EXPLORING GRADE 10 PHYSICAL SCIENCES LEARNERS' VIEWS AND PREFERENCES OF INSTRUCTIONAL STRATEGIES IN ELECTRICITY

by

Thulani Zakhele Dhlamini

(206501484)

Dissertation submitted in fulfilment of the requirements for the degree of Master of Education (Science Education) in the School of Education,

College of Humanities,

University of KwaZulu-Natal,

Supervisor: Dr L. Molefe

Co-Supervisor: Prof N. Govender

July 2022

Declaration

I, Thulani Zakhele Dhlamini, hereby declare that:

1. The research is my own original work.
2. The dissertation has not been submitted for any degree or examination in any other university or tertiary institution.
3. This thesis does not contain other persons' data, pictures, graphs, or other information, unless specifically acknowledged as being sourced from other persons.
4. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
   a) Their words have been re-written, but the general information attributed to them has been referenced.
   b) Where their exact words have been used, then their writing has been placed inside quotation marks and referenced.
5 This thesis does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and source being detailed in the thesis and in the reference section.

Signature: [redacted] Date: 20 July 2022

Thulani Zakhele Dhlamini (206501484)

As the candidate's supervisor, Dr L. Molefe (UKZN) and co-supervisor, Prof N. Govender (UKZN), agree to the submission of this dissertation.

Signatures: Data: July 2022

Ethical Clearance Letter

UNIVERSITY OF ™
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

01 December 2021

Zakhele Thulani Dhlamini (206501484)
School Of Education
Edgewood Campus

Dear ZT Dhlamini,

Protocol reference number: HSSREC/00003619/2021
Project title: Exploring Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 10 November 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

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

<u>This approval is valid until 01 December 2022.</u>
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

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

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

Yours sincerely,

[redacted]

Dedication

This study is dedicated to my mother, Nozipho Sonia Mdubo, who always gave me support, motivation and encouragement to complete this research.

Acknowledgements

First and foremost, I would like to thank the Lord for the grace given to complete this study.

Secondly, I express my appreciation to my supervisors Dr Leonard Mofele and Prof Nadaraj Govender for their scholarly tutelage throughout the research period. Their constructive critique, comments and guidance during the period of my study have provided me with immense encouragement and valour.

Finally, I sincerely thank my participants for making the time to be part of my study, and I am grateful for all your contributions to the research.

Abstract

Physical Sciences is one of the subjects perceived by high school learners in South Africa and beyond as difficult. The examiners' report from Department of Basic Education over the years have highlighted a poor performance in Electricity in the National Senior Certificate examinations. The researcher was then curious to find out other means of improving conceptual understanding of the topic in question. The aim of this research is to investigate Grade 10 Physical Sciences learners' views and preferences of Instructional Strategies in Electricity. Instructional Strategies also known as "teaching strategies" give direction and approaches teachers have to follow in order to achieve the fundamental aims of instruction. The study explored three aspects: firstly, Grade 10 Physical Sciences learners' views concerning Instructional Strategies used in Electricity. Secondly, the experiences of Instructional Strategies (i.e., teacher guidance, practical work and computer simulations) the present learners preferred during the exploration research. Thirdly, to understand factors that motivated learners to prefer the Instructional Strategies the way they do.

The research approach in this study is qualitative. This approach allowed the researcher to generate data directly from the learners through constant interactions while observing their behaviour within their context. A sample of twenty-five Grade 10 Physical Science learners was conveniently selected from one of the township schools in Umlazi. Case study research design was adopted. This design was an exploratory type, treating learners as both the case and the unit of the study. An interpretive approach complemented with action research was used to collect data through questionnaires, video recordings and one-on-one interview for triangulation purposes. The transcripts further assisted in the formulation of themes that were used to answer the research questions.

The analysis and interpretation of results indicate that learners enjoy the presence of their teacher in the classroom helping them throughout the lesson when working on assessments and practical experiments, which is why demonstration was selected as the most favourable Instructional Strategy amongst others. Furthermore, it was clear that teacher guidance was selected as the most preferred IS by the learners in comparison with practical work and computer simulation.

Glossary of Acronyms and Abbreviations

CAPS	Curriculum and Assessment Policy Statement
CCT	Conceptual Change Text
CL	Collaborative Learning
DBE	Department of Basic Education
FET	Further Education and Training
GET	General Education and Training
IBL	Inquiry-Based Learning
ICT	Information and Communication Technology
IF	Instructional Framework
IS	Instructional Strategies
LCA	Learner-Centered Approach
NCS	National Curriculum Statement
PhET	Physics Education Technology
SA	South Africa
SCT	Social Constructivist Theory
SGB	School Governing Body
SMT	School Management Team
SPS	Science Process Skills
STEM	Science, Technology, Engineering and Mathematics
TCA	Teacher-Centered Approach
ZPD	Zone of Proximal Development

Table of Contents

Declaration........ i
Ethical Clearance Letter ii
Dedication iii
Acknowledgements iv
Abstract........ v
Glossary of Acronyms and Abbreviations........ vi
List of Tables x
List of Figures........ xi
Chapter 1: Introduction and Background........ 1
1.1 Introduction 1
1.2 Background to the Study 1
1.3 Problem Statement 2
1.4 The Significance of the Study 4
1.5 Frameworks........ 4
1.5.1 Theoretical Framework........ 4
1.5.2 Conceptual Framework........ 5
1.6 The Purpose and Objectives of the Study 5
1.7 Research Questions 6
1.8 Overview of the Research Methodology........ 6
1.9 Delimitations of the Study........ 6
1.10 Summary and Organisation of the Remainder of the Study........ 6
Chapter 2: Literature Review........ 8
2.1 Introduction 8
2.2 The Global Perspective on Instructional Frameworks 8
2.3 Learner-Centred Instructional Approach 10
2.4 The Relevance of Physical Sciences in Schools 11
2.5 Instructional Strategies in Physical Sciences-Electricity 12
2.6 The Research on Learners Understanding of Electric Circuits 12
2.7 Misconceptions in Electricity (Ohm's Law) 14
2.8 Computer Simulations in Electric Circuits........ 16
2.9 Teaching and Learning using various Instructional Strategies: The South African Context 17
2.10 Frameworks for the Study 19

2.11 Chapter Summary....24
Chapter 3: Methodology and Research Design....25
3.1 Introduction....25
3.2 Research Paradigm....25
3.3 Research Approach....26
3.4 Research Design....27
3.5 Research Methods....28
3.5.1 Pilot Study....28
3.5.2 Data Generation Tools and Programme Phase....29
3.5.3 Sampling....33
3.5.4 Data Analysis....33
3.5.5 Ethical Consideration....34
3.5.6 Trustworthiness of Research Approach Used....35
3.6 Chapter Summary....36
Chapter 4: Results....37
4.1 Introduction....37
4.2 Instructional Strategies: Teacher Guidance, Practical Work and Computer Simulations....38
4.2.1 Teacher guidance....38
4.2.2 Practical work....40
4.2.3 Computer simulations....43
4.3 Instructional Strategies: Learners' Preferences....45
4.4 Qualitative Interviews Responses....50
4.4.1 Learners' Views Concerning Instructional Strategies used in Electricity....50
4.4.2 Learners' Preferences of Instructional Strategies used in Electricity....53
4.4.3 Learners' Reasons Regarding Preferred Instructional Strategies used in Electricity....58
4.5 Chapter Summary....61
Chapter 5: Discussion and Conclusion....62
5.1 Introduction....62
5.2 Answers to the research questions of the present study....63
5.2.1 What are Grade 10 Physical Sciences Learners' views on Instructional Strategies used in Electricity?....63
5.2.1.1 Classroom Practice....64
5.2.1.2 School Level Environment....66
5.2.1.3 Classroom/Laboratory-Based Resources....68

5.2.2 Conclusion 70
5.2.3 Recommendation 70
5.2.4 What are Grade 10 Physical Sciences Learners' preferences of Instructional Strategies in Electricity? 70
5.2.4.1 Teacher Classroom Practice and/or Instructional Strategies 70
5.2.4.2 Rationale for Practical work 71
5.2.4.3 Teacher's Praxis 74
5.2.4.4 Element of Good Teacher Praxis: Learner's Views 75
5.2.5 Conclusion 76
5.2.6 Recommendation 77
5.2.7 Why do Grade 10 Physical Sciences Learners prefer the Instructional Strategies in the way they do? 77
5.2.7.1 Factors that Shaped Learners' Choices of Practical Work and Teacher Guidance 77
5.2.7.2 Career Aspirations 79
5.2.8 Conclusion and Recommendations 80
5.3 Limitations of the Study 81
5.4 Recommendations for further Research 81
5.5 Concluding Comments 81
References 84
Appendices 100

List of Tables

Table 1.1 *Results analysis of Grade 12 Physical Sciences (percentage achieved at 40% and higher)*..........3

Table 3.1 *The IS Programme and the Associated Phases* 30

Table 4.1 *15 Instructional Strategies*..........46

Table 4.2 *Categories of Instructional strategies that Learners Selected and Ranked*............46

List of Figures

Figure 2.1 *The Instruction Framework Model (Researcher design model)*............................20

Figure 2.2 *Instructional Strategies to Teaching Approach*..22

Figure 4.1 *Learners' Performance Results obtained during Teacher Guidance Exploration* 38

Figure 4.2 *Learners Working on the Activity during Teacher Guidance Session* 40

Figure 4.3 *Learners Sharing Ideas through Peer Discussion*...41

Figure 4.4 *Learners Working Together to Construct the Circuit Board* 42

Figure 4.5 *Learners Recording Data from the Circuit Board Constructed*............................42

Figure 4.6 *Learners Engaging in Discussion about the Result(s) obtained* 43

Figure 4.7 *Learner actively Engaging with PhET Simulation Computer Software*................44

Figure 4.8 *Electric Circuit Constructed using a PhET Simulation Computer Software* 44

Figure 4.9 *A Learner Helping a Classmate to Understand better the Functions of PhET Simulation Computer Software* 45

Figure 4.10 *Frequencies of 15 IS Ranked by Learners as the Most Favoued* 47

Figure 4.11 *Frequencies of 15 IS Ranked by Learners as the Least favoured* 48

Figure 4.12 *Frequencies of IS Selected by Learners as Most Effective and Useful* 48

Figure 4.13 *Frequencies of IS Selected by Learners as Least Effective and Useful*................49

Chapter 1

Introduction and Background

1.1 Introduction

In this chapter, the background to the research topic will be outlined. This background description will provide the context in which the study was derived. Thereafter, this is followed by a detailed description of the problem statement being studied. A brief significance of the study will then be considered to show the importance of conducting the research. Frameworks will be detailed to show how the study was designed. Objectives and research questions of the study are discussed and finally, the research methodology used in the study will be briefly described.

1.2 Background to the Study

One of the key principles that foreground the South African science curricula include an emphasis on learners' ability to "identify and solve problems and make decisions using critical and creative thinking" (Department of Basic Education: DBE, 2011, p. 4). The importance of instructional strategies (IS) as key components of educational values for learners at different levels is, however, not explicitly stated except for practical activities. If the curriculum aims to mould active and critical thinkers, then this aspect of IS assumes even greater importance for teachers. Indeed, for example, IS such as identifying similarities and differences; homework and practice; summarizing and note-taking; setting objectives; cooperative learning, and providing feedback were put forward. They added that teachers should assess the instructional need for each learner and match that requirement with the appropriate strategy.

Following the revision of the first National Curriculum Statement - *Curriculum 2005* - the National Curriculum Statement (NCS) was established (Warnich & Meyer, 2013). As referred to earlier, it can be inferred that IS, though not explicitly stated, had since been a basis for the development of learners' educational outcomes (e.g., skills, knowledge & understanding and values) essential for them to be creative and critical thinkers. The development of critical thinkers has since remained as one of the key challenges facing educators (Warnich & Meyer, 2013). Thus, it is reasonable that the current National Curriculum Statement (the Curriculum and Assessment Policy Statement [CAPS]) for Physical Sciences, Grade 10-12, is also foregrounded on the principles that emphasise active and critical learning, that is, those that encourage "an active and critical approach to learning, rather than rote and uncritical learning of given truths" (DBE, 2011, p. 4).

From a practical perspective, our current education system experiences several challenges which at some points are not in harmony with the principles of CAPS for Physical Sciences. This issue is not new. For instance, earlier studies on IS in Physical Sciences, such as that by Hobden (2005) provided an insight into what teachers teach and how they do that. According to Hobden (2005, p. 308), "prescriptive syllabus and high-stakes matric examinations" have had influence on IS. He elaborated that the scientific inquiry was marginalised over solving numerical problems in preparation for examinations. Ramnarain and Hlatswayo (2018) add that the nature of inquiry is mainly to focus on the active involvement of the learners strictly on the 'why' and 'how' other than on the 'what' to ensure learners are able to gain a better understanding of what science is and how it is practiced. Today, CAPS for Grades 10-12 seems to encourage persistence of little involvement of the nature of inquiry in classroom context. For instance, it leaves little room for innovation and creativity on the part of teachers in interpreting how and what to teach. This includes the techniques teachers should use to help learners become independent.

1.3 Problem Statement

The issue of high school learners' poor performance in Physical Sciences in Electricity has been a problem to the education system in South Africa (Letsoalo et al., 2019, p. 20). Electricity in Physical Sciences is the subject content taught in Grades 10 to 12 (Further Education Training Band). It should also be noted that some elements of this section (Electricity) are introduced at General Education and Training Phase (GET) Grades 8 and 9, however, the focus of the study will be on Grade 10 learners since most of the concepts in this grade lay the foundation for the subject at Grade 12. Physical Sciences play an important role not only to the South African citizens but globally through the influence it has on scientific and technological development. It also contributes to the country's economic growth and the social well-being of its people (Fuzani, 2018). Education in South Africa holistically has been a controversial issue due to the performances obtained in the recent years mainly in Mathematics and Physical Sciences learning areas. Research by Simelane (2019) shows that South Africa for many years produces fewer learners in Physical Sciences due to poor performance. This is based on evidence for the past five years; the matric results nationally have been very disappointing. Table 1 on the next page shows matric results analysis at National level down to school level for the past five years (DBE, 2021). It also indicates the minimum admission percentage required for the subject (Physical Sciences) at tertiary institutions for science related degrees.

Table 1.1

Results analysis of Grade 12 Physical Sciences (percentage achieved at 40% and higher)

Years	2016	2017	2018	2019	2020
National	39.5%	42.2%	48.7%	51.7%	42.4%
Provincial	23.0%	27.3%	48.5%	51.2%	46.0%
School	0.1%	0	14.0%	11.1%	33.0%

Note. Adapted from 2021 National Senior Certificate examination report, by Department of Basic Education, 2021, Government Printers.

The study by Bhaw and Kriek (2020), also indicate that only 14% of learners from 2018 National Senior Certificate examination met the minimum entry requirements to study towards an undergraduate science degree in South Africa. Factors associated with decline in performance of Physical Sciences at secondary school were IS, lack of practical experiments and inability of learners to solve problems by integrating their knowledge from different topics in Physical Sciences, school resources for science department, content knowledge, parental involvement from motivational point of view, teachers' qualification in the subject content, class size and incompletion of the syllabus in a year (Letsoalo et al., 2019). Physical Sciences results in the NSC examination further show that the subject has poor results in questions relating to electric circuits (DBE, 2021). Moreover, the diagnostic report by DBE (2021) highlights poor performance in questions based on practical work, especially on Electricity.

As a science teacher, teaching the subject Physical Sciences from Grade 10 to 12 for the past 10 years. Teaching this subject at the under-resourced school has always put my learners at a disadvantage when comes to answering practical related questions and higher order questions because learners were always exposed to a theoretical-based teaching method. If learners' participation in practical experiments, like in Electricity, were introduced at early grades, it will not only boosts their confidence but also develop their problem-solving skills (Mngonyama, 2018). This suggests that the ultimate goal of Grade 12 improvement in Physical Sciences results should be focused on a good foundation starting from the lower grades.

The problem highlighted in this study is that there is a deficiency and a lack of emphasis in relation to instructional strategies (IS) in schools and learners' views and preferences of IS have been largely silent, hence a need to explore that, particularly within the South African context. This also calls for all Physical Sciences' teachers from Grade 10-12 to review their IS because our learners need to be adequately developed with problem-solving abilities, not only for high stakes matric examination but for obtaining skills needed to face global competition (Apriyani et al., 2019). The shortfalls created by the CAPS document on IS for Grade 10-12 should be addressed and appropriate IS implemented to ensure that learning strategies for learners are independently and appropriately selected to be used effectively to accomplish their learning goals. Thus, the study sought to explore Grade 10 learners' views and preferences of IS in Electricity in Physical Sciences.

1.4 The Significance of the Study

The value of this study is three-fold. First, it will help Physical Sciences teachers to improve their IS and assist them with important aspects that need to be considered when teaching the subject, especially the topic - Electricity. For example, teachers need to know, and understand suitable IS for a given topic in a particular context, as well as learners' different learning styles (e.g., whether learners prefer group work, practical work, simulations etc.). It is anticipated that Grade 12 learners' performance might improve if suitable IS are implemented especially in Grade 10. Secondly, the study will contribute to the community of researchers by providing a platform to access similar study materials for interventions needed on preferences of IS in Physical Sciences from township learners. Thirdly, this research will assist policy makers by informing them about learners' preferences of IS in Physical Sciences so that teachers can be assisted in planning their science lessons better. Through the results of this study, teachers will also be provided with training workshops with the aim to develop them about the relationship between learning styles and choosing appropriate IS.

1.5 Frameworks

1.5.1 Theoretical Framework

The study was informed by Constructivism Theory in concurrence with Social Constructivist Theory (SCT) ascribe to the work of Vygotsky (1980). The two theories were merged because learners in class were taught under the new paradigm Learner-Centred Approach, as they construct the knowledge for themselves. Furthermore, they worked in groups (group work is amongst the Instructional Strategies that was explored). Constructivism Theory in education has been a significant development in the attempt to avoid teachers being the centre of learning (Wilson, 2011). Teacher-Centred Approach as the only strategy where teachers are dominant in class has always placed the learning process at a disadvantage. Since the new development called constructivism, learners are now at the centre of their learning because they can construct knowledge through exploration and discovery as they encounter new experiences. Kapelari (2015, p. 3) adds that constructivist learning puts the focus on the learner that constructs knowledge while building upon the understanding that exists. This implies that learners come into the classroom not as empty vessels but with prior knowledge. In addition to constructivism, social constructivist theory (SCT) was applied in this study. According to Samuel (2017), SCT emphasize that knowledge construction take place through social interactions in the society. Furthermore, social constructivism is also a socio-cultural theory that supports that learning occurs because of social interaction with a knowledgeable individual. The concept of constructivism as active involvement during the mediating of learning also contributes to a better understanding of science (Samuel, 2017). Mediating learning is ascribed mainly to Vygotsky's theory, which state that learning subsuming under social constructivism is based on fundamental concepts known as the Zone of Proximal Development (ZPD). This is said to be a region between what a learner can do on his or her own and what he or she can do with the help of others including a teacher. The theories mentioned above were used to assist in framing the study since group work was one of the IS that were explored as preferred by learners.

1.5.2 Conceptual Framework

Instructional Strategies as a comprehensive plan in education provide directions to be followed by teachers to successfully implement fundamental aims of instructions (Akdeniz, 2016; Wahl, 2017). These instructions influence learners' achievements as well as teachers' applications to accommodate the diversity of learners' learning styles in class. On the other hand, IS are sets of principles used to devolve knowledge to learners and assist in creating a conducive environment for teaching and learning (Akdeniz, 2016; Wahl, 2017). In terms of practices, IS ensure that learners are actively involved with the subject matter through active learner participation. Therefore, it was important to utilize different IS, methods, and styles to accommodate the diversity in our classrooms. The study was framed on learner-centred approach (LCA) and IS, particularly in Electricity under the following categories: direct, indirect, interactive, experiential learning, and independent study. In this regard, the researcher was in a better position to examine different IS that could be used to explore Grade 10 learners' choices about their preferences of IS in Electricity.

