resources in to support PS learning

2.1 What kind of support do teachers need to efficiently use ICT resources in PS class?

2.2 What do you think can be done to support PS learners to learn through ICT?

2.3 How do ICT resources promote collaboration in PS class?

3. Opportunities of using ICT resources in PS class

3.1 What are the benefits of using ICT resources in the PS class?

4. Experiences of teachers and learners who use ICT resources in learning PS

4.1 What are the positive experiences of teachers who utilise ICT resources to teach PS?

4.2 What are the experiences of learners who use ICT resources when learning PS?

THANK YOU FOR YOUR COOPERATION

APPENDIX D: INTERVIEW SCHEDULE FOR LEARNERS

Constraints and opportunities of using Information and Communication Technology to support teaching and learning of Physical Sciences in Sekhukhune East District

SECTION A: DEMOGRAPHIC INFORMATION

What biographical information would you collect from your participants?

1. Age _____
2. Gender_____
3. Grade _____
4. Number of years in grade_____
5. Disability status_____

SECTION B: INTERVIEW QUESTIONS

1. Constraints affecting the use of ICT resources in PS class

1.1 What challenges do learners encounter when using ICT resources in PS?

1.2 How do the constraints hinder the progress of PS learners?

2. The use of ICT resources in to support PS learning

2.1 What kind of support do learners need to efficiently use ICT resources in PS class?

2.2 What do you think can be done to support PS learners to learn through ICT?

2.3 How do ICT resources promote collaboration in PS class?

3. Opportunities of using ICT resources in PS class

3.1 What are the benefits of using ICT resources in the PS class?

4. Experiences of teachers and learners who use ICT resources in learning PS

4.1 What are the experiences of learners who use ICT resources when learning PS?

THANK YOU FOR YOUR COOPERATION

APPENDIX E: INTERVIEW SCHEDULE FOR SCHOOL MANAGER

Constraints and opportunities of using Information and Communication Technology to support teaching and learning of Physical Sciences in Sekhukhune East District

SECTION A: DEMOGRAPHIC INFORMATION

What biographical information would you collect from your participants?

1. Age_____
2. Gender _____
3. Highest qualification_____
4. Work experience_____

SECTION B: INTERVIEW QUESTIONS

1. Constraints affecting the use of ICT resources in PS class

1.1 What are the constraints teachers encounter when utilising ICT resources when teaching PS?

1.2 What challenges does the school experience when using ICT resources enhancing learning PS?

1.3 Any measures put in place to resolve ICT constraints PS teachers experience? Please mention.

1.4 How do the constraints hinder academic performance of PS in school?

2. The use of ICT resources in to support PS learning

2.1 How do ICT resources promote collaboration in PS class?

3. Opportunities of using ICT resources in PS class

3.1 What are the benefits of using ICT resources in the PS class?

4. Experiences of teachers and learners who use ICT resources in learning PS

4.1 What are the positive experiences of teachers who utilise ICT resources to teach PS?

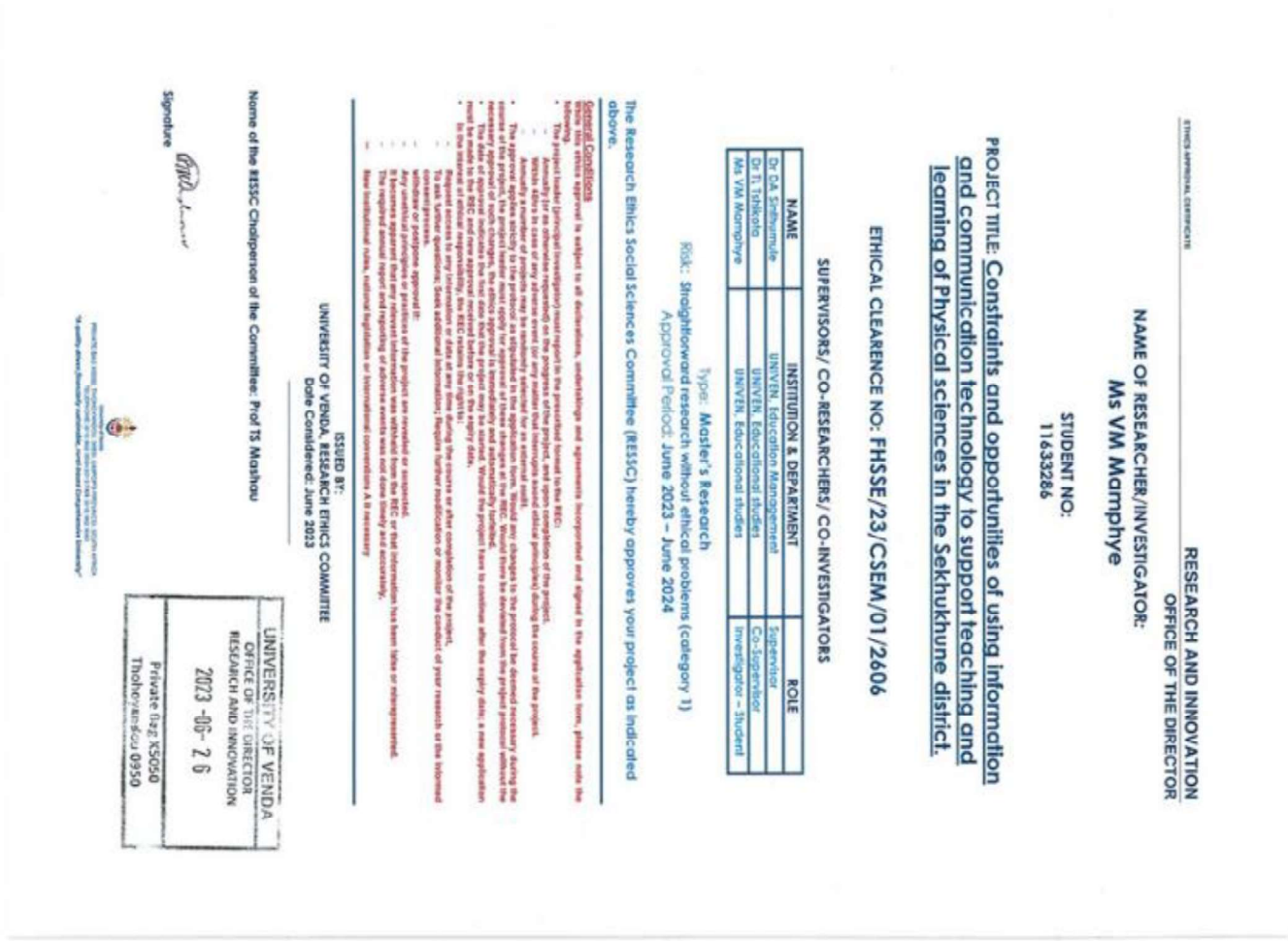
THANK YOU FOR YOUR COOPERATION

APPENDIX F: CLASSROOM OBSERVATION

The researcher will observe the following during class visits.

What to observe	Description of what is observed	Remarks (Researcher's insights)
1. Availability of ICT resources in the PS classroom	Availability of ICT resources	
	Status of the ICT resources	
2. Accessibility of the ICT resources and facilities	Learners	
	Teachers	
3. Usage of ICT resources	Lesson planning and presentation	
	Learner assessment and feedback	
	Interest of learners learning using ICT resources	
4. Internet connectivity	Stability and challenges of connectivity	

APPENDIX G: ETHICAL CLEARANCE CERTIFICATE



ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER /INVESTIGATOR:
Ms VM Mamphye

STUDENT NO:
11433286

PROJECT TITLE: Constraints and opportunities of using information and communication technology to support teaching and learning of Physical sciences in the Sekhukhune district.

ETHICAL CLEARENCE NO: FHSSE/23/CSEM/01/2606

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr DA Sinthumule	UNIVEN Education Management	Supervisor
Dr TL Tshikota	UNIVEN Educational studies	Co-Supervisor
Ms VM Mamphye	UNIVEN Educational studies	Investigator – Student

Type: Master's Research
Risk: Straightforward research without ethical problems (category 1)
Approval Period: June 2023 – June 2024

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principal investigator) must report in the prescribed format to the REC:
  - Annually (or as requested) on the progress of the project, and
  - Without delay in case of any adverse events or termination prior to completion of the project.
- Annually a member of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviation from the project protocol without the necessary approval such deviation may result in withdrawal of ethics approval.
- The date of approval indicates the first date that the project may be started. Should the project have to continue after the expiry date, a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC reserves the right to:
  - Request interim reports on the progress of the project.
  - Request access to any information or data at any time during the course or after completion of the project.
  - Any unethical principles or practices of the project are revealed or suspected.
  - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
  - The required annual report and reporting of adverse events was not done timely and accurately.
  - New institutional rules, national legislation or international conventions A is necessary.