1.6 The Purpose and Objectives of the Study

The purpose of this case study was to explore Grade 10 learners' views and preferences of Instructional Strategies in the topic Electricity in Physical Sciences at a school in Umlazi. As context plays a major role in this type of research studies, the study also sought to investigate the learning experiences that shaped the learners' preferences of IS at their school.

The objectives of conducting this research were:

1.6.1 To explore Grade 10 learners' views about the Instructional Strategies used in Electricity at their school.

1.6.2 To explore Grade 10 learners' preferences of Instructional Strategies used in Electricity.

1.6.3 To examine contextual factors that influence learners' selection of Instructional Strategies in the teaching of Electricity.

1.7 Research Questions

To accomplish the objectives, the following three research questions were formulated:

What are Grade 10 Physical Sciences learners' views on Instructional Strategies used in Electricity?
What are Grade 10 Physical Sciences learners' preferences of Instructional Strategies in Electricity?
Why do Grade 10 Physical Sciences learners prefer the Instructional Strategies in the teaching of Electricity in the way they do?

1.8 Overview of the Research Methodology

The research methodology espoused in this study is discussed in more detail in chapter 3. An interpretative paradigm with a qualitative approach was made use of to explore Physical Sciences learners' views and preferences of IS in Electricity. The current paradigm is complemented with the transformative type which entails action research. A case study served as a design for the study and three methods of data generation were used, specifically questionnaires, video recording for observation data, and one-on-one interviews. Reliability and validity of these instruments, ethical considerations and limitations are discussed in more detailed in Chapter 3.

1.9 Delimitations of the Study

The study was limited to Grade 10 learners' views and preferences of Instructional Strategies in Electricity, and factors that shaped the views. The research was restricted to the learners learning Physical Sciences in school in Umlazi, Durban, KwaZulu Natal, South Africa. The researcher also selected the participants' school based on it academic performance for the past five years (see Table 1.1).

1.10 Summary and Organisation of the Remainder of the Study

This chapter presented the contextual background of the study. The introduction, background, problem statement, significance of the study, frameworks, objectives of the study, research questions, the methodology and delimitations of the study were outlined. Although this introductory chapter briefly discussed the contextual background of the study, more detailed chapters are to follow. Some of the aspects examined in this introductory chapter are discussed in Chapter 2, where a detailed description of literature on them is discussed as well. Chapter 2 further discussed an extensive review on the main ideas and themes regarding IS and Electricity in Physical Sciences. Chapter 3 focused on the methodology in more detail describing the contextual factors that favour the interpretivist paradigm for the study. Sampling method discussed in Chapter 3, data generation tools, instruments, sampling strategy, reliability, validity, and ethics of the study. Chapter 4 discussed the results of data generation of the research for the qualitative instruments. Chapter 5 discussed the findings of the study and further gave concluding remarks, thereafter, suggested recommendations, and finally pointed out limitations of the research.

Chapter 2

Literature Review

2.1 Introduction

This chapter presented in eight sections. The thrust of the chapter will be on the review of literature enshrined in Instructional Strategies (IS) in Physical Sciences and learners' preferences thereof.

The teaching and learning process is considered complete when it entails both learners' acquisition of educational outcomes and their active participation in it. As such, in this study, learners were allowed to have a say in how IS are employed when learning about science topics such as Electricity. Thus, the first section is focused on IS in science from an international perspective. It also provides overviews of learner-centred approaches to teaching science, the relevance of Physical Sciences at schools, IS in Physical Sciences-Electricity, research on learners' understanding of electric circuits, misconceptions associated with the teaching and learning of the topic Electricity, and computer simulations in electric circuits.

As in teaching and learning, context is crucial in research. Therefore, the use of IS in the South African context is also focused upon.

Finally, the study also presents details of the conceptual and theoretical frameworks that informed it.

2.2 The Global Perspective on Instructional Frameworks

Instructional Framework (IF) has long been a key in the teaching and learning process because it outlines the interrelationships among proposed instructional strategies to sound educational practice (Saskatchewan Education, 1991). Very few researchers attempted to define Instructional Framework. For instance, Fries et al. (2020) define IF as a structure that guides instructional design for the development of understanding and transferable knowledge. Pelanek (2020), emphasises the ability of instructional methods as they (IF) depend on the kind of relevant knowledge components and learning processes. Nevertheless, the long-standing Saskatchewan Education (1991) definition provides more elaborate illustrations and definitions of IF, namely, "IF identifies and provides interrelationships among instructional approaches including Instructional Models, Instructional Strategies, Instructional Methods, and Instructional Skills that form the basis for the development of both the science and the art of teaching" (p. 12). Hence, this definition is a useful reference pointing towards the goals of education. Instructional Framework (IF) further identifies and illustrates the inter-relationships among all the instructional approaches that are used and acknowledged to be consistent with sound educational practices. Thus, one may argue that every teacher must determine instructional approaches that are better suited for individual learners so that they can be supported accordingly. The instructional approaches have been adopted in this study to address learners' needs and provide them with their preferred styles of learning use the Saskatchewan Education (1991) definition. The support given to learners include the appropriate Instructional Strategies (IS) - one of the components of IF.

Saskatchewan Education (1991) defines IS as "decision making that requires teachers to focus on curriculum, the prior experiences and knowledge of learners, learner interests, learner learning styles, and the developmental levels of the learner" (p. 15). Teachers' IS, therefore, play an essential role in facilitating the teaching and learning process. Evidently, without proper IS, the core educational right of a learner will not be achieved. Therefore, teachers need to be well informed about IS for better curriculum delivery of science subjects such as Physical Sciences. IS further determines the approach teachers may use to ensure that the learning objectives are achieved. The teachers must also focus on the curriculum, learners' prior experiences, knowledge, interests, and learning styles. To succeed in the objectives mentioned above, Saskatchewan Education (1991) further points to teachers' need to rely on learner assessment continuously. Also, an important aspect of IS highlighted in the study by Kock et al. (2015, p. 46) had shown that indirect instruction could allow "learners to experience essential characteristics of scientific research processes", mainly using and creating theories, testing ideas by experiments, models, hypotheses, interpreting data, and also being involved in social processes like discussing, questioning and collaborating. Saskatchewan Education (1991) further points to the need to foreground the decisions on ongoing learner assessment. For example, IS such as direct instruction are amongst the most commonly used strategies by teachers, particularly in higher grades, because they are easy to plan and use for effective teaching and learning.

Instructional Strategies also encompass teaching methods like a lecture, didactic questioning, explicit teaching, practice, and drill and demonstrations. These methods are effective for providing information or developing step-by-step skills. Djajalaksana (2011) further argues that IS are unique instructions pervasively used in educating learners in a specific discipline to prepare for their future professions. This indicates that different methods of teaching need to be implemented to ensure quality inclusive education among students.

Teachers, through proper IS, create a stimulating learning environment to ensure necessary instructional tools will facilitate learning and help learners gain quality education. As part of IS, active learning also allows learners to learn from each other in small groups through collaborative learning, cooperative learning, and problem-based learning (Leo & Puzio, 2016). Furthermore, active learning is encouraged as it involves hands-on activities, learners' involvement in the discussion, and collaboration in group learning (Leo & Puzio, 2016). Proficiency in solving problems in Physical Sciences is one of the learning goals as stated by many curricula, for example, in the Indonesian curriculum, it is a main focus (Supeno et al., 2018). Supeno et al. (2018) went further to argue that problem solving as part of the indirect instructional strategy is an essential skill to be developed in learning Physical Sciences. Also included in problem solving is higher-order thinking skills for cognitive processes if the desired solution is unknown as in the case of Physical Sciences problems.

The study by Von Korff, Archibeque and Gomez (2016) points to two additional IS, namely, discussion and experiment, as strategies that can enhance a better understanding of Physical Sciences in the classroom and to get learners actively involved. Discussion as interactive instruction also promotes collaboration amongst learners in sharing of ideas about something to reach a decision. It also helps learners build a positive classroom climate and lead them to subject interest. On the other hand, experiment as experiential learning develops learners' investigative skills, observation skills, and how to formulate a hypothesis for a test that is being carried out. By virtue of being interactive and experiential in nature, the two IS thereof are also very useful for teaching Electricity. Research conducted amongst 10^{th} grade learners in Kabupaten Bandung Barat in Indonesia indicates an increase in learners' problem-solving potential with the application of the integrated model problem and project-based learning as aspect of IS in direct current electricity on STEM-based education (Apriyani et al., 2019). Cooperative learning has also made a positive significance in the study conducted by Miriam and Salam (2020) on learner achievement in Physical Sciences. Furthermore, the study has shown that collaborative learning strategies such as cooperative learning amongst learners might positively impact achievement, especially when learners learn in collaboration. Thus, the instructional strategy of cooperative learning as an interactive instruction promotes greater motivation, higher achievement, and more positive interpersonal relations among learners.

2.3 Learner-Centred Instructional Approach

The learner-centred approach (LCA) is a paradigm shift from the teacher-centred approach (TCA), where the teacher is the primary source of knowledge and learners are spectators and just recipients of the knowledge. According to Kitta and Tilya (2018), LCA is an innovative concept of education that cultivates learners' ability to solve practical problems. Learners do not learn much just by sitting in the classroom and listening to teachers, memorising class activities and providing answers but they should discuss concepts they are learning, have a meaningful conversation, relate them to past experiences and apply it to their daily lives. Mkimbili (2018, p. 8) further states that LCA is the type of instruction rooted in constructivism - a philosophical approach in which learners are prioritised when teachers plan and implement their teaching. In LCA, learners are also given an active role in creating knowledge and monitoring their learning and, in the same breath, acquiring creative and critical thinking skills. LCA puts learners first in contrast to TCA. LCA departs from the traditional IS lecturing by focusing on learners more than teachers and learning more than teaching, and practical activities such as panel discussions, quizzes, projects, brainstorming activities, role plays, debates, textbook study, field trips, where discovery learning takes the centre stage (Shah, 2020, p. 46). Thus, it could be argued that LCA as a style of instruction is responsive, collaborative, problem-centred and democratic. Both learners and teachers decide how and when learning occurs.

2.4 The Relevance of Physical Sciences in Schools

Physical Sciences is offered as a subject combination of Physics and Chemistry in South African schools at the further education and training (FET) band. According to the Department of Basic Education: DBE (2011, p. 8), this subject should offer learners an opportunity to study "physical and chemical phenomena through scientific inquiry, application of scientific replicas, theories and laws to clarify and predict events in the physical environment". As subject content, it is concerned with everything that has to do with learners' background and everyday knowledge. It is taught to develop the science process skills (SPS), which have always been part of the curriculum for lower secondary school (Hodosyova et al., 2009). Science process skills are also activities (e.g., observing, measuring, interpreting information, etc.) that scientists perform when solving problems or answering questions. It should be noted that the development of SPS is an interdisciplinary matter, because topics of all science subjects imbricate each other in common science concepts (Hodosyova et al., 2015). For example, chemical systems; matter and materials; chemical change; waves, sound, and light; mechanics; and electricity and magnetism are standard in science subjects. These concepts associate subjects thematically, and they are the source of the creation and development of interdisciplinary relations.

Achievement in subjects such as Physical Sciences, in the examination for the national senior certificate in South Africa, is very important. Science-related degrees at higher education (i.e., universities) usually admit learners who have passed Mathematics and Physical Sciences. The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences clearly states that the subject is critical in "economic development, social well-being, sustainable environmental management and disease prevention" (Department of Basic Education: DBE, 2011, p. 8). For example, Physical Sciences learners can become qualified medical doctors, engineers and so forth, which is of great value for the country's stability.

Physical Sciences in schools aims to acquaint learners with their environment and equip them with skills to investigate physical and chemical phenomena (Department of Basic Education: DBE, 2011). CAPS also point to a critical role played by Physical Sciences in encouraging skills and knowledge in problem-solving and scientific inquiry. The knowledge obtained in Physical Sciences further enable learners to understand how to not only solve problems within the society, but also provide an aggregate of skills such as categorising, communicating, measuring, designing an investigation, drawing, and evaluating conclusions, formulating models, hypothesising, identifying, and controlling variables, inferring, observing, and comparing, interpreting, predicting and reflective skills. These skills are required to understand electrical circuits.

2.5 Instructional Strategies in Physical Sciences-Electricity

Physical Sciences is a subject that provides learners with scientific skills and knowledge. Instructional strategies (IS) in Physical Sciences "point the ways and approaches followed by the teachers, to achieve the fundamental aims of instruction" (Akdeniz, 2016, p. 61). Certain IS need to be employed to ensure that learners are always kept active during the teaching and learning process. For instance, argumentation-based science teaching is the kind of IS discourse through which arguments are individually and collaboratively constructed and evaluated based on empirical or theoretical evidence (Özdem Yilmaz et al., 2017). Furthermore, the constructivist views of science education highlight that argumentation is a social constructivist learning practice that guides significant gains in the learners' epistemological understanding of science. Learners get to develop not only conceptual understanding of science, but also the way scientific knowledge is constructed, especially in topics like Electricity. To develop learners' problem-solving skills in Electricity, teachers need to help learners understand that drawing a diagram can facilitate problem solutions (Maries & Singh, 2018).

Teaching concepts in Electricity and conducting experiments in a laboratory allow learners to work as a group, collect data using an investigative strategy while analysing experimental values, compare findings and present the results (Mngonyama, 2018). It should also be noted that well-structured and interactive demonstrations can increase learners' understanding of concepts and stimulate curiosity in Electricity (Kácovský & Snětinová, 2021). They are a learning strategy that combines a traditional lecture format with an active engagement of learners. Meanwhile, inquiry-based learning touch on learners' critical thinking skills in their quest to build their understanding of interactions with phenomena, and the environment (Yuliati et al., 2018). Computer software such as PhET simulations is another form of IS that support learners' engagement and understanding of physics concepts, especially in Electricity. For Ponto (2020), the use of "collaborative teaching is the most effective method of teaching" Electricity (p. 5). It promotes learners' interest in the subject matter and critical thinking. In short, effective teaching and learning of Electricity can be achieved through collaborative settings that tap into learners' critical thinking skills.

2.6 The Research on Learners Understanding of Electric Circuits

Research studies that focus on learners' understanding of electric circuits, internationally and locally (South Africa), reveal many challenges related to learners' conceptions of electric circuits due to the abstract nature of the associated concepts (Lin, 2016). Learners who lack understanding of a complete circuit for the electric current flow hold a unipolar model that assumes that it (electric current) flows from one battery terminal into the bulb. The unipolar model, in general, is a learners' initial developmentally earliest model of charge flow (Lin, 2016). On the other hand, the clashing-current model assumes that electric current flows from the battery terminals and runs through them until they reach the bulb. Another model, the crossing-current model, assumes that electric currents flow from both battery terminals. Further models such as the attenuation and sharing models state that electric current flows from one battery terminal through the bulb into the other terminals, and it is identical all over the series circuit. The attenuation model also assumes that the bulbs use up the electric current in a way that the first one will be brighter than the second; to some extent, this signifies that in the sharing model, the electric current is shared equally by the two bulbs (Lin, 2016).

A study by Lombard and Simayi (2019) has revealed that schematic diagrams used by teachers to teach at urban schools in the Eastern Cape, South Africa (SA) showed no engagement with the tasks. It was evident that learners' challenges in understanding concepts concerning electric circuits when they were taught using schematics diagrams, it was only done for the examination purposes for which learners were not prepared. The schematic diagrams created a lot of confusion in class as a result the key concepts of electric circuits could not be understood. Schematic layouts of electric circuits provide learners with a simplified version of what is happening inside real electronic devices; however, they can be difficult to comprehend since they have complex interconnections (Gumede, 2020). The intention of the schematic diagrams is to convey necessary information about electric circuits that can be easily understood by learners.

The introduction of analogies has always served one purpose to learners, namely, to present new concepts in electric circuits (Korganci et al., 2015). In this regard, one could argue that analogies are utilised to assist learners study the visualisation of abstract concepts, allowing for comparison between their real-world and new concepts, and increasing motivation. In terms of facilitating understanding of the abstract concepts, Tangible analogies also help learners in making the process of understanding easy for the abstract concepts by pointing similarities between objects or events in the learner's world. Furthermore, analogies can also motivate such that, as teachers use specific ideas from the learner's experiences. From a teaching perspective, analogies can stimulate conceptual change in science learning since they open new points of views, and play an important role in scientific discoveries, not as proof, but as inspiration (Korganci et al., 2015, p. 2464). Analogies are also part of many pedagogical resources used to present scientific concepts for a better understanding of electric circuits. Yet, to some extent, they might be taken for granted that they are easy to comprehend and utilise. Apart from analogy-based IS, research papers on inquiry-based instructional approaches and technology-driven report that the use of the IS mentioned above can help learners improve conceptual formation.

The issue surrounding difficulties in understanding the relationship between critical concepts in electric circuits is not just a South African problem (Gumede, 2020). Korganci et al. (2015) showed that high school learners in Romania found it difficult to understand basic concepts of electric circuits compared to those of mechanics. This may be due to different factors, including electric charge because we cannot see the movement of charge carriers electrons in an electric wire. The study further states that teachers should use different concepts of electric circuit models that will enable learners with difficulties to come up with mental pictures of their own current flowing in a circuit. For example, water circuit analogy has been proven helpful (Ismail et al., 2018). First, it shows several fundamental electric circuits properties to learners. Secondly, it dissipates some of the battery and light bulb misconceptions.

2.7 Misconceptions in Electricity (Ohm's Law)

The majority of high school learners do not like Physical Sciences lessons simply because some of the associated materials are very abstract, making the subject content difficult to understand (Hesti, 2021). The challenge of the dislike thereof could be rooted in the lack of supporting laboratory equipment, poor IS such as teaching physics with the lecture and discussing methods. To some extent, teachers often rely entirely on reading a book when teaching the subject, which reinforces learners to memorise formulas, hence the knowledge deficiency in aligning the content so that it makes sense to them (Hesti, 2021; Popat, 2021). The difficulty of learners understanding the concept and the failure of teachers to teach the concept properly can lead to misconceptions. Most physics teachers start teaching the chapter on Electricity at the secondary level when they introduce the concept of electric current but neglect the fact that the basic principle of electric current begins with that of charges (Popat, 2021). This again gives rise to the confusion of learners when they are in the process of learning. As a result, the element misconceptions are created.

Many models and methods can be utilised to learn Ohm's law, but none of them can explain the law in detail (Popat, 2021; Prastyaningrum & Pratama, 2019). Ohm's law serves as the fundamental one concerning Electricity, with a "potential difference (V) directly proportional to the magnitude of the flow of current (I), provided the physical condition is kept constant" (Popat, 2021, p. 88). If such a law is misinterpreted, then misconceptions are formed. Misconceptions are false beliefs in a learner's mental model (Hesti, 2021). They are also wrong ideas about a particular concept and are often found firmly upheld by learners and thus difficult to rectify or change. They usually require specific processes in changing them to the correct conception. Therefore, teachers need to ensure that misconceptions are eliminated because learners use the concepts they have in mind to interpret new phenomena.

The following are some of the commonly used misconceptions by learners in Ohm's law:

- Current is a flow of electrons due to potential difference. Electrons will flow from high potential difference towards low potential difference (Popat, 2021).
- The current is consumed by components in the circuits; the cell is a tank that stores current unit it runs empty (Brandley & Moodie, 2021).
- Learners think that wire connections without devices attached to the circuits are irrelevant and can be ignored (Shipstone et al., 1988).
- From the magnitude of resistance R=V/I in an open circuit, no current will appear because the voltage is equal to zero, then the resistance is automatically zero (Popat, 2021).
- Learners often think that positive electricity moves from the positive terminal and that negative electricity moves from the negative terminal of a power supply; thereafter, the positive and negative electricities meet at a device and clash, thereby powering the device (Heller & Finley, 1992).
- Learners think that power supply release the same fixed amount of current to every circuit (Cohen et al., 1983: Johsua, 1987).
- The current is proportional to the potential difference or voltage. (Considering that voltage and the potential difference is the same) (Popat, 2021).
- Learners think that the further away the bulb is from the battery, the dimmer the bulb will be (Heller & Finley, 1992).

Several studies have been conducted about the conception of Ohm's law. It was noted that the concept of Electricity to most learners had been a challenge (Prastyaningrum & Pratama, 2019). As a result, learners continue to experience difficulties concerning simple electric circuits. In addition, learners could not apply the concept of the relationship between current, voltage, and resistance (Mitchell et al., 2018). The study by Prastyaningrum and Pratama (2019) shows that some learners had difficulties demonstrating an electrical circuit system if the electrical circuit was changed. The difficulties suggest that cognitive levels possessed by learners were still low and a serious threat to the sustainability of learning in the classroom, not only to Ohm's law but to science education in general.

There have been several strategies and methods used to address misconceptions and promote the process of changing conceptions. These strategies include analogies, Conceptual Change Text (CCT), meaningful learning, constructivist concept maps, multiple intelligence theory and computer-assisted instruction worksheets (Hesti, 2021). Analogies are believed to impact learners' conceptual understanding of electrical circuits and assist learners in rectifying their misconceptions. For example, research on learners' conception and perception of simple electrical circuits conducted to determine learners' misconceptions shows that conceptual tests and presentation in different forms can be done to enhance the understanding of concepts (Prastyaningrum & Pratama, 2019). Moreover, the combination of CCT using computer software such as PhET simulation, animations, projection slides, and videos can facilitate converting conceptions and minimise misconceptions. The practical experiment in "the laboratory, demonstrations and other activities" should be consolidated with the textbook so that learners understand relevant scientific knowledge (Hesti, 2021, p. 2). For that, text-based methods can facilitate the need to eradicate misconceptions, especially in the development of conceptual knowledge, identifying misconceptions, and designing teaching materials.

2.8 Computer Simulations in Electric Circuits

Physical Sciences is one of the subjects offered in high school where the majority of learners' interest is less due to its complicated concepts and abstract form (Habibi et al., 2020). The subject challenges such as, for example, the lack of practical equipment for learners to conduct experiments, the inability of learners to solve problems and others (Letsoalo et al., 2020). All of the challenges thereof may result in low academic performance. However, concerning this, there must be an intervention on how to stimulate the interest of learners to learn more Physical Sciences in a meaningful manner. It is not a secret that learners learn only a little when the concepts are presented in a traditional classroom demonstration like in teacher-centred approach (Yunzal Jr & Casinillo, 2020, p. 221). This requires a call for the need to increase the efficacy of learning.

Most researchers have shown that the use of instructional material can improve the learning process. Information and communication technology (ICT) has changed in progress for many sectors including the learning space. In the current 21st century, technological advancements have entered different joints of life, especially in the field of education (Haryadi & Pujiastuti, 2020). Teachers and learners are required to possess the teaching and learning skills relevant to this era of modern times. However, to achieve those skills certain challenges require some attention. For instance, building knowledgeable communities that have ICT expertise. In the context of education, integrating ICT in the learning process will somehow enable the effectiveness of teaching and learning in classrooms for learners to engage in activities. Such activities might entail making a presentation using computers or laptops, searching for learning resources through the internet, making observational videos with mobile cell phone cameras, sending e-mails and being able to create a community of learning through social network platforms (Haryadi & Pujiastuti, 2020).

The most recent powerful educational tool that could be integrated with ICT is Physics Education Technology (PhET) software simulation (Haryadi et al., 2012). This software has the potential to support and allow teachers to deliver high-quality lessons and stress the relationship between real-life phenomena and the underlying science. They can also make the invisible visible while providing multiple representations. PhET simulation can actively engage learners and make learning processes fun and relevant. Through PhET simulation learning is supported with interactive and constructivist approaches and provides a creative workplace. The study by Haryadi and Pujiastuti (2020, p. 2) reports that the use of PhET simulation can have a positive impact in teaching and learning. That may be achieved through careful preparation and knowing and implementation stages in terms of classroom preparation, activity sheet, pre-post assessment, topic introduction and motivation, sim playtime, during sim activity, and reflections. Based on the above information, it is clear that PhET simulations are instrumental factors designed to achieve learning outcomes, such as science process skills, which are used to discover and develop scientific knowledge with a specific scientific method.

Electric circuits, a topic in Physical Sciences can be very abstract. The use of PhET simulations in this context can help learners visualise these abstractions (Phanphech et al., 2019). Phanphech et al. (2019) further argue that computer simulations are one of the tools that can be used to change learners' misconceptions in the topic like electricity. The importance of PhET simulation in electric circuits is that learners can envision the concepts and observe the results of interactions. Also, teachers on the other hand, are assisted by the software in demonstrating science lessons. Recent studies have shown that learners' understanding of science improved when learning is taking place in a technology-based multimedia environment that entails integrating movement into an on-screen representation with peer conversation (Burde et al., 2021; Phanphech et al., 2019). PhET simulation can provide learners with an opportunity to observe concepts in electricity that are difficult, time-consuming, expensive, dangerous to demonstrate in the real event but observable. Through PhET simulations learners can further control and observe experiments without any harm or inconvenience of equipment failure in their own space and time.

2.9 Teaching and Learning using various Instructional Strategies: The South African Context

The connection between teachers' beliefs on inquiry-based learning (IBL) and their teaching practices has shown that teachers were dominant in implementing a reform-based pedagogy (Ramnarain & Hlatswayo, 2018). For example, IBL gives rise to a paradigm shift from a traditional teacher-dominated to a learner-centred approach (LCA). In this approach (i.e., IBL), the role of the teacher is redefined into different roles such as, for instance, innovator, motivator, experimenter, mentor, diagnostician researcher, collaborator, learner and modeller (Ramnarain & Hlatswayo, 2018). According to Stefaniak and Tracey (2015), LCA provides positive results because it promotes amongst learners, a sense of responsibility regarding their learning. In addition, it supports learners' development through the use of different activities, provides learners with opportunities to solve authentic problems, and actively encourages critical thinking. Mupira and Ramnarain (2018) conducted a preliminary study using piloted questionnaires with Grade 10 learners seeking to explore learners' preferred IS, which pointed out two additional key factors - students' interest in science and their school environment. The study indicated that learners who took part in the research preferred the way science was taught at school because they could explore new knowledge in science and engage in areas of interest that shape their investigations in the form of IBL.

Physical Sciences in schools should be taught by qualified teachers who understand that learners have different backgrounds and contexts and varying learning styles. The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences states that this subject "promotes knowledge and skills in scientific inquiry" (Department of Basic Education: DBE, 2011, p. 8). The statement implies that instructional methods should be considered when teachers engage in lesson planning. Indeed the study by Gaigher et al., (2014) shows that South African learners performed well in a test when the instructional approach used was learner-centred. The findings suggest that Physical Sciences might be better understood through an IBL.

Direct instruction as the predominant method of teaching, needs to be evaluated and recognise it limitation of methods for growth in capacities, processes, and "attitudes required for critical thinking, and for interpersonal relations" (Saskatchewan Education, 1991, p. 16). Indeed, a recent study by Ogegbo and Gaigher (2019) shows that there is a need for teachers to advance their content knowledge, professional attitudes and IS to ensure that meaningful progress in Physical Sciences is maintained at a higher level. The argument thereof, though hardly new, points to areas that teacher training institutions should prioritise to adequately equip teachers (e.g., Physical Sciences teachers) with competencies essential to deal with the current challenges facing our education system. Learners' performance in Physical Sciences for National Senior Certificate (NSC) remains moderate, indicating that IS needs to be revised. The study by Ogegbo and Gaigher (2019) shows that less than 40% of learners achieved over 40% in Physical Sciences in 2016 NSC examination results. The researchers thereof attributed such results to the lack of practical work in schools to inadequate resources and IS commonly used. One of the aspects that might be used to address the challenges thereof is the use of appropriate IS, such as collaborative learning. The study by Olaniyan and Govender (2018) attributed collaborative learning, an interactive instruction that promotes learners working together for a common objective of solving problems to enhancing higher achievement and interactivity.

Learning science, particularly Physical Sciences, in the modern times, aims at teaching learners to be able to "understand concepts, develop process skills and also develop thinking abilities to be able to transfer knowledge" (Aidoo et al., 2016, p. 103). Aidoo et al. (2016, p. 104) also pointed to the significance of problem-based learning in this context such as scientific inquiry. For them, problem-based learning IS providing learners with the occasion to design an investigative activity using problem-solving strategies and aid students in employing an open inquiry approach in learning to apply scientific knowledge in real-life situations. The study by Akdeniz (2016) also add that IS include activities that help create the classroom environment for good-quality learning to occur. One more inquiry-based method that provides learners with an authentic environment for inquiry in science is practical work (Tsakeni, 2018). Practical work provides experiential learning in which tests are conducted under controlled conditions to reveal unknown truths while examining the validity of a hypothesis. Learners on the other hand get to demonstrate an understanding of scientific laws and theories in science and procedural knowledge through practical work instead of using worksheets.

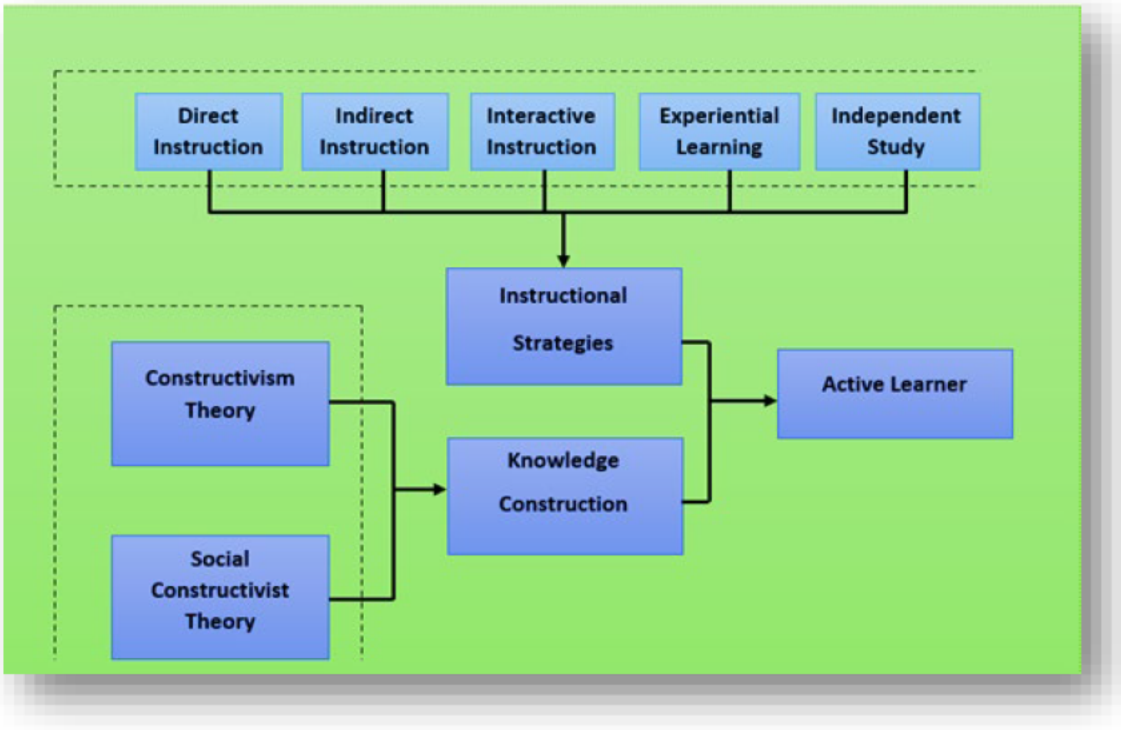
Physical Sciences is the study of inanimate and natural objects. To some extent, the subject of Physical Sciences requires so much emphasis on explanatory, predictive and evaluative function of modelling (Seel, 2017). Thus, the use of model-based teaching is essential. This IS (model-based teaching) is designed to support the development and evolution of learners' mental models for abstract and higher knowledge development (Seel, 2017). The study conducted by Seel (2017) further states that learning takes place when learners working together construct meaningful representations like models. Indeed, in Physical Sciences, different models are used to better demonstrate concepts such as electricity. Simulations have been used in Physical Sciences to enable learners to understand the concept thereof. Computer software like PhET simulation in South Africa is usually used to simulate real actions of imagination and act as the event that would take place in the laboratory (Seel, 2017). The study by Ramnarain and Moosa (2017) suggested that the use of PhET simulation with Grade 10 Physical Sciences learners had a positive impact on the reduction of the number of misconceptions learners have in electric circuits, such as "the current is consumed by components in the circuits, the cell is a tank that stores current until it runs empty" (Bradley & Moodie, 2021, p. 10). Furthermore, the features of PhET simulation allowed learners to experiment with hazardous phenomena that are usually avoided in actual hands-on practical work.

2.10 Frameworks for the Study

Constructivism theory and its derivative social constructivist theory and concepts such as direct and indirect instruction, interactive instruction, experiential learning, independent study, constitute the theoretical and conceptual frameworks that were adopted and used in this study. Figure 2.1 on the next page represents the Instructional Framework Model that is integrated with the theoretical frameworks.

Figure 2.1

The Instruction Framework Model (researcher designed model)



Constructivism and social constructivist theories are theories that emphasise the notion of knowledge construction. The knowledge is constructed through social interaction. For example, constructivism is the process of constructing meanings and knowledge by the learner (Mngonyama, 2018). According to Taber (2019), constructivism is commonly used in education, especially in the social science discourse. Constructivism is also "associated with philosophical and sociological stances that question the traditional views of the nature of public knowledge" (Taber, 2019, p. 2). For Bada and Olusegun (2015), constructivism is an approach to teaching and learning based on the premise that learning results from mental construction. In other words, learners learn by connecting new information with what is already known. This is also how learners acquire knowledge and learn from the psychological point of view. Learners will always try to acquire their mental model of the natural world from their perceptions of that world (Bada & Olusegun, 2015). As they perceive new knowledge, learners will continue to update their mental models to reflect the latest information and construct their interpretation of reality. Constructivism is used when "learners take charge of the learning situation, as in problem-based learning" (Agarkar, 2019, p. 855). Thus, it provides opportunities for interaction among learners so that they can be able to derive new meaning for themselves. However, it should be noted that the teacher's role has changed significantly from that of a person imparting information to the one facilitating the construction of knowledge (Agarkar, 2019).

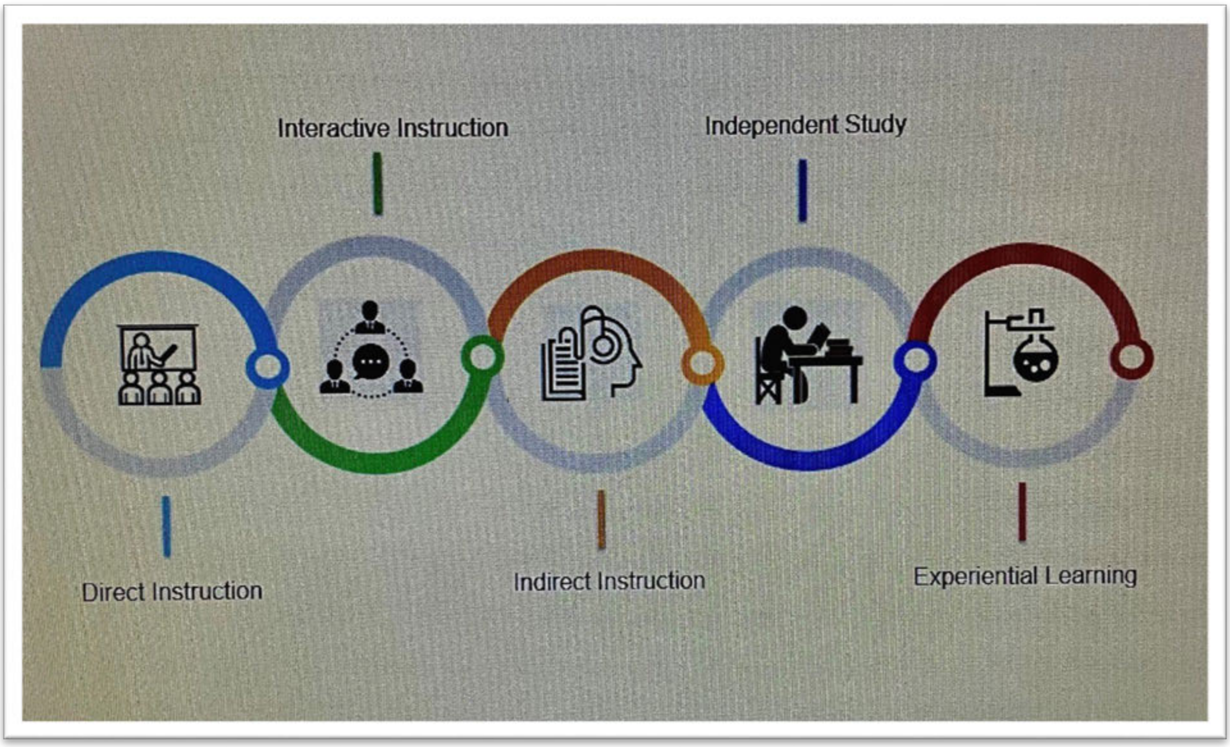
On the other hand, social constructivist theory (SCT) is ascribed from the work of Vygotsky (1980) - the father of SCT. His work was also based on John Piaget's idea, the child as an active learner (Adam, 2017). Through the lens of SCT, learners try to understand everything in their society through knowledge construction, while teachers assist learners in terms of resources that are easily accessible (Gumede, 2020; Samuel, 2017). SCT conceives an active construction of knowledge on the part of learners and unifies and transforms the mind, environment (socio-cultural) processes into new, embodied forms of knowledge (Gumede, 2020). Samuel (2017) argued that all the things that humans do show that real and meaningful learning occurs when individuals are involved in social events. Therefore, the learners must be equipped with skills that will be used in society so that they can fit into it. In other words, the school curriculum should be designed in such a way that it can address the needs of society. SCT perspectives on learning maintain that cognitive development is a social process and reject the notion that it is an individual process (Barak, 2017). Learning is considered a social, cultural, and motivational process acquired from subconscious discourse and communication with meaningful people (ibid). SCT is a socio-cultural theory that supports that learning occurs due to social interaction with a knowledgeable individual (Samuel, 2017). This approach highlights that knowledge is constructed through social encounters where learners are placed at the centre of learning.

The two theories indicate that knowledge cannot be constructed in isolation but through the interactions of individuals working together. For instance, learners' conceptions of knowledge are derived from a meaning-making search in which learners construct individual interpretations of their experiences (Amineh & Asl, 2015). Therefore, learners' constructions during the assessment of tasks and experiences yield knowledge which is filtered through a process of social negotiation. The constructivist approach to teaching, highlight the key important points regarding teachers IS, in a manner that their role is to take measures to ensure that the process of learning takes place. Learners on the other hand show signs of being responsive to the process implemented to indicate that knowledge has been constructed through finding new meanings (Rankhumise, 2012).

Several teaching strategies may be used to determine the approach teachers may take to achieve learning objectives. These strategies can be classed as direct, indirect, interactive, experiential, and independent. Saskatchewan Education (1991, p. 15) argued that for teachers to make an informed decision regarding instructional strategies (IS), they "need to focus on the curriculum, the prior experiences, and knowledge of learners, learner interests, learners' learning styles and the developmental levels of the learner". Those decisions rely solely on a continuous learner assessment linked to learning objectives and processes. Figure 2.2 below represent five Instructional Strategies to teaching approach according to Mancosa (n.d.).

Figure 2.2

Instructional Strategies to Teaching Approach



Note. The image of teaching strategies adapted from Mancosa (n.d.)

The *first* instructional strategy **direct instruction** - a learning model that is highly on teacher-centred approach (TCA), and is often used to introduce new learning topics to provide instructions to the learners (Al-Kadi, 2018; Risdianto et al., 2020; Saskatchewan Education, 1991). Direct instruction is well suited for learning basic skills learners need to make sense of concerning what is being taught. Saskatchewan Education (1991) further contend that this strategy includes lecture, demonstrations, explicit teaching, practice and drill and, didactic questioning.

The *second* instructional strategy **interactive instruction**. This is another instructional strategy that encourages LCA (Ukata & Nmehielle, 2021). This instructional method allows learners to engage in ideas and experiences, give an insight into the knowledge from other peers, and generate other ways of solving problems. Furthermore, the interactive strategy allows learners to have a platform where they can learn from each other and their teachers in terms of developing social skills and abilities to solve problems. Interactive instruction depends mostly on discussions and sharing information among other learners (Saskatchewan Education, 1991). The study by Saskatchewan Education (1991) further argued that, through discussion and sharing, learners can develop rational arguments and organise their thoughts.