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: June 2023

Name of the RESSC Chairperson of the Committee: Prof TS Mashau

Signature

UNIVERSITY OF VENDA
OFFICE OF THE DIRECTOR
RESEARCH AND INNOVATION
2023 -06- 26
Private Bag X5050
Thohoyandou 0950

APPENDIX H: LETTER TO THE SCHOOL PRINCIPALS

PO Box 802
Glen cowie
1061
08 July 2023

The Principal

_____

_____

_____

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR INSTITUTION

I am a Masters of Education in Curriculum Studies student at the University of Venda. I hereby request permission to conduct my research titled **"Constraints and Opportunities of Using Information and Communication Technology to Support Teaching and Learning of Physical Sciences in the Sekhukhune East District''** at your school. Physical Sciences teachers, learners and SMT members are the main research participants, and data will be collected through interviews and classroom observations. The names of the participants will be kept anonymous throughout the study and no information be shared that reveals their identities in any way. Information collected will be confidential and will only be used for the purpose of the study. Furthermore, the findings will be shared with education authorities in the circuit as well as the district.

Yours truly

Mamphye V.M

Student Number:11633286

APPENDIX I: LEARNERS' INTERVIEW RESPONSES

Two public secondary schools participated in the study. The schools were coded SA and SB. One learner was interviewed from each school. The learners were coded LA and LB.

	Constraints Affecting the use of ICT Resources in PS Class	
Researcher	**1. What challenges do learners encounter when using ICT resources in Physical Sciences?**	
LA	Lack of enough digital devices. Not all learners have equal access to technology and the Internet creating disparity disparities in the learning experience. Technical issues, learners encounter software or hardware problems that disrupt their learning and information overload the abundance of online information and it can be overwhelming making it challenging to use relevant sources.	
LB	Lack of computer hardware like you find in the class of 30 learners with only few computers. There is also a slow speed communication problem with Internet, poor condition of commuters and load shedding affecting effective usage of ICT resources to enhance learning of Physical Sciences.	
LC	No internet connection. We experience less or low access therefore we cannot get more information to access desired learning outcomes. We cannot research on our own as this prevent us.	

LD	There is no internet connection in class. No Wi-Fi password but only the principal and school administrators. No computers to search.	
Researcher	**2. How does these constraints hinder the progress of PS learners?**	
LA	It hinders progress by limiting access causing technical issues and raising concerns about distractive and privacy.	
LB	As learners we're unable to access some information we cannot use them because of this lack of power and lack of resources and so it obvious affects our academic progress.	
LC	Academic results are poor as more information is not known as we are unable to access more updated information need internet in order to communicate with them outside the learning environment. Without internet teachers has not enough time to cover all the content prepared. One period lasts only 30 minutes therefore time play a significant role in limiting the information we get from teachers.	
LD	There is no detailed information from the approved Physics textbooks. Academic performance is affected more negatively as teachers sometimes do not explain further. We are unable to answer questions in the exam or during less as those topics were not fully covered but we are given only a summary.	
	The use of ICT resources in to support Physical Sciences learning	
Researcher	**3. What kind of support do learners need to efficiently use ICT resources in PS class?**	

LA	Curriculum integration resources and guidance to seamlessly integrate ICT into our classes, monitoring and evaluation regulating assesses monitoring and evaluation wriggling assesses the effective effectiveness of ICT integration in the classroom and make adjustments as necessary. Professional development to offer teachers ongoing training to help them effectively incorporate technology into their teaching methods so we can benefit more.	
LB	As learners we need more computers and if we can be provided with hardware like CPUs and generators to help during power failure and load shedding so we can have undisrupted internet connectivity. The school must provide us with more computer hardware, tablets, whiteboard interactions for learners and also provide hardware and devices for learners with disabilities. We need to easily access internet everywhere around the school and also at home.	
LC	The school must provide unlimited access to the internet so we can supplement missing information from text books with new and updated information or learning materials uploaded daily online. This will also enable us to download study guides that have more detailed information because the school sometimes have no money to buy study guides for all of us.	
LD	The school must buy tablets so we can download books, study guides and previous question papers.	
Researcher	**4. How do ICT resources promote collaboration in PS class?**	
LA	Collaborative learning it fosters collaboration and communication among learners through online platforms and tools promoting peer learning and problem solving and blended learning by creating collaboration by promoting a mix of traditional and digital	

	learning methods to create a well-rounded educational experience.	
LB	ICT learning promotes collaboration in class because learners are able to share hardware and software. They are able to share study materials online and discuss topics they did not understand in class. ICT resources will help form a WhatsApp group charts where we will work together you start working together on that particular topic.	
LC	ICT promotes collaboration because during research project we can work as a group on that particular part. Working as a team will help us to understand better and also learn from one another also be able to help other teams that are struggling to understand.	
LD	ICT promotes collaboration in class as we are able to communicate with others through group charts where we can conduct group discussions with other learners and educators. We will be able to share study material and contact lessons during school holidays with our teachers and mentors.	
	Opportunities of using ICT resources in PS class	
Researcher	**5. What are the benefits of using ICT resources in the PS class?**	
LA	Benefits of ICT in PS class include enhanced engagement access to rich information in a global perspective, collaborative learning, data analysis and instant feedback to learners.	
LB	Benefits of ICT include unlimited access of information easily and fast as learners can search whatever they don't understand anytime and anywhere. This is more beneficial to teachers as they will not have to spend much time teaching the same topic. It promotes collaboration amongst the learners it improves	

	concentration of learners because they'll be able to see what the teachers are explaining. In Physical Sciences there are topics where you cannot understand unless you see the experiment done live, because our school is under resourced, we have no necessary equipment and chemicals to perform experiments, it is better to watch experiments being performed on YouTube videos.	
LC	ICT usage encourages critical thinking and encourage learners to be flexible and helps improving concentration. It improves communication between teachers and learners even outside the learning environment.	
LD	ICT usage have many benefits especially for me as a shy learner. I am sometimes unable to ask some questions in class during lessons but if there was an internet connectivity in the school, I was going to be able to quickly check on google to ask questions for topics which I did not understand when the teacher was teaching during lessons anonymously.	
	Experiences of teachers and learners who use ICT resources in learning PS	
Researcher	**6. What are the experiences of learners who use ICT resources when learning PS?**	
LA	My experiences involve active participation by actively engaging in ICT based lessons and activities by paying attention mostly and ask questions and participate in discussions or a group work which we mostly do as a class when the teachers come and teach in person classes. It also underlines research this type of resources learning in ICT resources when learning Physics as it enables an online research and active participation in class.	

LB	I have positive experience of ICT in learning because it also allows us as learners to chat on video calls and interact with our teachers via voice notes asking each other what they don't understand even if you're at home we are able to interact with one another.	
LC	Positive experience as it helps me get two steps ahead of the teacher. It promotes self-efficiency as I can study on my own through visual lessons conducted online, Physical Sciences lessons conducted on television, Physical Sciences applications to access more and be able to assess myself.	
LD	ICT is helpful as it makes it easier for us to understand and to sharpen out scientific knowledge. We are able study through seeing things like experiments being performed online.	
Researcher	**7. Which ICT tools do you use and able to access in PS class?**	
LA	We have Learning Management Systems (LMS) such as Google Classroom and online forums such as groups that we have based on the substitute we're doing we have groups on WhatsApp that we share work and papers so we could study and practice for the exams. We also use Microsoft Office, Google workplace dogs and Adobe spark by creating documents that could help us in the exams. Our Physical Sciences educators are mostly likely to use this type of tools to help them teach besides teaching the old traditional way this will help also educators to find out more technology systems rather than treating teaching traditional and also by engaging in the type of from activities and learning systems.	

LB	ICT resources available in school include to access to computers laboratory, overhead projectors for teachers to project notes, printers and Wi-Fi.	
LC	We do not have any computers or any projectors in our Physical Sciences classroom. We have none even if we want to search more information or download previous question papers and memorandums, we are not able to because we don't have ICT instruments. We are sometimes not able to perform experiments instead we just listen to the teacher teaching and leave without understanding anything.	
LD	There is a projector at school, but sometimes our teachers are not able to use it.	

APPENDIX J: INTERVIEW RESPONSES WITH SCHOOL PRINCIPALS

Two public secondary schools participated in the study. The schools were coded SA and SB. The principals of the two schools were interviewed and coded PRA and PRB for school A and school B respectively.