The *third* instructional strategy **indirect instruction**. This instructional strategy favours learner-centred approaches (LCA) in which learners are active and teachers passive (Saskatchewan Education, 1991; Ukata & Nmehielle, 2021). Terms like decision making, inquiry, inductive, problem solving and discovery are all associated with indirect instruction (Saskatchewan Education, 1991). Thus, the methods used for indirect instruction include concept formation, reflective discussion, guided inquiry and problem-solving. Indirect instruction also looks for a higher level of learner involvement in formulating hypotheses, observing, drawing inferences from data, and investigating. Indeed Ukata and Nmehielle (2021) showed that this instructional strategy (the indirect type) normally creates room for a high degree of learners dominating the learning environment and taking charge of what is learned. Furthermore, it usually stimulates the learner's interest, curiosity, and eagerness to learn different ways of solving a problem since they are in control. It is a strategy that is flexible, probing, reduces fear and enhance the learner's confidence.

The *fourth* instructional strategy **independent study**. Independent study fosters the development of individual learner initiative, self-improvement and self-reliance (Saskatchewan Education, 1991). It also includes learning in collaboration with other individuals or the form of a small group. Saskatchewan Education (1991) further suggests, in independent studies, that the primary educational goal is to assist learners in becoming self-sufficient so that they can be responsible citizens, think critically and enhance their inner potential. Even though the school provides help to learners for their growth as independent learners, there are factors associated with independent learning that needs to be acquired. For example, knowledge, attitudes, abilities, and processes. It is a fact that learners will always be guided under the supervision of the teacher (Ukata & Nmehielle, 2021). Nevertheless, learners must construct knowledge for themselves provided their supervisors have cemented a proper foundation. Independent study has many benefits.

The *final* instructional strategy **experiential learning**. In this case, the focus here "is on the process of learning rather than on the product" (Saskatchewan Education, 1991, p. 16). The kind of instructional strategy inductive, activity-oriented, and applies to LCA. Moreover, it (experiential learning) can be used in and outside the classroom. For instance, learners in the classroom can construct an electric circuit or engage in computer software – PhET simulation. Whereas outside the classroom, learners can conduct a field survey. Experiential learning utilises different kinds of resources (Saskatchewan Education, 1991).

With the combination of the listed instructional strategies and the theories appropriately implemented, an active learner could be produced with knowledge constructed through social interactions.

2.11 Chapter Summary

In this chapter, the relevant literature that supports the research was discussed. The global perspective on instructional frameworks, learner-centred approach to teaching and learning of science, the relevance of Physical Sciences at school, IS in Physical Sciences-Electricity, research on learners' understanding of electric circuits, misconceptions associated with the teaching and learning in Ohm's law, and computer simulations in electric circuits was detailed. The study further discussed teaching and learning using various IS in the South African context, which gave historical importance of IS in science learning for the local context. The researcher also noted and highlighted the limited number of studies that focused on IS preferred by learners in the topic of Electricity within the South African context. The review of literature also revealed a paucity of documented research relating to the learners' views on IS in Electricity. However, it noted that most of these studies focuses on the teachers' IS. The South African CAPS document was reviewed. The inadequacy of IS in this challenging subject such as Physical Sciences in the policy document was also noted. Therefore, there was a need for research to explore learners' views and preferences of IS in Electricity was important.

The chapter gave a detailed review of the frameworks that frame the current study through the model. The constructivism and social constructivist theory were presented as the theoretical frameworks which informed the study. The five categories of IS, namely direct, interactive, indirect, independent study and experiential learning were discussed as conceptual frameworks which also framed the study. The review of literature and theories provides an insight into the study and has informed the research design, analysis, findings and recommendations.

The next chapter discusses the methodological framework and research techniques used in the study.

Chapter 3

Methodology and Research Design

3.1 Introduction

The aim of the study was to explore Grade 10 learners' views and preferences of Instructional Strategies in Physical Sciences for the topic Electricity. This chapter presents the research methodological orientations that guide the study. The chapter entails an overview of the paradigms employed, that is, a descriptive interpretive paradigm complemented with a transformative type. The latter accommodates action research. Thus, the study employed a qualitative approach. The associated case study design was used as this was an in-depth study of Grade 10 learners' preferences of IS in Electricity. The design is an exploratory type. Furthermore, the chapter provides reasons underpinning the choice of data generation tools (i.e., questionnaires, video recording, and one-on-one interview), suitable sampling method used and issues concerning the trustworthiness of the research approach adopted as a basis for producing reliable and valid data. The chapter concludes by discussing ethical measures, delimitations and limitations of the study.

3.2 Research Paradigm

Kivunja and Kuyini (2017) define a paradigm as a philosophical way of thinking. It constitutes the abstract beliefs and principles that shape how a researcher sees the world, interprets, and acts within that world. It includes several components "categorised as ontology, epistemology, methodology, and methods" (Alharahsheh & Pius, 2020, p. 40). Paradigms are thus important because they provide beliefs and also dictate which discipline can influence scholars on what should be studied, how it should be studied, and how the results of the study should be interpreted (Kivunja & Kuyini, 2017).

The study used an interpretive paradigm because it seeks "to understand the subjective world of human experience" (Cohen et al., 2018, p. 17) and believes in socially constructed multiple realities (Rehman & Alharthi, 2016, p. 55). Interpretive paradigm also assumes that reality is subjective and can differ considering different individuals (Alharahsheh & Pius, 2020). For Thanh and Thanh (2015), this paradigm uses qualitative methods such as case studies and ethnography, which are enshrined in the qualitative research approach. The paradigm used was complemented with the transformative type, which entails action research. This paradigm (transformative) focuses on the realisation that researchers have a responsibility to understand the participants they work with to challenge the societal processes that maintain the status quo (Laher & Kramer, 2019). Combining the two paradigms have assisted the researcher in terms of understanding learners' preferences of IS since truth and reality are created, not discovered.

3.3 Research Approach

The research approach in this study is qualitative. According to Creswell and Creswell (2018), qualitative researchers tend to collect data in the field where participants experience challenges in a natural setting. In relation to the present study, such challenges may be due to a need for suitable IS that can be used in a classroom in a particular context. Aspers and Corte (2021, p. 600) defines qualitative research as an iterative process in which an improved understanding to the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied. Qualitative research uses soft data that is presented in the form of words, sentences, impressions, pictures, symbols, etc., because this kind of research is dynamic and a competitive field with many inconsistencies and point of view (Mulisa, 2022).

In qualitative research approach, researchers gather their data through interacting directly with the people while observing their behaviour and interviewing them. For example, a researcher may observe, utilising video recording, learners engaging in practical work to explore certain IS preferred by learners. Researchers also review all the data generated through multiple sources, including questionnaires, interviews, and video recordings, to try and make sense of it, then organize it into codes and themes through inductive and deductive data analysis to better present the data of the study. To ensure the authenticity of qualitative data, researchers focus on exploring phenomenon (e.g., preferences of IS preferred by learners) even if it means the design of the study should change; in qualitative research, there is no prescribed one method of collecting data, this is regarded as emergent design (Creswell & Creswell, 2018).

Qualitative research approach, in most cases, comes into play when the research is more exploratory where contextual variables are less well understood. This kind of research is also characteristically exploratory, flexible, data-driven, and context-sensitive to the extent that the researcher studies the subjects in their natural settings, attempting to have an understanding about phenomena (Levy & Moore, 2018; Mason, 2017; Mertens, 2014). For Creswell and Creswell (2018), "qualitative researcher seeks to establish the meaning of a phenomenon from the views of participants". Qualitative research approach is also known to accommodate reflexivity. In this case, researchers should abstain from interpreting data based on their background and experiences because that is considered as advancing biases into the study (Creswell & Creswell, 2018). Instead, they should develop a complex picture of the study's problem to report on different factors interacting in different ways. This is usually called a holistic account. Qualitative approach research was employed because the researcher intended to examine the experiential data generated to explore IS preferred by learners in a classroom in a township school in Umlazi. Moreover, the researcher had an opportunity to interact with the participants at a personal level through one-on-one interviews. Learners shared their views and experiences about their learning journey at school. Furthermore, the researcher was also excited to learn that learners had certain preferences of IS in Physical Sciences.

It should be noted that, in relation to this approach, information is usually collected directly through interacting with the learners, and observing their behaviour within their context. Qualitative researchers generate data themselves by also interviewing learners. Researchers as key instruments are the ones who generate data and elucidate it without relying upon others. Different sources of data generated such as questionnaires, observations in practical experiments, and interviews are important because the qualitative study does not rely on a single data source (Creswell & Creswell, 2018).

In qualitative research approach, data is analysed inductively and deductively so that categories and themes are formulated for the better abstract units of research and, thereafter, data is revisited from the themes to determine more evidence for the additional information of the study (Levy & Moore, 2018).

Participants' meanings play a crucial role in a qualitative study because the researcher is able to focus on learning the meaning that the participants hold about the problem and understand the participants from a reflexive point of view.

It was vital for the researcher, as the teacher of the participants in the current study to adopt the above-mentioned features of qualitative research because the study became a *case* explored in terms of the participants' experienced challenges within the school.

3.4 Research Design

The study utilised a case study research design. This kind of research design is an exploratory type that seeks to find a new and deeper understanding of the phenomenon (Mertens, 2014, p. 305), in this case, IS preferred by learners. For Yin (2018), a case study investigates a case to understand the real world. It also depends on numerous sources of evidence for triangulation purposes. Case study strategies are usually based on "a written description of a problem or a situation, where small group problems are presented on a particular issue" (Rahi, 2017, p. 2). For example, the group that makes up the case might be learners of a particular grade at school. In this case, Grade 10 learners proved to be a suitable case worth being studied because it constitutes the foundation phase that provides prerequisite knowledge and skills in Electricity to enable them to better understand the topic in a higher grade (Grade 12). It should also be noted that case study research allows for multiple data generation and analyses (Cohen et al., 2018). The current study used three data sets of data generation tools, namely from questionnaires, video recordings, and one-on-one interviews.

As referred to earlier, it was important that the transformative paradigm complemented the current interpretive one. Thus, the researcher used an action research approach to consolidate the case study research design that was employed. Cohen et al. (2018) state that action research is a methodology for researchers to understand and generate knowledge about educational practices and their complexity. It was the kind of approach that was used in any setting where a problem involves people, tasks, and procedure that needs a solution. Likewise, this research study has entailed tasks in which learners were actively engaged in solving problems related to the topic - Electricity. Thus, it is inevitable that practical work had to be used in which learners collectively discussed a phenomenon under study while working towards a common goal. The practical work dovetailed with the use of complementary activity such as simulations. Simulations, as an instructional strategy, allows learners to do practical work without being physically present in the laboratory. Cohen et al. (2018) further elaborate that this action research approach can be undertaken by the individual teacher within a school.

3.5 Research Methods

Researchers embarking on qualitative studies usually generate data in the field where participants experience problems (Creswell & Creswell, 2018). This is called a natural setting. In this section, the researcher maps out the stages that were taken concerning the research process. These included information about the piloting of the study, the current programme's phases and the associated tools used to generate data that was used to answer the research questions, the sampling method that was employed as well as the method/technique that was used to analyse data generation tools. The study has also detailed the ethical measures that were applied in the study and the approach of trustworthiness to ensure rigor.

3.5.1 Pilot Study

Pilot studies have several functions. For instance, they are used to increase the reliability, validity, and practicability of data generation tools, such as questionnaires and interviews. Pilot studies also enable researchers check the clarity of both questionnaires and interview schedules and gain feedback on the validity of these two data generation methods (Cohen et al., 2018). Piloting the instruments may allow the researcher to check whether the questionnaire is too long or too short and whether it is too easy or difficult. Piloting data generation tools also assist researchers in the feasibility of a study and provide an advantage to be gained as early as possible so that any problems are identified obstacles to overcome rather than impediments to completion (White, 2011, p. 244). For the current study, questionnaires and one-on-one interview schedule were piloted. There were many aspects that needed to be considered by the researcher when he did the piloting of the instruments. For instance, the instruments were first given to the researcher's supervisors so as to examine whether the contents were ambiguous and the structures of them were appropriate. This first stage was therefore for expert validation. Thereafter, the questionnaires were then given to the participants of the study (learners) to check whether the questionnaires were clear and easily understood and whether they were too long or not. The one-on-one interview schedule was validated by the teachers who were not teaching in the Grade 10 classes.

Data generation tools were subjected through a series of changes post pilot session. For instance, the second questionnaire (Appendix 2) and third questionnaire (Appendix 3) were amended from the series of IS reduced to three IS (i.e., teacher guidance, practical work, and computer simulations) where the study's exploration was based on. The interview schedule was also revised as well to align to questions of the interviews with the new questionnaires mentioned above.

3.5.2 Data Generation Tools and Programme Phase

Qualitative research data mode of inquiry can be generated using various methods including questionnaires, practical observations, one-on-one interviews, textual analysis, applied ethnography, and many other methods (Mkandawire, 2019). In this study, the piloted questionnaires and interview schedule were used at various phases. The research that is qualitative can be broadly defined as the kind of inquiry that is naturalistic and deals with non-numerical data. Data is generated to understand and explore rather than explaining and manipulating variables. It should be noted that, though the data generated was not numerical, enumeration was applied.

This section outlines different phases of data generation and further unpacks the associated tools that were used to generate data.

In order to provide a clear description of the usage of data generation tools, it was essential that the study's programme is outlined. It was implemented in three phases, namely brainstorming of IS, selection of IS and one-on-one interviews (Table 3.1). Apart from the interviews thereof, several questionnaires were also used to generate data.

Table 3.1

The IS Programme and the Associated Phases

Phases	**Description**
Phase 1: Brainstorming	Brainstorming sessions included descriptions of the IS used in the present study's questionnaires to generate data. The brainstorming entailed use of different video clips of the IS for the purpose of clarification. Thereafter, learners were given opportunity to *rank* the IS. As referred to elsewhere, several questionnaires were used. They contained some IS. The first questionnaire (Appendix 1) was administered to generate data on learners' ranking of the 15 IS items. The learners were expected to *rank* the IS in terms of their effectiveness and usefulness in Physical Sciences at school and provide reasons for their choices.
Phase 2: Selection of implemented IS	As this was a case study intertwined with action research, it was important that the learners were engaged in learning *experiences* that entailed use of several IS. The learners engaged in problem-solving activities which included *teacher guidance, practical work, and computer simulations.* This was then followed by a selection of an IS, now in the second questionnaire (Appendix 2), that they considered the most effective and useful in Physical Science at school (out of the three thereof) and give reasons for their choices. Learners were also expected to select the least effective and useful IS (Appendix 3) and provide a reason for their choice. The data from the three questionnaires was analysed and the findings were used to inform the contents of the data generation tool in Phase 3, that is, one-on-one interviews.
Phase 3: One-on-one interviews	The final stage of the data generation process was one-on-one interviews (Appendix 4). Then, the country was under lockdown level 1 due to increased Covid-19 infections. Nevertheless, the interviews went ahead and were conducted under strict Covid-19 protocols. The interview sessions were meant to provide data/information about contextual factors that influenced the learners' choices of the IS.

Questionnaires. Qualitative questionnaires such as the open-ended (unstructured) are among the best ways to generate data; they are commonly used in qualitative research to capture the audience's views or opinions (Kumar, 2011) such as those of learners in explorational studies concerning IS (i.e., teacher guidance, practical work, and simulations). This kind of questionnaire does not contain boxes to tick only but instead leaves a blank section for participants to write their opinions based on their answers. They also offer the benefits of standardised and open responses to various topics from a large sample or population (Cohen et al., 2018, p. 471). The most appropriate way to generate data to ensure content validity is by conducting qualitative research with direct communication with the participants of interest (Ricci et al., 2019). This indicates that the questionnaire should fully reflect participants' perspectives and relevance to their condition. The generation of the questionnaire items should also involve participants of interest through qualitative methods.

In the current research study, the questionnaires were used to generate data that would answer the research questions one and two associated with the learners' views and preferences of IS in Electricity.

Questionnaire 1: Instructional Strategies

Questionnaires are an important source of information for evidence-based research (Alexandrovsky et al., 2020). Information was needed regarding the learners' *opinions* about the IS **(question one)**. The questionnaires used contained examples of direct, indirect, interactive, independent, and experiential learning IS that formed the basis for the learners' ranking. Moddley and Gaigher (2019) used a questionnaire to explore teachers' perceptions and learners' misconceptions in electric circuits. In the current study, it was also essential that the learners engaged in a problem-solving activity to identify their misconceptions while exploring the planned IS.

Questionnaire 2: An Effective and Useful Instructional Strategy

The second and the third open-ended questionnaires were also tailored on the questionnaire 1's contents. However, they were now focused on the implemented IS, that is, teacher guidance, practical work, and simulations. This kind of questionnaires could have been an attractive device for smaller-scale research, and for those sections of the questionnaire that invite an honest, personal comment from respondents in addition to ticking numbers and boxes (Cohen et al., 2018, p. 475).

It should be noted that, although the researcher was involved in the data generation process, he experienced challenges in terms of ensuring that the participants provided answers to all the questions of the questionnaires. Moreover, there is a possibility that the participants did not read the questions in the questionnaires properly before they provided their responses.

One-on-one interview. Creswell and Creswell (2018) eloquently elaborate on the purpose of interviews and their characteristics. According to them, the purpose of an interview is to understand, evaluate or assess a person, situation, or event in some respect. Interviews are one of the flexible tools for data generation, enabling multi-sensory channels to be used such as verbal, non-verbal, seen, spoken, heard, and written. Interviews can do what surveys cannot. For instance, they can explore issues in-depth to see how and why people frame their ideas in the way they do. For Cohen et al. (2018, p. 508), interviews as a research tool may range from the formal types set of question asked and the answers are recorded on a standardized schedule to less formal ones in which the interviewer is free to modify the sequence. Still, the informal interview is structured such that it may have several key issues which s/he raises in conversational style instead of having a set of questionnaires. In this study, it was equally important that the researcher used interviews so that it complemented and supplemented the qualitative research design that has been employed and the information concerning the study's objectives. The difference between the two methods, that is, questionnaires and interviews, is that in the latter, the interviewer asks questions if necessary, explains them and records the respondent's replies on an interview schedule; in contrast, the former's replies are recorded by the respondents themselves (Kumar, 2011). The interviews assisted the researcher in terms of providing complementary and supplementary data that could be used to examine the contextual factors that influenced learners' selection of IS (question 2 and 3). The researcher engaged in one-on-one interviews in which there were six interviewees. These learners were in the top three and bottom three in terms of academic performance.

The schedule was framed around themes that were discovered during the preliminary study in which the interviews schedule was piloted.

Video-recording material. Video recordings were used to capture a hands-on practical and classroom-based IS. This provided an insight into challenges learners experienced during the implementation of three IS preferred by them (learners). Video recording can also overcome the partialness of the observer's view of a single event and further offer a more unfiltered monitoring record of natural human behaviour in real-time and maintain the sequence of the event, including the capacity for completeness of analysis and comprehensiveness of material (Cohen et al., 2018, p. 556). This was conducted under strict conditions of Covid-19 protocol. The resultant data was used to supplement data from the questionnaires and interviews.

It should be noted that the limitations of the interviews had warranted the use of video-recording material as the participants were interviewed by the researcher who is their subject teacher for Physical Sciences. The presence of the subject teacher in the one-on-one interviews could have had some impact on the research in terms of the responses provided by the participants.

3.5.3 Sampling

The present study utilised purposive sampling. This sampling method is usually based on a researcher's judgment about who can provide the best information to achieve the study's objectives (Kumar, 2011). It was employed by selecting participants from the learners doing science at school. The participants were twenty-five (25) Grade 10 learners specifically doing Physical Sciences. The selection of the 25 learners was based on their academic performance (i.e., high, middle, and lower ranking). The researcher, as the teacher of the participants, understood and acknowledged the conundrum in power redistribution that goes with the study's research design. Therefore, learners were allowed to participation in the research voluntary, they can withdraw themselves at any time.