	Constraints affecting the use of ICT resources in PS class	
Researcher	**1. What are the constraints that teachers encounter when utilising ICT resources when teaching PS?**	
PRA	In terms of diagram educator need to understand how to elaborate diagrams to the learners so that they can be exposed not just seeing their turn an exam so they need to be exposed first before they could go and drive them or to see them exam question papers.	
PRB	Teachers facing inadequate number of projectors for use and also the laptops are also limited for teachers and learners. We once got tablets donations but later lost them due to burglary as they were stolen. Internet connectivity is not accessible. This is caused mostly by the fact that the school is situated at mountainside. The school cannot easily connect to the internet, and this affects both teachers and learners as they are unable to access useful teaching material online.	
Researcher	**2. What challenges does the school experience when using ICT resources to enhance teaching of PS?**	
PRA	As I said it's difficult for learners to understand sometimes, we try to give them the worksheet since they are unable to	

	use them. We expose learners to Learning Centre (computer laboratory) so that they can be able to access more information whenever they need it. The Learning Centre is always available for both teachers and learners because there is unlimited internet connection.	
PRB	As the school, we only have two laptops used by the principal and the school administrator. We have one projector, so it becomes difficult if there are number of educators who want to use it all at the same time as periods are running concurrently.	
Researcher	**3. Any measures put in place to resolve ICT constraints PS teachers experience? Please mention.**	
PRA	We expose the learners to Learning centre.	
PRB	As the school we sometimes borrow from neighbouring schools to some extent if he does that that teaching Grade 12 oh so other classes where I can see these, or they have to wait for any other time not using them	
Researcher	**4. How do the constraints hinder academic performance of PS in school?**	
SMTA	It makes it difficult for learners to take notes or write down everything as the teacher is teaching. This means learners will miss more detailed ICT tools enables teachers to display slides detailing all the information so the learners can capture full information which will not be easier for them to forget.	
SMTB	It is extremely disturbing. These days' learners are supposed to be well advanced in terms of moving with the changing world. They need to also be prepared possibly in the future for when they reach institutions of higher learning.	

	Our learners are not yet skilled to use ICT resources when learning Physical Sciences. We are unable to equip them with ICT skills as we have limited number of resources, so this become more challenging as it affects learners' academic performance negatively hence our Physical Sciences results are poor.	
	The use of ICT resources in to support PS learning	
Researcher	**5. What kind of support do teachers need to efficiently use ICT resources in PS class?**	
PRA	Teachers need to be trained on how to utilize ICT tools. This will help them to be exposed to different software that can help them deliver content in more meaningful way. I believe this is the time that department of education organise trainings workshops for the educators. The training workshops will help teachers to get their skill and knowledge to utilize the tools in the classrooms and outside the learning environment.	
PRB	The school is under resourced, we sometimes ask the assistance of projectors from neighbouring schools. In Physical Sciences, there are experiments that need chemicals to be completed. Since we have a budget constrain and are expensive, teachers can make use of YouTube where they will play videos so learners can see when these experiments are performed.	
Researcher	**6. What do you think can be done to support PS learners to learn through ICT?**	
PRA	I think we should have ICT lab assistant to help learners who experience challenges, so they can be assisted so that they can be able to use these ICT resources on their own.	

	Some learners have never seen or used a computer before, so it sometimes comes as a challenge for them to utilize ICT tools.	
PRB	Learners are in unable to utilize them like they find it difficult to understand while using them. For example, if you try to explain angles, sometimes they don't understand. They find it difficult to understand unlike when you show them on the diagram from the projected information.	
	Opportunities of using ICT resources in PS class	
Researcher	**7. What are the benefits of using ICT resources in the PS class?**	
PRA	It saves time and it makes learning to be more efficient. Learners who use these resources because learners are exposed to proper diagrams and good accuracy. Which will be exposed to the diagram even the accuracy.	
PRB	It saves time for educators because they won't have to prepare the worksheet because they will display everything on the projector. Teachers need to do practical with the learners so that they can understand, and it will get them to be interested in the lesson.	
	Experiences of teachers and learners who use ICT resources in learning PS	
Reseacher	**8. What are the positive experiences of teachers who utilise ICT resources to teach PS?**	
PRA	It saves time and it makes learning to be more efficient.	