3.5.4 Data Analysis

Questionnaire: as a method of generating data may at some point produce different types of data, including the numerical. When numbers are used in a qualitative questionnaire's data analysis, new meanings are discovered (Dey, 1993). In this case, a basic statistical method was employed to analyse data generated from Grade 10 learners' responses concerning the questionnaires. as data generation tools. Thereafter, data generated from *ranking* the IS was manually exported into a spreadsheet. After that, data was organised based on the research objectives and research questions and presented in textual and pictorial formats, such as tables and graphs.

Interviews: Interviews, as social and interpersonal encounters, sometimes pose a challenge to qualitative researchers to the extent that the interviews reduces data set to interpret and distil the essence of participants' descriptions (Flick, 2014). Understanding the main ideas is accomplished by applying codes to transcripts (Appendix 5) conceptualised through extensive reflection and memo writing (Flick, 2014). For the current study, data generated from the interviews was analysed based on the statements and data relevant to the phenomenon being examined. This included coding and categorising information into themes.

Video-recorded material: Video recorded material do not faithfully reproduce reality; rather, they are ideological interpretations and selections from reality because they are a particular version or view of reality (Creswell & Creswell, 2018). Researchers are urged to interrogate the moving images with caution in light of the research questions and to understand a more valuable and ideology-critical reading of their content (ibid). The present researcher analysed the video-recorded material based on two levels – textual realism and subversive. The researcher first started with an overall view of the recorded material, thereafter, noting themes, impressions and key points. Then, the researcher went into details. For example, the scenes, events and sequences that directly addresses the research questions of the study. After the first and second level views, the researcher was able to look for points of resonance, consonance, dissonance and contradiction between the two levels of analysis.

Holistic analysis of the results. As referred to elsewhere, the researcher generated data in three different sources - questionnaires, one-on-one interviews and video-recorded material. The use of multiple data generation methods particularly helped the researcher in the study for triangulation purposes.

3.5.5 Ethical Consideration

All professions are guided by a code of ethics that has evolved over the years to accommodate the changing ethos, values, needs and expectations of those who hold a stake in them (professions) (Kumar, 2011, p. 217). Ethical measures by principles of conduct are considered correct, especially in those professions that need to be observed at all costs in a research study to ensure the protection of both the researcher and the participants. Confidentiality and anonymity are part of the ethical measures. Coffelt (2017) describes confidentiality as modifying any personal or identifying information provided by participants from the data. On the other hand, anonymity refers to generated data without obtaining any personal or identifying information. To ensure confidentiality and anonymity of participants, researchers usually assign pseudonyms to the participants so that they cannot be traced (Coffelt, 2017). Ngozwana (2018) used numbers as codes given to the participants when transcribing and translating data. In the current research study, ethical measures were observed during a data generation. For instance:

- Participants signed a consent form (see Appendix A) expressing their willingness to participate.
- Participation was voluntary; participants had a freedom to withdraw at any time.
- In the case of minors, a separate form was issued for a minor to request permission from parents (see Appendix B).
- The study had not invaded the privacy of the participants in terms of asking for sensitive information.
- Strict confidentiality was always maintained to protect the information of the participants.
- The researcher ensured not to disclose identifiable information about participants and protect their identity.
- Participants were given codes (numbers) when transcribing and translating data to protect their identity.
- The researcher ensured that findings were reported correctly but not in the researcher's own interests.

- The researcher also avoided bias in terms of reporting on something that is not a true reflection of the research findings.

3.5.6 Trustworthiness of Research Approach

In qualitative research studies such as the current one, it is important to ensure rigor. Measures to ensure the trustworthiness of present research approach used entailed:

Credibility. It is concerned with whether the study findings represent a reliable and conceptual interpretation of the original data and whether a new and more sophisticated understanding of a situation has been provided (Cohen et al., 2018; Kyngäs et al., 2020). The present study ensured credibility through a carefully designed research process and details of the study's programme (see Table 3.1). The validity and reliability concerning the questionnaires and the data generation was employed. Sample of questionnaires were given to learners before the actual data generation and a brief explanation of the instructions in the instrument (questionnaire) in the form of video clips of (IS) to ensure reliable data is generated. Peer checking by two colleagues ensured that instrument was well understood and fit for the responses. Supervisors of the study were able to make final recommendations. Triangulation was applied in the study for different data sources to ensure a coherent justification.

Transferability. In this case, generalising from a biased sample or sub-group to a broad population needs to be considered to ensure a transferability of results, including generalising from one situation to another similar situation without considering contextual and causal differences (Cohen et al., 2018). Transferability also describes the extent to which the research findings might apply to other fields of study (Kyngäs et al., 2020). The current research has ensured that the participants and sampling techniques were clearly stated to ensure that other researchers can assess whether the results generated from this study apply to different contexts.

Dependability. It has to do with consistency to ensure that the study is dependable, consistent, and replicable over time. The research needs to demonstrate that if it were to be carried out on a similar group of respondents in a similar context, similar results would be found (Cohen et al., 2018). According to Kyngäs et al. (2020), dependability assesses the quality of integrated processes of data generated, data analysis, and theory generated in terms of conceptual structures and theoretical models. This refers to the stability of data over time and in various conditions. For the present study, the researcher has consulted colleagues familiar with the research subject to critique the findings in order to share their views.

Confirmability. It refers to the researcher's objectives; this is something that a rigorous development process contributes to in many ways, such as measuring of how well the research findings are supported by the data generated (Kallio et al., 2016; Kyngäs et al., 2020). In addition, the criticism gained through pilot testing of data generation tools, such as questionnaires has contributed to the objective development of a new data generation. This has also put a researcher in a better position to deduce whether the findings were shaped by the data generated from participants or elsewhere.

3.6 Chapter Summary

This chapter described the methodological framework used to generate data for the research. The interpretive paradigm complemented by the transformative paradigm was discussed which informed the research and followed by a discussion of the research approach and research design which was undertaken. This was followed by a description of data generation tools, an instrument used to generate data, and these include questionnaires, video recording, and one-on-one interviews. The chapter also gave a detailed description of the sampling method which was purposive to answer the research questions and for the research design. Finally, the chapter described ethical considerations and the issue of validity and trustworthiness to produce reliable and valid data. The next chapter will present the results of data generated.

Chapter 4

Results

4.1 Introduction

The previous chapter outlined the methodology employed to generate data. This chapter reports on the results obtained from data-generation phase. Data generated and the associated information are analysed in relation to the Grade 10 Physical Sciences learners' views concerning the instructional strategies (IS) that were used when teaching electricity at their township secondary school (see Chapter 1, Section 1.6). Inherent in the learners' views thereof is the assumption that learners also have their preferences of IS. Thus, the chapter also provides the analyses of data on the learners' preferences of IS used in the topic. The learners' context was also influential in their choices of the IS. Thus, the chapter is presented in two main sections.

The first two sections (i.e., Section 4.2 and 4.3) are based on the three IS – teacher guidance, practical work and computer simulations – that were explored at the learners' school, and 15 IS that were brainstormed. Thus, the data generated entailed learners' **choices** of one IS (out of the three) that they considered the *most* and *least* effective and useful in Physical Sciences at school. It should be noted that the learners were expected to **rank** the 15 IS brainstormed. The learners provided reasons for their choices and rankings. Thus, evidence from activities the learners engaged in (textual and pictorial information [e.g., photos]) and complementary and/or supplementary information from three questionnaires are used to answer the first two research questions of the study. As basic statistical method was also employed to analyse data generated from the questionnaires, further textual and pictorial information (e.g., graphs) are used to answer the two research questions.

The second section (i.e., Section 4.4) addresses the basis for the learners' choices of the IS. Evidence from **one-on-one** interviews is used. It provides a deeper understanding of the choices and rankings made from the questionnaires. The interviews were transcribed, coded, and categorised for the formulation of themes. These (themes) are classified and presented according to the research questions of the study. The analyses of data were informed by the frameworks of the research study and were used to identify Grade 10 learners' views and preferences of IS in Physical Sciences topic – Electricity.

4.2 Instructional Strategies: Teacher Guidance, Practical Work and Computer Simulations

As referred to elsewhere (Chapter 3), the study employed a case study research design because the intention was to explore the IS preferred by learners. Participatory action research was used because:

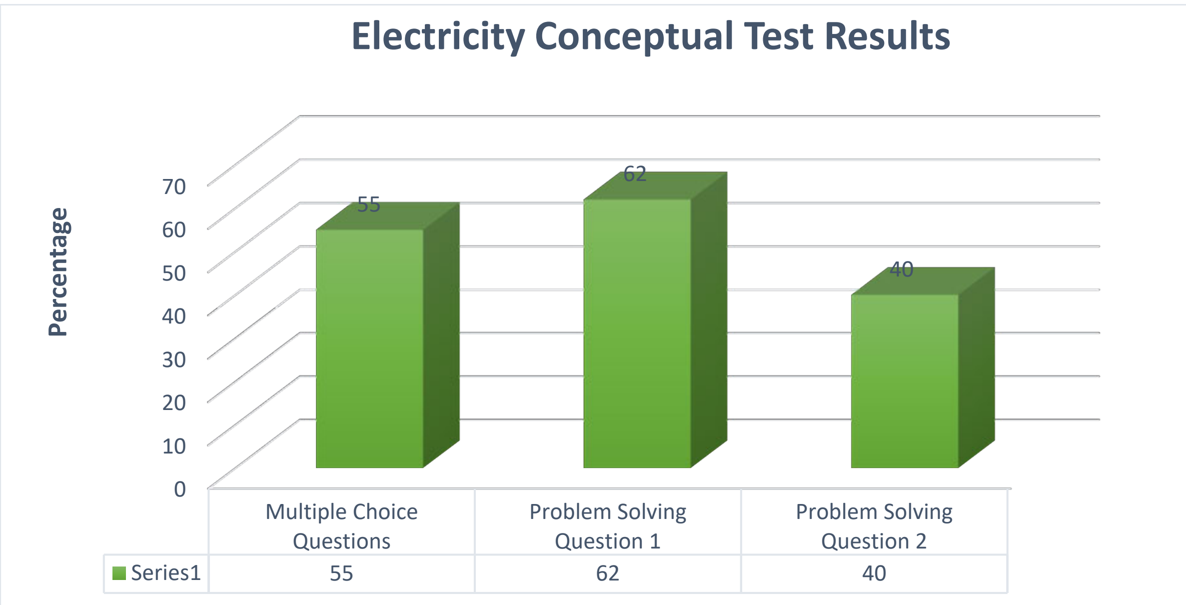
The "*constructivist paradigm* is infuenced by facets of *transformative paradig*m, such as *action research*…[which accomodates cooperative inquiries] closer to the concept of classroom action research in which teachers (sometimes with help from academics) conduct research into their own practice and ways to improve it" (Mertens, 2015, pp. 297, 311; emphases added).

The three Instructional Strategies (IS) were explored, namely *teacher guidance*, *practical work* and *computer simulations*. The idea was to enable the learners to have a theoretical and/or practical experience of these IS so that they will be in a better position to state their preferrences amongst them.

Figure 4.1 below shows the performance results obtained by the learners in percentage per question (e.g., multiple choice, question 1 and question 2).

Figure 4.1

Learners' Performance Result(s) obtained during Teacher Guidance Exploration



4.2.1 Teacher guidance

Learners often find it difficult to comprehend assessment criteria and the essence of good quality work in their field of study, such as Physical Sciences. This is sometimes evident in the challenges learners face in identifying and communicating (in oral, textual, pictorial, etc.) what teachers are looking for in an assessment task. To and Carless (2016) state that useful teaching strategies usually helps learners understand the nature and characteristics of the quality of assessment through discussing and analysing exemplars prior to taking their related task. Teacher guidance is considered the form of scaffolding for learners' cognitive development within the zone of proximal development (Hsu et al., 2015). In other words, when teachers focus on providing direct instruction for correct and incorrect answers, learners showed less elaboration and raised fewer questions. Teacher guidance also serves to explicate the characteristics of the good quality work and increase learners' critical awarerness of the differences between exemplars and their own writing (To & Carless, 2016).

The learners in the present study participated in a teacher-led interaction. They were given electricity conceptual test in class for the benefit of exploring the first IS, *teacher guidance*. This test had two parts, the first part was multiple choice questions and the second part was two long questions on the topic of Electricity. It should be noted that PAR is "built upon the notion that knowledge generation is a collaborative process in which each participant's diverse experiences and skills are critical to the outcome of the work" (Mertens, 2015, p. 310). In the present study, learners worked collaboratively and paid careful attention to the details of the task, which was an open test assessment in which the learners were allowed to share their thoughts and ideas through discussion pertaining to it (the task). Some of the aspects that the researcher observed is that learners were comfortable in their engagement with the task. They were able to ask questions and sought clarifications on the details of the questions concering the task. Other learners had an opportunity to seek clarification from the teacher in terms of whether they were correct in relation to their answers to the task at hand.

The researcher also noticed that as the exploration of the IS – teacher guidance proceeded, learners were excited about the assessment as well. Others would seek guidance from the teacher based on the appropriate approaches to answering the questions. This was essential because peer discussion and teacher guidance play a significant role in engineering a supportive learning environment for positive transfer of insights (To & Carless, 2016). Indeed through the synergy between teacher guidance and learner involvement in this study proved useful in enabling the learners generate ideas and negotiate meanings. Furthermore, teacher guidance, in tendem with peer discussion, allowed learners to articulate their options about the characteristics of the task and obtain cognitve and emotional support from their peers.

Figure 4.2 (below) and Figure 4.3 (on the next page) are two of the samples of photographs taken during the teacher guidance session.

Figure 4.2

Learners Working on the Activity during Teacher Guidance Session

4.2.2 Practical work

Practical work in the science classroom that falls within the inquiry-oriented practical where learners normally follow the procedures in the laboratory manual while they make sense of the results and concepts behind the scientific investigation (Pun & Cheung, 2021). Practical work plays a crucial role in science education. It can provide learners with the authenticity of science and through activities in which they experience scientific phenomena firsthand (Pun & Cheung, 2021). One of the teaching and learning lauded for providing authentic environment in which learners engage in hands-on and minds-on activities is the application to real-life situations (Tsakeni, 2022). The study by Wei and Li (2017) also state that practical work is often acknowledged by science teachers, science educators, and science curriculum developers as having a special role in science curricula with regard to making sense of the natural world. Practical work, as the scientific inquiry, allows learners to engage in hands-on and/or computer-based activities to discuss experimental design and the concepts behind it (Akuma & Callaghan, 2019). The skills and processes are considered to be as vital as theories in science (Pun & Cheung, 2021). Such skills and processes also inform learners about how science can be applied in practice as there is a wide range of practical work in the science classroom. It should also be noted that constructing knowledge through collaborative practical work is a complex procedure and it involves the use of multiple modalities by group members.

Figure 4.3

Learners Sharing Ideas through Peer Discussion

Practical work was conducted with selected participants. Learners were grouped into five teams and each team had its own set of practical equipment, that is circuit board, bulbs, wires, switch, etc. The exploration of this IS was based on investigating the resistance of resistors in series and parallel connections. During the experiment learners worked together, shared ideas, communicated with one another and engaged in discussions. In a science classroom context, learners working on practical tasks in groups are expected to discuss and follow lab procedures and record any noticeable results (Pun & Cheung, 2021). Learners in the current study were observed sharing ideas in the form of discussions to constructing the circuit board and recording any changes from the voltmeter and ammeter readings. Moreover, learners were excited about the practical experiment conducted durinng the exploration of the instructional strategy in question since it was not a common practice at school. The researcher was also present in the session to ensure that all the groups do the practical as expected.

Figures 4.4, 4.5 and 4.6 (next page) shows three samples of photographs taken during the practical work session.

Figure 4.4

Learners Working Together to Construct the Circuit Board

Figure 4.5

Learners Recording Data from the Circuit Board Constructed

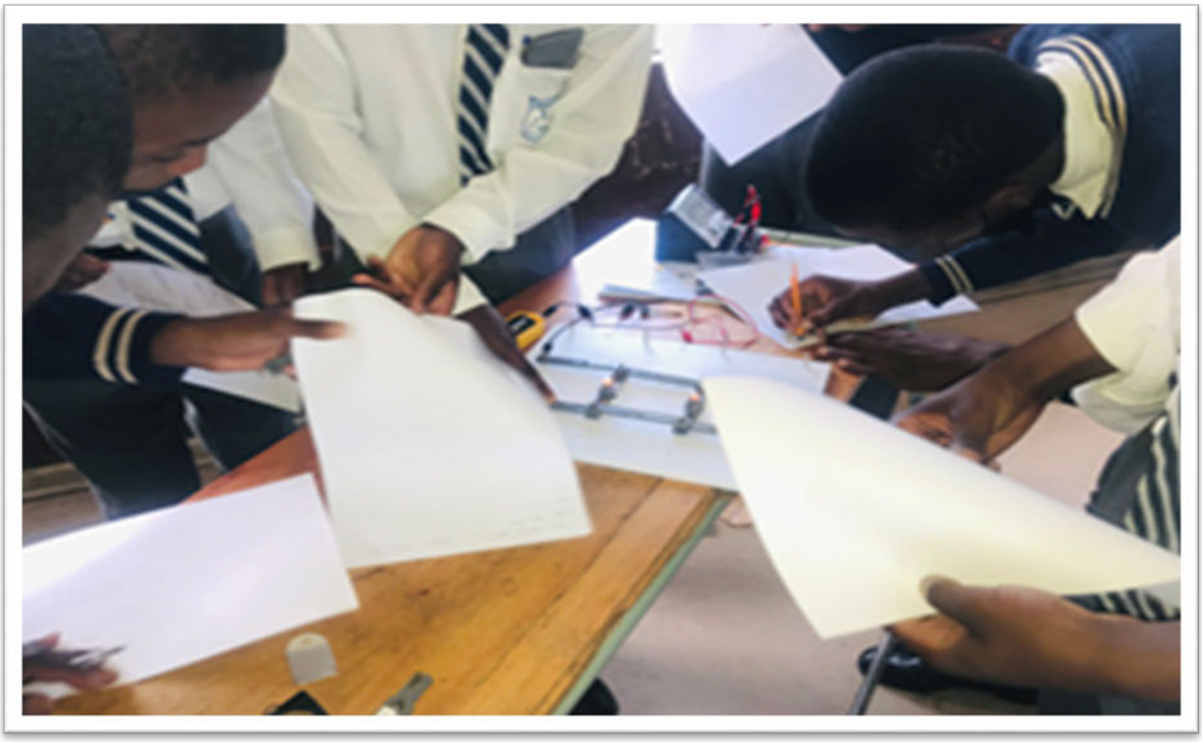


Figure 4.6

Learners Engaging in Discussion about the Result(s) obtained

4.2.3 Computer simulations

Computer simulations have been dealt with in-depth under the literature review. However, this instructional strategy has the potential to enhance learners' understanding of abstract concepts in Physical Sciences. Learners' understanding of abstract concepts is enhanced by interactive computer simulations as compared with traditional pedagogical approaches (Nxumalo-Dlamini & Gaigher, 2019). The learners used this learning tool on their own with limited support from their teacher. They worked in groups and each member of a group was given an opportunity to experiment with the learning tool. Most of the learners found the IS more interesting and user-friendly.

Figures 4.7, 4.8 and 4.9 (next page) are three of the samples of photographs showing learners actively experimenting with the learning tool computer simulations.

Figure 4.7

Learner actively Engaging with PhET Simulation Computer Software

Figure 4.8

Electric Circuit Constructed using a PhET Simulation Computer Software

Figure 4.9

A Learner Helping a Classmate to Understand better the Functions of PhET Simulation Computer Software

4.3 Instructional Strategies: Learners' Preferences

In the present study, it was important that the researcher afforded the learners an opportunity to select instructional strategies (IS) they preferred (i.e., favoured) from a pool of them. As referred to elsewhere (Chapter 3), in order to elicit a new and deeper understanding of the learners' views, scaffolding had to form the basis for the data generation phases of the study. This included brainstorming the IS and problem-solving activities tailored to the selected instructional strategy.

In this section, the researcher drew from the Saskatchewan Education's (1991) framework of IS to explore the learners' choices. The framework was adopted because it formed the basis for many IS in the Literature (e.g., see Akdeniz, 2016). Fifteen (15) IS were presented to the learners to rank as the most favoured and the least favoured. Table 4.1 (next page) presents IS used in the present study.

Table 4.1

15 Instructional Strategies

Instructional Strategies
Demonstration
Didactic Questioning
Teacher/Lecture
Problem Solving
Enquiry to Investigate
Concept Mapping
Discussion
Co-operative Learning group
Brainstorming
Homework
Research Project
Assigned Questions
Field Trips
Conducting Experiments
Simulations

Table 4.2

Categories of Instructional strategies that Learners Selected and Ranked

Instructional Strategies	**Categories**
Demonstration, Didactic questioning and Teacher/Lecture	Direct Instruction
Problem solving, Enquiry to investigate and Concept mapping	Indirect Instruction
Discussion, Co-operative group and Brainstorming	Interactive Instruction
Homework, Research project and Assigned questions	Independent Study
Field trips, Conducting experiments and Simulations	Experiential Learning

Figures 4.10 to 4.13 present the ranking of the IS that the analysis of three sets of questionnaires showed they had selected. As Dey (2003, p. 4) pointed out that “there is no reason to exclude quantitative methods, such as enumeration and statistical analysis, from qualitative toolkit”, basic statistical analysis was used in the present study. Figure 4.10 shows that learners selected demonstration

as the most favourable IS. On other hand, teaching/lecture was selected as the least favourable IS (see figure 4.11). However, this IS (teaching/lecture) also indicated almost a tie between most favoured IS and least favoured IS. These findings suggest that certain percentage of learners in class consider the IS as effective and useful in Physical Sciences.

The data results in Figure 4.10 shows that learners were more comfortable when the teacher is present in the classroom and helping them throughout the lesson. The implication is the teaching and learning process should be guided by the teacher at all times so that learners can have the opportunity to seek clarity whenever they need to.

Furthermore, the results show IS that were selected as the most favoured and the least favoured. Figure 4.10 shows that most learners selected *demonstration* as the most favoured instructional strategy. on the other hand, Figure 4.11 shows *teaching/lecture* as the least favoured instructional strategy. It should be noted that although other IS were also selected by the learners, the researchers' focus was based on the ranking of number 1 (most favoured) and number 15 (least favoured). The selection of demonstration as the most favoured IS maybe due to the research being conducted during Covid-19 pendamic and/or traditional mindset of learners.

Figures 4.10 (below) and 4.11 (next page) represent the ranking of the most favoured IS and the least favoured IS respectively.

Figure 4.10

Frequencies of 15 IS Ranked by Learners as the Most Favoued

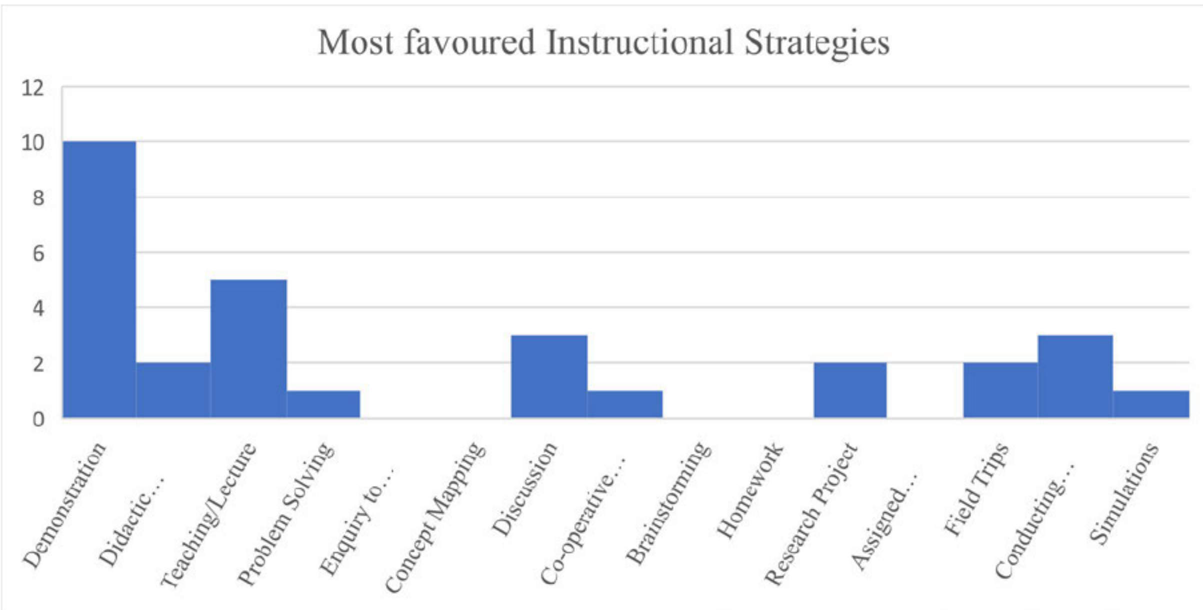
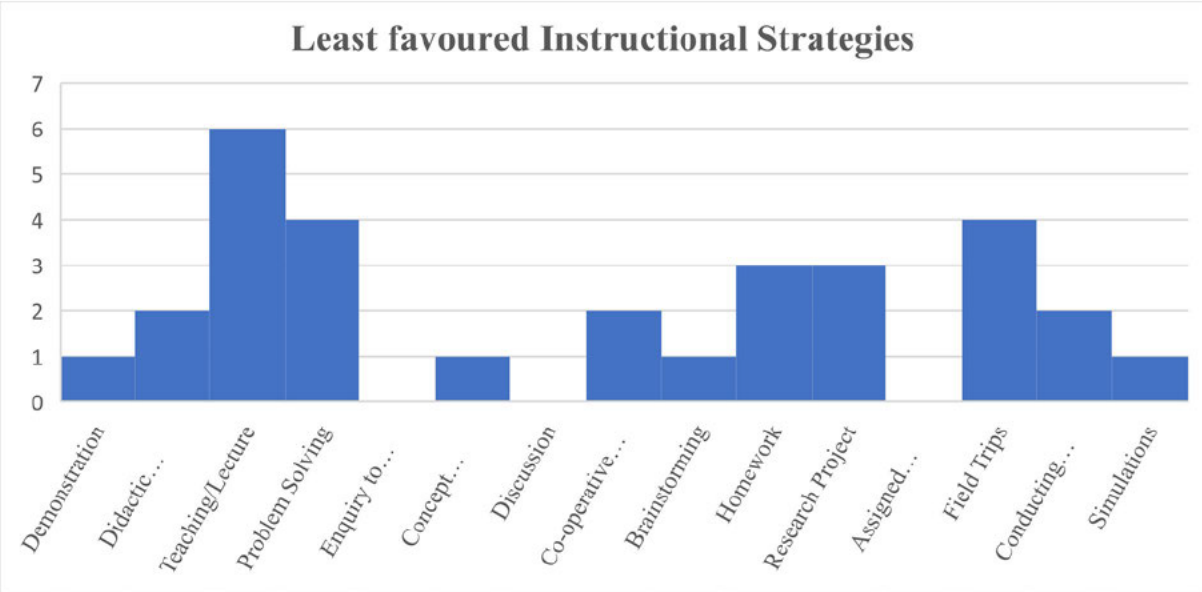


Figure 4.11

Frequencies of 15 IS Ranked by Learners as the Least favoured



The researcher further challenged the learners to select IS, in this case, the three IS that were explored, namely teacher guidance, practical work and computer simulations (see Appendices 2 and 3). The learners were instructed to selected the **most** effective and useful IS and the **least** effective and useful one.

Figures 4.12 below and 4.13 next page shows the results of the learners' selections respectively.

Figure 4.12

Frequencies of IS Selected by Learners as Most Effective and Useful

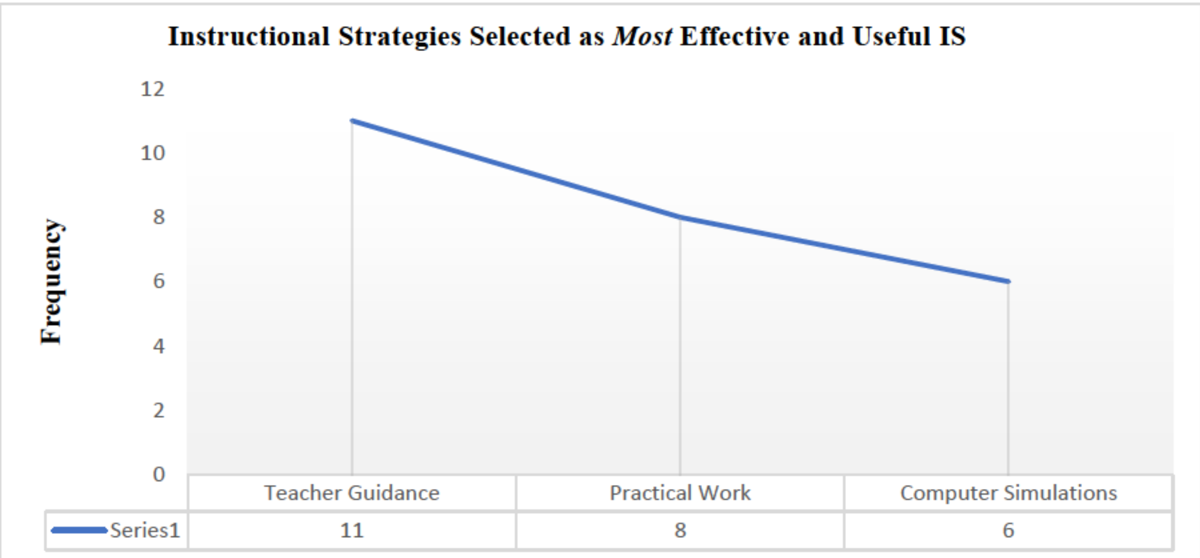
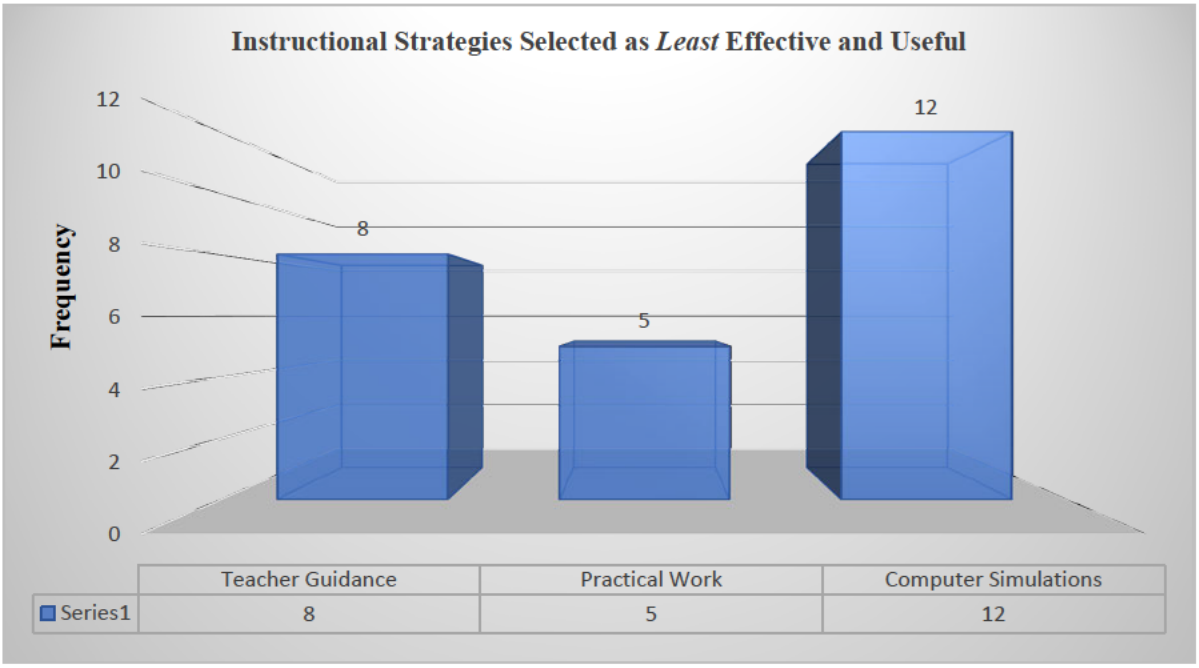


Figure 4.12 clearly indicates that teacher guidance was the most selected IS prefered by learners as the most effective and useful IS compared to computer simulations and practical work. This shows that learners found it easy to learn Physical Sciences under the supervision of the teacher actively involved in their learning. Also, learners prefer learning Physical Sciences when they can constantly seek assistence from their teacher for guidance. One may also question the outcome of this selection made by learners in Figure 4.12, if it was motivated by the fact that Physical Sciences for the longest time have been presented through abstract concepts especially in topics like Electricity. This issue of abstract concepts causes a major problem to secondary school learners mostly if the school is under-resourced and no practical experiments are conducted in Physical Sciences lessons (Burde & Wilhelm, 2020). Literature on the learners' understanding of electric circuits was provided in Chapter 2.

Figure 4.13

Frequencies of IS Selected by Learners as Least Effective and Useful



Data generated with the instrument tool Appendix 3 represented by Figure 4.13 above shows that most learners found computer simulation as the least effective and useful IS. It was interesting that some of the underlying factors for this outcome could be the fact that learners were not exposed enough to computer devices to experiment the computer software since the school is under-resourced. The only instructional strategy commonly used in the school was a teacher-learner interaction, according to the study, teacher guidance, as indicated in Figure 4.12. As a result some learners during the exploration session of this IS had no clue on how to use a computer which resulted in learners being shy and afraid to participate in the activity of constructing electric circuits using a computer device. The implication is the lack of resources in schools is one of the barriers in teaching and learning because IS such as simulations have the ability to simplify abstract concepts in Physical Sciences.

4.4 Qualitative Interviews Responses

As described in Chapter 3, this study used a case study research design which is an exploratory type. The purpose of this section was to portray the learners' views and experiences concerning IS (i.e., teacher guidance, practical work and computer simulations). Each and every theme selected by the researcher in this section presented the learners' views that were quoted verbatim in order to portray their views and experiences, hence answer the research questions presented in Chapter 1. This section has further touched on the learners' views concerning IS used in Electricity based on the theme such as classroom practice, school level environment, and classroom/laboratory-based resources. The next subsection deals with learners' preferences of IS used in Electricity supported by the themes like teacher classroom practice and/or IS, rationale for practical work, teacher's praxis, and element of good teacher praxis: learner views. Final subsection, learners' reasons regarding preferred IS used in Electricity with themes like factors that shape learners' choices of practical work and teacher guidance and career aspirations. The nine (9) themes that emerged formed the basis for highlighting contextual factors that were influential in the learners' ranking and choices of the IS.

4.4.1 Learners' Views Concerning Instructional Strategies used in Electricity

Theme 1: Classroom practice. The first category under this theme is repertoire (habitually used skills & behaviour) concening Instructional Strategies. When learners were interviewed about many things their teachers are doing well when teaching Physical Sciences in the school, the analysis of the interviews shows that learners appreciate the way Physical Sciences is taught at school. Three participants answered during the interview:

Learner 3: You too Sir, when you are teaching, you also make jokes during the lesson and it makes us as learners relax and enjoy the lessons.

Learner 5: Sir, when you are teach us, you take your time to explain what you are teaching and use different examples on the board.

Learner 6: When you teach us you make an example and guide us through the activities, which makes a lot of sense in my mind.

This clearly suggest that the teacher's habitually used skills and behaviour in their classrooms praxis might be influential in learners' ranking of IS.

In terms of structuring practices, learners highlighted different methods the teacher has demonstrated while he was actively involved in the lesson with them.

Learner 1: Sir, when you are teaching, you make sure that the homework is given and the following day you also assist us in corrections to ensure that we understand.

Learner 6: Sir, when you teach us you do a lot of examples and give us homework and assist us in correcting the homework that was given.

One of the practices that have been viewed by learners is that the teacher always ensures that at the end of the lesson, homework is given and not only that but further assist learners with the corrections of the homework in the following day. The teacher also demonstrates practical activities on the board in the form of examples to show learners how it's done. In other words, learners view the teachers' effort as a good practice because they feel assisted by the teacher through homework and examples that are done on the board.

Teacher support beyond classroom has also been viewed by learners as a common practice the teacher engages with them. Learners were cited during the interview and comment:

Learner 5: Sir, when you teach us you also avail yourself for questions outside the classroom.

Learner 2: We have an opportunity to ask for more information from the teacher outside the classroom i.e., staffroom, for further assistance on one-on-one.

Again, teachers' effort in assisting learners with the school work beyond the classroom has been viewed by the learners as another crucial attempt to make them understand Physical Sciences better in class.

Theme 2: School level environment. Teacher-learner relationship (e.g., generosity with time) has emerge as one the categories of the school level environment, when learners were interviewed about many things their teachers are doing well when teaching Physical Sciences at school. Learners answered during the interview:

Learner 3: Sir, you allow us to ask questions that we do not understand and now I am not afraid to ask questions.

Learner 4: You give your time to explain everything and ask us if we understood.

Learner 5: Sir, when you teach us you take your time to explain what you are teaching and also avail yourself for questions outside the classroom.

In this context of school level environment, learners' views suggest that their teacher put the learners' interest first in terms of supporting them academically. As a result, this has influenced learners' choices when ranking the IS.

Another aspect of school level environment is teacher-learner relationship (e.g., extra assistance). A learner has indicated that Physical Sciences teacher also integrate different teaching methods for the benefit of learners' understanding and also make himself available for learners' enquiries pertaining to the explanation of the abstract concepts such as Electricity.

Learner 6: When you teach us you use different examples on the board to show us how it's done and that makes a lot of sense in my mind because without examples I normally get lost.

The element of commitment has been viewed by learners where the teacher tries by all means to make a follow-up on the learners' work and check if there are no challenges learners are experiencing. Another learner added that:

Learner 6: When you teach us you make examples on the board and try to check most of us if we understand what was taught, I like that because it shows that you are committed to teaching us Physical Sciences.

Theme 3: Classroom/Laboratory-based resources. The prominence of using practical work in science lessons is extensively viewed as the most effective way of constructing knowledge meaningfully (Samuel, 2017). However, in the absence of proper resources to conduct practical experiments in schools, teachers tend to rely on textbooks as resources of content delivery. When the interviews were analysed based on whether the school has enough resources, three participants answered:

Learner 1: No, we don't do practical work, we just rely on the textbook and take notes on the board.

Learner 2: No, we don’t have enough resources, even the new books that are currently available for Physical Sciences we don’t have them because we are a government school.

Learner 5: No, because when we learn we learn only using textbooks, there are no other resources that we are using.

The above responses suggest that learners have been subjected to learn Physical Sciences using only textbooks. Practical activities as a prominent teaching method that allows learners to comprehend the significance of experiencing hand-on activities in science lessons was never used.

Learner 3: No Sir because yesterday was my first time using that practical equipment for experiments.

Learner 1: No, we don’t do practical work.

Learner 2, No, because we don’t have a laboratory where we can do practical experiments.

Also, this may indicate that learning has not taken place since knowledge was received passively; to some extent one may say that learners were not actively involved in the learning process. Similar comments were also obtained from the learners when they were interviewed about the resources used at school such as information and communications technology (ICT) based on the exploration of computer simulations, participants responded:

Learner 4: No, in my view the school doesn’t have enough resources since we lost computers. We cannot do practicals using computer simulations.

Learner 3: No Sir, because yesterday was my first time using a computer for simulations.

4.4.2 Learners’ Preferences of Instructional Strategies used in Electricity

Theme 1: Teacher classroom practice and/or Instructional Strategies. Learners in the current study were noted mentioning their preferences of IS in Electricity. The analysis of the interviews shows that their teacher applied structural practices and the enactment when delivering the content. Learners’ response during the interview:

Learner 1: When teachers are teaching us Physical Sciences, they must give us home works to research every day so that we can understand the subject and get more information.

Learner 3: I would like to learn Physical Sciences every day even during the study so that it can be easy for us as learners to understand since the duration of the subject period is an hour long.

Learner 5: I would like to learn Physical Sciences through more examples and more activities as well.