PRB	Teachers who use these resources are able to use different teaching methods that helps learners to understand better and are able to present excellent content delivery.	
Researcher	**9. What are the experiences of learners who use ICT resources when learning PS?**	
PRA	Learners who use these resources because learners are exposed to proper diagrams and good accuracy. Which will be exposed to the diagram even the accuracy.	
PRB	Leaners who use ICT resources to learn Physical Sciences understand better. They use updated and improved methods of learning and they have deeper understanding of Physical Sciences as they have unlimited sources of information.	

APPENDIX K: INTERVIEW RESPONSES WITH TEACHERS

Two public secondary schools participated in the study. The schools were coded SA and SB. Four teachers of the two schools were interviewed and coded TA and TB for school A and TC and TD for school B respectively.

	Constraints affecting the use of ICT resources in PS class	
Researcher	**1. What are the constraints teachers encounter when utilising ICT resources when teaching PS?**	
TA	Teachers cannot use ICT resources due to lack of knowledge especially older generation. There are no workshops for older teachers to teach them how to best utilise ICT resources. There are no tangible ICT resources in the school.	
TB	Unavailability of ICT resources in the school. ICT tools such as projectors, internet connectivity, software, smartboards and computers are not available. These are hindrance towards teachers using ICT to achieve teaching objectives as it is not easy. It is also not easy for educators to do preparations thoroughly because of limited information provided by textbooks used. Lesson preparations are done manually which is time consuming also.	
TC	Not having enough ICT material, I think not having enough material.	
TD	Difficulties to explain learning materials as you are projecting the information from the computer. Summarising	

	on slides makes it difficult for learners to understand as you are summarising.	
Researcher	**2. What challenges do learners encounter when using ICT resources when learning PS?**	
TA	ICT approach is not much different from theory so there is no consolidation of understanding. Lack of knowledge in terms of how to operate devices/tools hinders effective learning.	
TB	There are no computers to assist learners when doing research or access more study material. They are not able to perform certain tasks and cannot do thorough preparation for the class. Since the resources are not available for me as a teacher, it affects them as well.	
TC	Since we don't have them at school, the challenges experienced by learners includes access information from them. The biggest problem is availability and also just going through also I think that how this hinderer is going to progress.	
TD	Difficulties affecting learners is that ICT resources are not available.	
Researcher	**3. How do the constraints hinder the progress of PS learners?**	
TA	Learners find adoption to ICT approach challenging since most subjects use teaching approach where not much learning is taking place.	
TB	Learners won't be able to investigate contents of the subject. They have a limited information from the textbooks. The information they get from us teachers is limited as we	

	rely most on textbooks. The textbooks are not updated compared to the Internet when new information and updated books are posted on daily basis.	
TC	Learners rely more on the information that they get from them. Although they have a Learning Centre (computer laboratory), it is too small. Learning Centre is there but not for the whole school. Although the learning centre is available with free Wi-Fi resources available for the learners whenever they need to use it.	
TD	As ICT resources are unavailable, learners will lack knowledge. They will not be able to further do research to understand better.	
	The use of ICT resources in to support PS learning	
Researcher	**4. What kind of support do teachers need to efficiently use ICT resources in PS class?**	
TA	Teacher trainings on how to use ICT resources. Condition learners to adopt to ICT approach from early grades.	
TB	Department of Education must come up with programs to train us how to use ICT and importance of it. I think it would be much better to give educators the skill and knowledge on how we can take advantage of online teaching to successfully deliver content. If laptops can be provided, we will be able to project something on the smartboard, so learners are able to take notes. These training will also help educators who are not able to use ICT tools and expose more ways to make teaching and learning more interesting. We still have teachers who always ask for help in terms of connecting the computer to the internet, connecting the	

	projector to the computer, preparing slides, which consumes too much time.	
TC	Teachers need the labs and classrooms be installed with projectors in order to make teaching much easier. ICT resources will enable us to do simulations (practical) so it will make life easy.	
TD	We need the school to make available ICT resources in our Physical Sciences classroom and that are easily accessible.	
Researcher	**5. What do you think can be done to support PS learners to learn through ICT?**	
TA	The school must make available ICT resources for learner to utilise them. They ned to select topics which require ICT approach to enable understanding and not shifting from traditional teaching method.	
TB	If we use videos to teach it will make the learners to be more interested and engage during lessons. Which will promote that collaboration and you believe it is promoting collaboration, so the benefits say I want to understand I want to know from you.	
TC	ICT resources must be available in the classrooms so that learners can access them during their free time. It will enable them to work on their own and they can do research or check learning materials that they did not understand in class. Since resources are unavailable, teaching and learning is compromised somehow because more information is not easily accessible.	
TD	Internet services must be introduced since learners are always on their phones, it will be easier for them to utilise	