Learner 6: I would like to learn Physical Sciences in a simple way so that I can be able to ask questions that I do not understand. Sir, please use simple examples and explain thoroughly all the concepts so that I can understand them.

Learner 6: When you come to class, bring along past question papers so that we can try them to see how far we understand Physical Sciences, especially in Electricity.

The responses provided by the participants shows that they like the way Physical Sciences is taught at school based on the instructional methods their teacher is using. Learners believe that if homework is given every day they can understand the subject better. Even though, the subject Physical Sciences has a prescribed notional time which is four (4) hours per week from the CAPS document, however, learners believe that more than four hours need to be dedicated to the subject so that abstract concepts like Electricity can be understood better. Learner 5 on the other hand, believes that through more examples demonstrated by the teacher and more activities the learner can comprehend the subject better. Another learner prefers to learn Physical Sciences in a simple way, meaning, the teacher must use simple examples so that the learner can be able to ask questions where clarity is not feasible. One of the prominent comments made by the learners is the fact that when the teacher comes to the class, learners prefer the teacher to use past exam papers so that they can be able to see if their level of understanding the concepts of Physical Sciences meet the standards of the examiners.

Another aspect that was noted during the interview sessions was that learners were so keen to learn through practical work (e.g., laboratory procedures and techniques). Learners would like to see practical experiments conducted more often for the benefit of understanding the subject better. One learner pointed out that if practical experiments are conducted every day that will put them in a better position to understand the subject.

Learner 5: I would like……if we learn Physical Sciences to do experiments more often like every day so that I can understand better.

The application of different teaching methods plays a significant role in the understanding of Physical Sciences concepts. For example, the use of complementary activities allows learners to experiment different learning styles as well. Learner 4 mentioned that through complementary activities, the learner has gained trust and confidence in the subject because such activities make the subject more easy to understand.

Learner 4: The way I would like to be taught….just like you did, what do you call it? Sima….simulations because it makes me gain trust and confidence about the subject and I have also experienced it. I find simulations simple.

Theme 2: Rationale for Practical work. Working in groups and sharing ideas was one of the factors that emerged when the interviews were analysed. Learners found that group work was effective when learning Physical Sciences in class. When they were interviewed about why they chose practical work as the most effective and useful IS in learning Physical Sciences, the participants responded:

Learner 1: I chose practical work because yesterday we did one in groups and working as a group or going to the libraries as a group, sharing ideas, and getting more information, helps me a lot to understand.

Learner 5: I chose practical work because it is easy to understand, and I can also learn from others as we do practicals as a group.

Working in groups clearly shows that learners were able to easily understand and get more information through sharing and improve knowledge and understanding by doing practical work. Learners can also gain the knowledge of personal observation and involvement in group work while performing practical work. In the interviews learners commented:

Learner 1: If I am doing practical work alone it is not helpful because no one can help me, and I cannot share ideas but if I am working with other learners I understand better. So, I prefer practical experiments if we can work as a team.

Learner 2: Yes, because when we do practical experiments, we see that were're learning something theoretically and also doing it in hands on practical, therefore it makes sense to us.

Learner 3: Yes, because sometimes when you write on the board, I don't get a full picture of what is being taught, so practical experiment that we did yesterday was right since I can physically see the circuit board and the brightness of the bulbs, it made a lot of sense to me.

Learner 6: Yes, it's great because even though Physical Sciences is difficult but through examples and practical experiments it's understandable through sharing ideas as a group.

Furthermore, in group discussions, learners were seen actively participating in groups, helping each other and asking questions to each other as well.

Theme 3: Teacher's Praxis. Participants of the study were also noted when they were interviewed indicating that they prefer to work with their teacher in class in the form of collaborative, engaging and communication because they believe that through these interactions, they can understand the subject better. Two participants answered during the interviews:

Learner 5: I would like us as learners to work together with the teacher, when the teacher is teaching he should not only focus on the board, but he should involve us to demonstrate what he's teaching. The line of communication should be smooth between the teacher and learners, and the teacher should be open to assist with any question.

Learner 6: When teaching Physical Sciences, I would like the teacher to try and slow down so that we all can understand what is being taught.

In terms of learner orientation and cognitive activation, learners' preferences go to the extent that their teacher should bring past question papers into the class so that learners can be able to assess themselves whether they understand the concepts of the subject or not through past examination questions. When they were interviewed about the advice they can give their teachers in order to engage learners better and make the subject more interesting, enjoyable and fun, learners response were:

Learner 6: When teaching Physical Sciences, come to the classroom with past question papers so that we can try them and see how far we understand the subject, especially in Electricity. Also, the teacher should come up with different ideas to make us understand Physical Sciences since it's not an easy subject.

Learner 3: Sir, when you come into class, come with a smile and create other things that we can do so that the subject can be interesting.

While on teachers' practice, learners prefer to conduct practical work and be taught under the supervision of their teacher simply because they believe that through teacher guidance as the instructional strategy, they can easily remember what they were taught in class.

Learner 2: I would like to be taught Physical Sciences under the guidance of the teacher and with practical experiments because in practical work we are taught things that we can easily remember in tests or exams and through your guidance Sir I can also remember what you taught me in class.
Learner 5: I would like to learn Physical Sciences through more examples and practical experiments.

Theme 4: Element of Good Teacher Praxis: Learner Views. It is important that teachers ensure that learners when they come into the classroom to learn, they are welcomed with a positive energy. Some learners can sense if the teacher in not in a good space to teach them and that is reflected in the disconnection from teaching and learning process. During the analysis of the interviews, learners were noted expressing their appreciation from the structuring practices displayed by their teacher in class. This teacher praxis might be influential in participants' choices of IS. Participants responses during the interviews:

Learner 1: Sir, when you teach us, you make sure that homework is given and on the following day you also assist us with corrections for that homework to ensure that we understand Physical Sciences better and I like that.

Learner 3: Sir, I enjoyed the practical experiment that we did yesterday because I was able to physically see the circuit board and the brightness of the bulbs, it made a lot of sense to me.

Learner 4: Just that you give your time to explain everything in class and even ask questions to the learners and tell us to relax.

Learner 5: Sir, when you teach us, you take your time to explain what you're teaching and also avail yourself for questions outside the classroom.

The learning process of science learners is critical because learners are exposed to abstract concepts. As such, the subject like Physical Sciences needs learners to learn many types of representation such as practical experiments, graphs, and mathematical symbols (Lee & Sulaiman, 2018). Therefore, learner guidance and/or engagement is very crucial in this context for the development of the learner in order to be able understand the content. Learners' preferences in this regard were also noted when they were interviewed about how they would like Physical Sciences to taught in the school. The responses were:

Learner 2: I would like to be taught Physical Sciences through practical work and teacher guidance because in practical work we are taught things that we are able to remember in the exams. With teacher guidance, it helps me to remember what Sir has taught me in class, then I am able to write in the exams.

Learner 2: I would like teachers to teach me while guiding me throughout the process because it is easy when I interact with the teacher, asking questions while taking notes as well this allows me to remember easily and understand better.

Learner 5: Sir, I would like us to work with the teacher, when the teacher is teaching he should not focus on writing on the board, but he should engage with the learners to demonstrate what he's teaching.

Moreover, teachers should also make it a point that classrooms are conducive enough for learners to be able to express themselves freely without any fear. Meaning, friendly classroom environment must be maintained at all costs for learners to interact with the teacher and be able to ask questions and seek clarity at any time of the lesson. For instance, learners' answers in the interviews:

Learner 2: The advice that I will give you Sir is that you must listen to what we are asking you to do because some of us like to learn Physical Sciences with some games and some rhythms attached to the concepts so that we can easily remember.

Learner 6: Sir, when you come to class to teach us, have fun with us while you are teaching so that we can enjoy the subject, do not be too serious.

4.4.3 Learners' Reasons Regarding Preferred Instructional Strategies used in Electricity

Theme 1: Factors that shape learners' choices of practical work and teacher guidance. Practical work and teacher guidance were the two Instructional Strategies that were most selected and preferred by the learners in this research. During the analysis of the interviews, it was noted that learners liked the way their teacher conducted the experiment in class. This has motivated learners to view practical work and teacher guidance as the best practice. In the interviews learners answered:

Learner 5: Yes, Sir, if we do experiments, the teacher is able to do more demonstrations for us so that we can be able to understand whatever we are learning. Also, through practical work, I can see what the teacher is teaching us.

Learner 6: Even though Physical Sciences is a difficult subject, but through more examples and practical work it is understandable.

Another aspect that was also noted during the interviews was teacher-learner interaction and/or better understanding and content retention. For instance, it was important for teachers to have a solid relationship with their learners so that they can be able to ask questions when they seek assistance especially when learners come across difficult concepts in Physical Sciences. Two learners responded:

Learner 6: Through teacher guidance, I have the opportunity to ask questions and get assisted without struggling or getting the task wrong.

Learner 2: I chose teacher guidance because I easily understand through it, even in the exams it is easy to remember what my teacher taught me.

The connection with group work and better understanding of content were also analysed as one of the factors that influenced learners to select practical work and teacher guidance as their most preferred IS. In the exploration of the two IS, learners were observed working together as a group, communicating amongst group members, discussions taking place and learners were seen actively participating in the task at hand. The comments from the interviews were:

Learner 1: I chose practical work because it involves group work and when I was in grade 9 doing work as a group and sharing ideas, it helped me a lot in understanding what was learned. Also, when we do practical work, some learners are able to help me understand what is happening in that session, for instance, in group work we come up with ideas and share knowledge amongst the group members in a form of helping each other.

Learner 5: I chose practical work because it is easy to understand and learning from the chalkboard is sometimes difficult while in practical it is easy because we see real events as we work as a group.

The notion of hands-on, minds-on and words-on on practical activities have promoted scientific skills of observation, investigation, problem-solving and others as learners could visualise phenomena and promote the enhancement of conceptual understanding (Samuel, 2017). Therefore, hands-on and minds-on aspects were also seen as learner 3 answered:

Learner 3: I chose practical work because I do not enjoy writing all the time, I love doing things with my hands it assists me to get a picture of what I am doing.

Learner 2 and learner 6 appreciated the good teaching methods used by their teacher as he applies the teacher guidance when teaching them. Learners state that through this instructional strategy they can understand the concepts easily and were able to interact with the subject teacher, ask questions and take notes. Through this IS learners mentioned that there is less struggle on the practical tasks given to them.

Learner 2: I chose teacher guidance because I easily understand through it, and I am able to easily interact with the teacher while taking notes and asking questions and getting a response immediately.

Learner 6: I chose teacher guidance because if we are given a task, we have an opportunity to ask questions and the teacher is also actively involved in assisting us so that we do not struggle and get the task wrong.

Furthermore, learner 3 and learner 1 were also noted commenting on the opportunity to ask questions and engaging in individual activities in class as they were assisted by the teacher to focus on the lesson and do the activities.

Learner 3: You too Sir, to me you are teaching very well because you allow us to ask questions where we do not understand after that I am able to do the activity by myself.
Learner 1: Just that you give your time to explain everything and even ask questions to the learners because it even makes us get more information when you ask questions and make us focus and be able to do the activities.

Theme 2: Career aspirations. It is not a secret that learners who choose science stream at school are solely motivated by the professional career opportunities the science field can offer. For the present learners to be able to achieve those goals, choosing science as entry to medical fields was their first step in reaching those goals. When they were interviewed about what motivated them in choosing Physical Sciences over other subjects, their responses were:

Learner 1: I chose Physical Sciences because of my career, I want to be a gynaecologist.

Learner 2: I like medicine, I want to be a doctor, so I chose science because it offers subjects that are required in medicine like Physical Sciences, Mathematics, and Life Sciences.

Learner 4: I chose Physical Sciences because of my career, I want to be a doctor and I like Physical Sciences because I enjoy it.

Learner 3 and learner 5 clearly state that they were inspired to choose science as it provides diverse jobs**.**

Learner 3: Because I love Physical Sciences and my father also told me that Physical Sciences has better job opportunities and I believe that by choosing Physical Sciences I will have a better chance of finding a job as compared to other non-science subjects.

Learner 5: I chose Physical Sciences because there are many job opportunities and for me choosing this stream, I can be able to study for my career.

Learner 6: I chose the science stream because I want to become a paramedic or firefighter.

The above comments from the learners clearly states the reasons why learners prefer the IS the way they do. Also, the careers they aspire to, all require a secondary school science background.

4.5 Chapter Summary

Chapter 4 presents the data explication using a basic statistical method to analyse data that was obtained during the exploration of Grade 10 Physical Sciences learners views and preferences of IS in Electricity. The first task that the researcher embarked on was to give a detailed description of the three IS that were explored with the participants. The next task presented fifteen (15) IS together with their categories in Table 4.1 and Table 4.2. The data generated using the three data collection tools (see Appendix 1, 2 and 3) presented in Figure 4.10 to Figure 4.13 in order to get a clear understanding of what learners prefer or do not prefer. The follow up task was the analysis of the interviews results. Interview results were used to validate the data generated in Figure 4.10 to Figure 4.13. Thereafter, the analysis of the interviews was used to formulate categories based on the similarities in the responses provided by the participants. The categories provided nine (9) themes which were used to answer the research questions of the study.

Chapter 5

Discussion and Conclusion

5.1 Introduction

This chapter presents discussion of the results presented in Chapter 4. This study also sought to investigate the contextual factors that influenced the learners' views and preferences of the IS. The chapter further provides a summary and discussion of the findings that emerged from the data. Data related to each research question was analysed and used to discuss the themes formulated in Chapter 4. Additionally, an overall discussion on recommendations to the Department of Basic Education (DBE) and all the stakeholders at the school level and future studies. Lastly, the chapter discusses the limitations of the study.

Instructional strategies (IS) are one of the proposed keys in the teaching and learning processes of Instructional Framework (IF) for outlining the interrelationships to sound educational practices (Chapter 2, p. 7). For the long time, IS in the South African (SA) curriculum were not explicitly stated in the previous policy documents except for the practical activities (Chapter 1, p. 1). Akdeniz (2016) states that the product of teaching and learning occurs for the development of the target behaviour that learners are expected to have. This behaviour is the development of the learners' educational outcomes such as skills, knowledge and understanding and values essential for learners to be creative and critical thinkers (Warnich & Meyer, 2013). Even though, such development stated above has remained a challenge for teachers in schools, the Curriculum and Assessment Policy Statement for Physical Sciences, Grade 10-12, is at the forefront of the principles that proposes active and critical learning, which encourage "an active and critical approach to learning, rather than role and uncritical learning of given truths" (Department of Basic Education, 2011, p. 4). The researcher, therefore, saw it fit to conduct a study that focuses specifically on the learners' views and preferences of IS on the topic of Electricity.

There have been challenges with the current education system pertaining to some of the aspects that are not in consonance with the principle of CAPS for Physical Sciences (Chapter 1, p. 2). The literature reviewed (see Chapter 2, p. 8-9) clearly states that teachers play an essential role in facilitating the implementation of IS in the teaching and learning process. For teachers to achieve the core educational right of a learner, they need to be well informed about IS in order for better delivery of the curriculum of the subject Physical Sciences (Saskatchewan Education, 1991). Furthermore, teachers must not only understand the concepts of Physical Sciences, but use IS such as scientific inquiry to help learners develop thinking abilities. Our current education system (in South Africa) is limited on IS that might be preferred by learners, such as the nature of inquiry in the classroom context. Indeed, CAPS has deprived teachers of the opportunity to express their creativity and innovation in terms of interpreting what and how they can teach science and apply better techniques such as learner-centred approach.

The current National Curriculum Statement (the Curriculum and Assessment Policy Statement [CAPS]) for Physical Sciences, Grade 10-12 proposed three formal prescribed practical activities and four informal recommended practical activities that must be integrated with theory to strengthen the concepts being taught (DBE, 2011, p. 12). The study intended to investigate the views and preferences of IS of conveniently selected learners the researcher is currently teaching. This was based on the fact that the policy document CAPS has little emphasis on IS in schools. Therefore, there was a need to examine the views and preferences of learners with regard to IS.

The research intended to answer three research questions - *What are Grade 10 Physical Sciences learners' views on IS used in Electricity? What are Grade 10 Physical Sciences learners' preferences of IS in Electricity? and Why do Grade 10 Physical Sciences learners' prefer the IS in the way they do*. The methodology of the study adoped a qualitative research approach because the study was more exploratory. The design was case study research design. The study further employed a purposive sampling method to recruit twenty-five Grade 10 learners in Physical Science class. Triangulation was applied in the study to ensure the credibility of the results from different data sources.

5.2 Answers to the research questions of the present study

This section provides a detail discussion on the answers to the study's research questions complemented with the literature to support the argument. Three research questions were discussed together with their respective themes developed in Chapter 4 (section 4.4).

5.2.1 What are Grade 10 Physical Sciences Learners' views on Instructional Strategies used in Electricity?

Previous studies on classroom preferences indicate that there is an effect on learners' learning in different educational environments (Lu et al., 2021). For example, Lu et al. (2021) found that learners' learning outcomes were in alignment with their environment preferences in classroom setting where learner-centred and teacher-centred Instructional Strategies coexisted. The current study has identified themes elicited from learners' views and preferences of IS in the subject Physical Science in Electricity. These themes include classroom practices, the school level environment, laboratory-based resources, teacher classroom practice and IS, good teacher praxis, factors that shape learners' choices of practical work and teacher guidance, and many others.

5.2.1.1 Classroom Practice

According to Badem-Korkmaz and Balaman (2020), teachers' instruction-giving practices in the classroom are largely recognised as the primary condition for the smooth progression of pedagogical activities. The social constructivist theory clearly states the position of the teachers' instructions as the resource that should be easily accessible in the classroom to assist the learner as s/he tries to understand the society through knowledge construction (Gumede, 2020). Dhurumraj (2013) argues that learners academic performance is also dependent on whether the teacher applies relevant pedagogical skills in order to keep the learners interested in their subject matter as the essential component in ensuring successful learning.

In the current study, learners have been noted expressing appreciation for the instructions used by the teacher for conceptual understanding. For some learners, the appreciation may be based on a teacher providing an example and guiding them throughout the activity which makes a lot of sense in their minds (Learner 6; Chapter 4). Similar findings in Benonguil and Barnido (2022) indicate that learners participated in the study like the methods of teaching used by their teacher including the activities given to them as a way to unify their whole class since cooperation and collaboration of ideas, the people, and the like are wielded in each of them. Social constructivist theory states that learners are able to develop knowledge through the interaction with one another in the classroom (Taylor, 2018). This suggest that teachers need to carefully choose the teaching instructions to ensure that all learners in the classroom are accommodated. The role of the teacher in a classroom context is to communicate knowledge and apply the skills to capture the learners' attention and assign class activities and homework to reinforce what was discussed in class. This is done through carefully selected teachers' Instructional Strategies such as using different teaching methods to accommodate the diversity in class and providing examples to clarify the concepts being taught. This was based on the researchers' ten (10) years of teaching experience.

Teacher's instructional practice has been perceived across the world to be one of the most important factors influencing learner learning outcomes and has always been considered as vital indicators of the teacher effectiveness in the classroom context (Burić & Frenzel, 2021; Fischer et al., 2020). The contemporary theoretical models of domain-independent instructional quality state the three differential key aspects of instructional practice that is cognitive activation, classroom management and supportive climate.

The analysis of the current study indicated that learners appreciate the way Physical Sciences was taught at school (Chapter 4, p. 49). The research conducted by Benonguil and Barnido (2022) shows that learners expresses approval of the teachers' repertoire concerning IS. This is an indication that the current study supports the research that has been conducted. Again, this shows that it is important for teacher to self-monitor there IS and ponder on how they are performing in the classroom. Also, teachers should take note of the diversity of learners in class because IS becomes effective and meaningful when learners feel that the teaching is recommendable in the classroom.

Structuring practices can be seen as major part of classroom instruction and in contrast to other factors relevant for learners' learning (Fischer et al., 2020). For example, learner's socio-economic background is one of the more readily modifiable factors and, thus, can be subjected to targeted interventions. There is still a gap in terms of how various practices relate to each other and what is the best beneficial teaching method. The natural culture and the pedagogical tradition have influenced approaches to teaching and learning in such a way that leading to differences of recurrence and combination of teaching practices and consequently challenging the supposition of a universal structure of teaching practices.