	ICT materials because they like technology and will be interested in learning.	
Researcher	**6. How do ICT resources promote collaboration in PS class?**	
TA	ICT promote collaboration in Physical Sciences class. Due to limitations of ICT resources, learners work in group. Learners spend time working together and adapting spirit of collaboration and working together. Learners who are not exposed to ICT can learn from others.	
TB	Learners will work together to solve problems.	
TC	Leaners can share learning materials through social media platforms or on internet.	
TD	Helps learners to learn from one another.	
	Opportunities of using ICT resources in PS class	
Researcher	**7. What are the benefits of using ICT resources in the PS class?**	
TA	ICT brings some concepts to life. Some concepts can be demonstrated. Leaners understanding is enhanced because through ICT leaners can rewind and fast forward unlike in the case of teacher explanation. It promotes collaboration and cooperation since learners can work together. It increases classroom productivity and stimulates motivation to learn.	
TB	It will benefit learners as they will be able to see real things. For example, in Physical Sciences, if we are working with momentum, maybe say two cars are colliding the learners will be able to see the collusion taking place on their own unlike just demonstrating it. The learners will be able to	

	time the collision took place. ICT benefits learners as they will see videos of someone demonstrating the practical doing the experiment live and this will help them to remember.	
TC	If ICT resources were available in Physical Sciences classroom, it would make teaching much easier. Some content is difficult to explain as they are too abstract. Teachers can easily show using the slides and this will make teaching much easier and the learning information(material) understandable.	
TD	We will have progress when we teach, and learners will progress as well.	
Researcher	**8. What can teachers do to enhance the teaching of PS through ICT?**	
TA	Teachers can adopt various ICT approaches to match different learners needs and learning styles. Teachers can also train learners to adapt to utilising ICT approach.	
TB	I will use range of different teaching strategies and explore the E-learning so that learners can understand and be exposed to more information outside the classroom environment.	
TC	The only thing I can do is ask the school management to buy the ICT materials. I am now using my own laptop because the school does not provide us with one. There's a school projector available sometimes as we are many in the school. So, the school must make available more projectors and smart boards.	

TD	Teachers must utilise ICT resources efficiently like projecting lessons on the overhead projectors so that learners can get all necessary information.	
	Experiences of teachers and learners who use ICT resources in learning PS	
Researcher	**9. What are the positive experiences of teachers who utilise ICT resources to teach PS?**	
TA	It promotes better information presentation. Enables better record keeping of class registers, lesson plan development is more effective.	
TB	ICT can instil motivation into learners as they will be able to know what these things are not difficult simply because there will be a seeing what's happening there unlike just imagining things.	
TC	ICT resources (access to internet) makes any topic that is so difficult to explain to be easier when you teach it. For example, when teaching simulations especially when you're looking at abstract topics like electrodynamics, generators, motors and so forth, leaners can easily see them on the screen. There are some topics that are too abstract you explain it explain the learner does not understand but if you show it on the on the board this is how he motorways they've never seen motors and you're just saying the motor is like this is like this then when you have it on the on the screen, they can understand what you are talking about. There are topics that are a bit complex that you can show from YouTube you show it on the projector and learners will be able to understand as learners learn through seeing things.	

TD	ICT helps explaining concepts especially in Chemistry where there are lots of concepts that need to be explained and show the learners as well.	
Researcher	**10. What are the experiences of learners who use ICT resources when learning PS?**	
TA	It stimulates learners' curiosity in the subject matter. ICT provides classroom with engaging and interactive learning experiences. ICT usage promotes deeper understanding and retention of concepts.	
TB	ICT can instil motivation into learners as they will be able to know what these things are not difficult simply because there will be seeing what's happening there unlike just imagining things.	
TC	Teachers are sometimes explaining contents so learners end up not getting what you're saying, but when they see them, they won't forget just tell them and this will improve their understanding.	
TD	They will understand easily.	

APPENDIX L: PROOF OF LANGUAGE EDITING

Registered with the South African Translators' Institute (SATI)

Reference number 1000686

22 February 2024

CONSTRAINTS AND OPPORTUNITIES OF USING INFORMATION AND COMMUNICATIONS TECHNOLOGY TO SUPPORT TEACHING AND LEARNING OF PHYSICAL SCIENCES IN THE SEKHUKHUNE EAST DISTRICT

This confirms that I edited substantively the above document, including a Reference list. The document was returned to the author with various tracked changes to correct errors and clarify meaning. It was the author's responsibility to attend to these changes.

Yours faithfully

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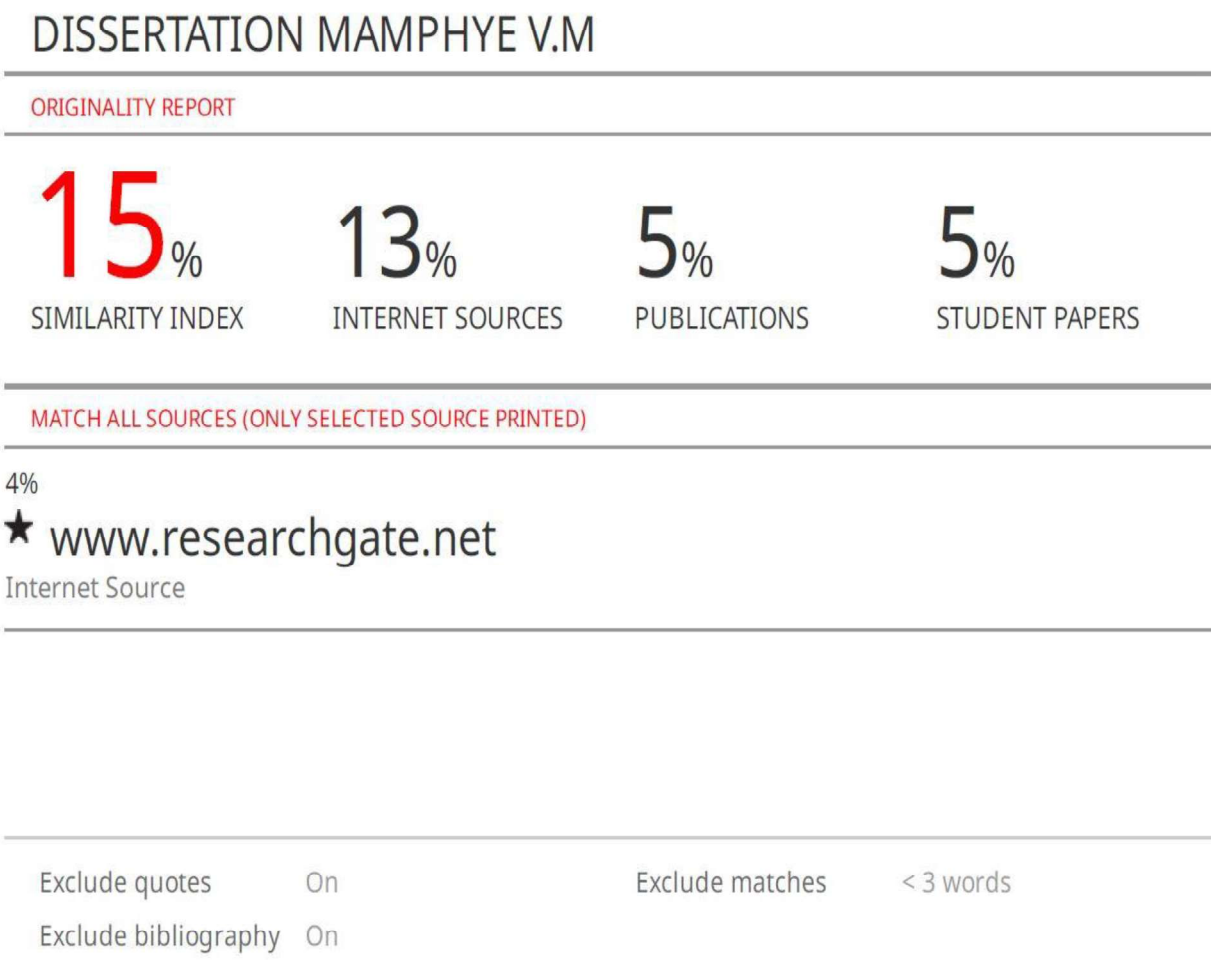
APPENDIX M: SIMILARITY INDEX



DISSERTATION MAMPHYE V.M

ORIGINALITY REPORT

15%	13%	5%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

4%

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Exclude quotes	On	Exclude matches	< 3 words
Exclude bibliography	On		