The current research showed that learners noticed different instructional strategies (IS) demonstrated by the teacher in class. The findings of the current study are similar to that of Fischer et al. (2020) in a sense that the participants' views indicated that when the teacher is teaching, he ensured that homework is given and on the following day he assisted learners with corrections and provided feedback which is the most essential part of instructional practices. In addition, the recent international debate on classroom assessment such as providing feedback, has been considered as part of instructional practices that teachers implement in the classroom (Fischer et al., 2020). As for the tailor targeted interventions to further high-quality teaching in a culturally sensitive way, it is indispensable that a comprehensive understanding of the structure and co-occurrence of teaching practice across countries. Therefore, classroom practices are critical for the enhancement of learners' learning (Schildkamp et al., 2020). They require a fundamental change in the role of the teacher in the classroom. They further require a fundamental shift in the power relations between teachers and learners in a classroom context, whereby, teachers and learners become jointly responsible for the quality of teaching and learning.

The present study revealed that there was an effort made by the teacher to assist learners with school work beyond classroom interaction. One learner reported that the teacher gave them the opportunity to ask questions outside the classroom, that is, staffroom, for further assistance on one-on-one (Chapter 4, p. 50).

The findings of the study were congruent with the research by Girard et al. (2021) such that, they showed that teacher's social support entailed a relationship that was based on teacher empathy and benevolence. This kind of relationship is characterised by clear explanations, assistance, and guidance to achieve academic goals as well as the learners' emotional support to structure the interactions between teacher and learner. In addition to that the engagement of learners in their school work is an important professional issue including the relationship between the learner and teacher (Girard et al., 2021). Social support from teachers is recognised as an important aspect for involvement of learners in classroom activities. Therefore, teacher support beyond classroom has emerged in the current study, where the teacher avail himself for all the queries learners might have for the work that was given in class (Girard et al., 2021). This clearly indicates the level of commitment from the teacher to dedicate his time in helping the learners as well as the level of activity as a learner as they seek assistance even beyond the classroom.

The key findings of the study indicate that learners preferred teacher guidance as the instructional strategy (IS) when learning the content of the subject followed by practical work. The views of learners were indeed supported by the performance results obtained in the Electricity conceptual test (see Figure 4.1) that was given to them as they were guided throughout the test. The implication is that even though Physical Sciences especially in Electricity have abstract concepts but with the assistance of the teacher, learners might have the courage to commit themselves to comprehend the subject, supported by the help of practical experiments.

5.2.1.2 School Level Environment

The current study revealed that learners view their teacher as a person who has put learners' interest first when it comes to supporting learners academically. This had a significant impact on the learners' choices when they were ranking the IS.

The findings of the current study support Wilson et al. (2020) views that, a positive school environment is the one in which teaching, management, other staff members put learners interest first for the purpose of working together in harmony. This kind of environment comprises a number of factors such as institutional integrity, resources influence, teacher affiliation and academic emphasis. Moreover, the above findings also indicate the element of social constructivist within the school environment as it was cited that learners do not develop their knowledge in isolation.

The school environment encompasses the different elements of an educational institution's culture that define it's beliefs, values and operations (Wilson et al., 2020). The implication is that School environment concerns with the overall feeling within the institution based on beliefs regarding interpersonal relationships within the school, organisational norms, values and teaching practices.

Learners spend between 6 to 8 hours at school depending on the programmes of the school. They spend the whole day in the presence of a teacher/teachers and the school environment which makes the school the foremost extra-familial environment learners are exposed to (Grobler & Wessels, 2020). This is where the self-configuration of the learners has an effect on by the manner in which the teacher interacts with learners. In the same breath, the teacher's reaction to the learners was also influenced by the learners' response towards the teacher. Clearly, this indicates that the reciprocal nature of the relationship between the learners and teachers and their environment contributes a lot on how and what learners think and learn about themselves. It was for such reasons that the importance of listening to how learners experience themselves within their relationship with their teachers is crucial.

For example, in the current research, one learner stated that their teacher allows them to ask questions when they do not understand, and the learner is no longer afraid to ask questions in class. Another learner said that when the teacher is teaching them, he ensures that he takes his time to explain what he is teaching and also avail himself for questions outside the classroom. The research reveal that learners appreciate the generosity their teacher shows towards them in terms of the support he provides for their academic journey. Moreover, the research findings indicate a similarity to the study conducted by Grobler and Wessels (2020) because their research discovered that the learner-teacher relationship is very important in the process of self-configuration. Furthermore, the study states that learners who experience a positive relationship with their teacher are motivated to perform or work harder for their teacher. This was reflected in the current study when one learner said that the teacher allows them to ask questions that they do not understand, and the learner was no longer afraid to ask questions in class. In this context, it is clear that the learner expresses the level of confidence s/he has gained due to the flexibility of their teacher toward them in the classroom.

Teacher-learner relationship emerged in the current study where the learner indicates forms of appreciation to the teacher for using different examples to teach. The participant said that when the teacher is teaching them, he uses different examples on the board to show them how it's done and that has made a lot of sense in their minds because without examples they were lost. The findings of the current research is similar to the study by Awoniyi and Butakor (2021) view, that, teacher support plays a key role when it comes to the teacher-learner relationship. There are many ways where teachers can provide support to the learners within the classroom context. The research by Awoniyi and Butakor's (2021) further argued that the assistance teachers provide to learners strengthens the teacher-learner relationship. Also, when teachers support learners by showing them care and concern, learners in turn respect and follow the classroom rules. This shows that the teacher applies extra effort to ensure that learners understand the content in class. The integration of different examples on the board were prepared through a careful planning to make sure that the diversity in class is accommodated. Similarly, when teachers motivate learners to work together with others in a form of cooperation and shape learners interaction such that learners support and challenge each other, learners learning improves (Awoniyi & Butakor, 2021). The implication is that the level of commitment from the teacher in this regard is very important as to ensure that learners do not lose focus in class. The participant in the current research commented that 'when the teacher teaches them, he used examples on the board and tries to check whether most of them understood what was taught, that shows that the teacher was committed to teaching them Physical Sciences.

5.2.1.3 Classroom/Laboratory-Based Resources

The current study's findings suggest that proper learning has not taken place based on the fact that the knowledge received did not actively involve learners in that process. Literature on the role of teachers indicate that, they play a crucial role in shaping learners' academic outcomes, and it is a fact that some teachers are more effective than others in such pursuits (Burić & Frenzel, 2021). The effectiveness of the teacher that is aggregated by the complex set of in-classroom teacher behaviour on learners and the use of different resources in the classroom has been linked with various teacher variables such as personality traits and motivation of learners. Teachers and laboratory-based skills practice are vital components of science classrooms (Takase et al., 2019). However, it is a different story for under-resourced schools where practical equipment and laboratories are scarce. One should indicate that the lack of resources does not mean that learning does not takes place, although it may not be as comprehensive as it should be with the presence of hands-on practical work.

The participants of the study were learning in under-resourced school. The school had no laboratory for practical experiment; learners only rely on textbooks to learn. When they were asked about the resources that are used to facilitate learning in Physical Sciences at school and whether the school has enough resources, one learner said, no, we do not have enough resources, even though there are new books that are currently available for Physical Sciences we do not have them; we only rely on textbooks because we are a government school. Another learner said, no, because yesterday was her first time using practical equipment for experiments. The study by Samuel (2017) states that learners learn best when they are actively involved in the learning process which helps them in developing their ability to think. Also, practical work further offers means for learners to attain hand-on skills that are essential for the new workforce that requires cutting-edge scientific knowledge and specialised skills. Furthermore, in a constructivist learning environment, the teacher's role is to facilitate or guide the learning process (Bada & Olusegun, 2015).

Learners express feelings of disappointment due to the fact that laboratory experiments are not conducted at school and the learner 2 was aware that there were good books that are available but since the school was under-resourced, they could not have access to them. This findings were similar to the study conducted by Takase et al. (2019) when the study found that the lack of resources in schools demotivate learners from learning.

The impact of information and communication technology (ICT) on teaching and learning as it necessitates integration in the classroom. The integration in some school contexts remains a challenge, despite ICT integration being a policy prerogative in many countries (Munje & Jita, 2020). Karunaratne et al., (2018) argued that the lack of resources in schools as a potential negative contextual factor hindering the ICT usage in classrooms. For instance, computer simulations as part of the ICT component, have been considered as one of the IS that can provide both a particular aspect of visualisation and manipulation of objects which is critical for the understanding of electrical circuits concepts in Physical Sciences (Manunure et al., 2020). This instructional strategy computer simulation has a potential to replace the laboratory practicals in terms of the development of cenceptual understanding in the classroom. The study by Manunure et al. (2020) argues that computer simulations should only be used as a substitute to hands-on practical experiments but not as a replacement. This is simple because simulations to some extent cannot manipulate real laboratory materials. For example, learners using a computer simulations are unable to tell if the battery is not functional or they cannot have the opportunity to smell or feel the heat produced as a result of the wiring connection error.

In the current study, participants were asked if they have enough resources, learner 4 said, no, in his view the school does not have enough resources since they lost computers through vandalism, therefore they cannot do practical work through computer simulations. When computer simulations were explored for the purpose of the study, learners were excited about this resource and many of them found it useful and effective. For example, learner 4 also said, he chose simulations because they make him understand better and he has confidence about what he has learnt. It should be noted that the integration of ICT in teaching and learning has a positive potential to enhance better results from learners, especially in areas that are suffering with low socioeconomic background like the research site of the current study (Khan, 2020). ICT as another resource of teaching and learning in schools has the potential for learners' good achievement in science classrooms. This calls for the need for empirical research to provide a broad picture of the impact the lack of ICT resources has in schools, more especially in impoverished areas.

5.2.2 Conclusion

Learners' views on Instructional Strategies used in Electricity are solely based on the themes formulated (i.e., classroom practice, the school environment, and classroom/laboratory-based resources) during the one-on-one interviews. The results of the study showed that learners view their teacher as an instructor who engages learners when teaching the concepts of Physical Sciences, applying different examples to abstract concepts and, also, guiding them throughout the lesson to ensure that learners comprehend the concepts in Electricity. The results further indicate that learners view the teacher as a caring educator who is always available to assist learners and ensures that for every homework given, it is checked the following day and feedback is provided. It can be concluded that, through teacher support in the classroom context, learners are able to obey the instructions in class and show interest in the subject and further strengthening the teacher-learner relationship.

5.2.3 Recommendation

Classroom practices are vital for the successful implementation of Instructional Strategies for learners' learning (Schildkamp et al., 2020). Therefore, teachers need to ensure that they strengthen the teacher-learner relationship in class so that learners can be able to share their views on the IS used at schools. This will not only help teachers plan their lessons better but also assist learners to maximise their conceptual understanding of the subject in question.

5.2.4 What are Grade 10 Physical Sciences Learners' preferences of Instructional Strategies in Electricity?

5.2.4.1 Teacher Classroom Practice and/or Instructional Strategies

The current study revealed that the elements of structural practices and the enactment were applied when the content was delivered in class. Learners were noted indicating that they like the way Physical Sciences is taught at school in terms of the selective instructional methods used by the teacher. The findings of the study further showed that learners preferred to be engaged with the subject at all times, though the notional time of the subject as per CAPS policy document does not allow that. Participants in the current study were noted stating their preferences in terms of classroom practices and IS. Learner 1 said, when teachers are teaching them Physical Sciences, they must give them class activities and homework to research every day so that they can understand the subject and get more information. Learner 2 said, she would like to learn Physical Sciences every day during the study period at school, so that it can be easy for them as learners to understand since the duration of the subject in their time table was only one hour. Learner 5 on the other hand responded by saying, she would like to learn Physical Sciences through more examples and more activities as well. The above responses clearly indicate that learners are keen to learn through the inquiry-based approach. This approach is more learner-centred, promote active learning and advocates the use of authentic real-world problems (Thibaut et al., 2018). The instructional strategy that advocate learner-centred approach is interactive instruction. This instructional strategy provide learners the space to engage in knowledge sharing and experiences and further give insight into the knowledge from other learners while they also learn from each other (Ukata & Nmehielle, 2021). Furthermore, the responses provided by learners also highlighted the element of constructivism in a sense that learners had the courage to explore active techniques (i.e., experiments, real-world problem solving) to create more knowledge (Bada & Olusegun, 2015).

These findings suggest that learners are motivated to learn Physical Sciences and they are prepared to go the extra mile to ensure that they understand the subject. For instance, learners mentioned that they prefer their teacher to use simple examples when teaching and he must come to the class with past exam papers so that they can understand the style and standard of examiners.

Structuring practices and enactment are the concepts, guidelines, approaches or the main line to conduct, measure and evaluate instruction (Seechaliao, 2017). Teachers as the implementers of IS need to consider many instructional components before the IS are executed. For example, learners, learning objectives, content, learning context, the overall context, various conditions, and teachers' skills in selecting the learning principles and the techniques to accomplish the learning objectives they specified. For the most factors linked with learner achievement in schools, there is a day-to-day practice of teachers that exert the most powerful influence on classroom learning (Windschitl et al., 2012). Teachers have the capacity to mediate learning grows out of a professional repertoire that is relational, complex, grounded in deep understanding of the subject matter, and adaptive to learners' needs.

Inquiry as a pedagogical approach and one of the formally used Instructional Strategy in schools, was defined by Hayes et al. (2016) as the instructional strategy that involves learners in investigation and experimentation activities in order to develop knowledge and understanding of scientific ideas including the understanding of how scientists examine the natural world. In spite of being the hallmark of excellent science education for decades. inquiry-based approach has also eluded precise definition in both research and practice, due to lack of consistency in the implementation on learners learning about inquiry.

5.2.4.2 Rationale for Practical work

In the current study learners showed that working in groups helped them to easily understand the concepts of Physical Sciences and further improves their knowledge.

The findings of the current study suggest that learners prefer practical work so that they can understand the subject better. For example, when learner 5 was interviewed he said, he would like if they can learn Physical Sciences through experiments more often like every day so that he can understand better. Learner 2 also mention that she would like to be taught Physical Sciences through practical work, because in practical work they were taught things that enable them to remember in the exams. This clearly indicates that learners prefer to construct knowledge on their own. The constructivism theory states that teachers should first consider their learners' knowledge and allow them to put that knowledge into practice (Amineh & Asl, 2015). Practical work is important for science education in schools and it also referred as the direct instruction (Kibirige et al., 2014; Saskatchewan Education, 1991). Direct instruction is used to introduce new concepts in order to provide clear instructions to the learners in the learning of basic skills. Learners do practical work to expand their knowledge in order to understand Physical Sciences concepts better. The benefits of doing practical work were to develop learners' understanding of theories, ideas and models (Kibirige et al., 2014).

The findings of the current study support the claim made by Lee and Sulaiman (2018) that practical work offers learners an interactive experience where learners can broaden the scope of constructivist learning. Also, practical work creates exceptional learning surrounding where learners can work as a group helping each other to construct knowledge, enhance logical and inquiry skills. Sharing ideas in group work is one of the critical aspects that is developed by the practical work where learners are able to communicate their ideas throughout the group for the common goal which is to understand the science concepts. During data generation stage in the exploration of the practical work, learners were observed through video recorded data working as a group, communicating with one another with the groups and discussion and showing teamwork. Learners, also, ranked demonstration as the most favoured instructional strategy amongst the 15 IS given (see Figure 4.10). Saskatchewan Education (1991) state that part of the direct instruction includes lecture, demonstrations, practice and drill, explicit teaching and didactic questioning. This clearly shows that learners prefer practical work as the instructional strategy that provide learners with constant interaction with their teacher explaining the concepts of Physical Sciences for better understanding. The research findings from the study conducted by Samuel (2017) indicate that learners were more successful when learning in shared surroundings such as group work as opposed to working alone.

Practical experiments are a necessity for the school science education (Kibirige et al., 2014). In science, this instructional strategy is done by learners in order to expand their knowledge and understand more complex and abstract concepts. Practical work also promotes cooperative and collaborative learning. Cooperative learning is the instructional method where the teacher moves around from team A to team B, observing the interactions and provides support when s/he feels it is necessary (Thibaut et al., 2018). In collaborative learning on the other hand, learners organise and structure their own group work; the teacher does not actively monitor the groups but s/he refers all the questions back to the groups in order for them to resolve group conflicts on their own (Thibaut et al., 2018). Saskatchewan Education (1991) refer this instructional strategy as indirect instruction, where learners are active participants and teachers are passive in the learning process.

Through hands-on activities, learners are less restricted and more actively involved in the learning activity (Thibaut et al., 2018). The relevance of this instructional strategy is conveyed through hands-on learning as learners take ownership of their learning by being allowed to observe the role of innovation in everyday life. Again, this instructional strategy being inclined with learner-centred approach, and the good thing was that no specific recommendations for implementing hands-on instruction, learners explored this IS while they were learning. Learner 4 was asked how he would like to be taught Physical Sciences at school, he said, he would like to be taught just like how the teacher did in computer simulations, because it made him gain trust and confidence about the subject and as he had also experienced it, he found simulations simple. The use of ICT in the school is a matter of emergency as learners see themselves learning better through the integration of such devices in the classrooms.

In science classrooms, practical work is an inherent feature not only to Physical Sciences but to all the school science subject (Wei et al., 2020). Kibirige et al. (2014) define practical work as a learning experience in which a learner interacts with materials or with secondary sources of data to observe and understand the natural world. When practical work was conducted in a current study, there were many aspects that emerged as the learners were exploring this instructional strategy. During the observation, learners were working as a group, communicating with one another within a group and discussion and team work was seen as well. This indicate that learners enjoy working together as a group sharing ideas and communicating with one another through social interactions. Social constructivism theory states that for meaningful learning to take place, learners should share knowledge and be actively engaged in large or small groups (Barak, 2017).

The study by Amineh and Asl (2015) adds that social constructivism does not exist in advance, but it is constructed through human activities. Therefore, as learners working as a team sharing their individual understanding, knowledge is constructed as the end product. For example, when learners were interviewed about why they chose practical work as their preferred IS in Physical Sciences, learner 1 said, ‘I chose practical work because yesterday we did one in groups and working as a group or going to the libraries as a group, sharing ideas, and getting more information, helps me a lot to understand’. Learner 5 on the other hand responded that, ‘I chose practical work because it is easy to understand, and I can also learn from others as we do practical work as a group’.

Similarly, with cooperation learning for better understanding of the concepts learnt in class, the participants also appreciated working in groups; this was noted in their comments when they were interviewed. For instance, learner 1 said, when he was doing practical work alone it was not helpful because no one can help him, and he cannot share ideas but when he was working with other learners, he understood better, so he preferred practical experiment if they can work as a team. Meanwhile, learner 6 mentioned that, yes, he found practical work useful, because even though Physical Sciences was difficult but through examples and practical experiments, it was understandable through sharing ideas as a group and helping each other. Indeed, as part of the observation in the exploration of practical work, learners were engaged in discussions, one could hear disagreements while others were sharing common ideas in a form of agreements. However, a positive spirit and the notion of working together for a common goal was observed. Research study on practical work states that learners who did very well in practical experiment have the great possibility to excel in the Physical Sciences examination (Lee & Sulaiman, 2018). This is through cooperative learning and comprehension where learners were able to perform better when working together as a group and learn from each other. This was also observed in the current study in practical session where learners communicating within the group, sharing information and through discussions there were agreements and also disagreements.

5.2.4.3 Teacher's Praxis

Teaching according to Gholami (2011) is a kind of human action closer in meaning to praxis. It is a teaching engagement that has intrinsic end or internal good. Also, teaching is conceptually and practically dependent on the learning where the teaching activities aim at transmitting the content of subject matter and bring about learning in pupils. The current research on the other hand, indicates that learners prefer their teacher to be actively involved in their learning through collaboration and communication. The findings above are supported by the research conducted by Benonguil and Barnido (2022) which states that learners' attitudes towards their teachers and the subjects taught by them are judged on how the teacher efficiently delivers the lessons. Also, the study by Gholami (2011) states that for the effective teaching environment, teachers should share joy and good feeling with as many learners as possible and support learners in their academic journey. Again, the findings on Figure 4.12 in Chapter 4 clearly indicate that teacher guidance was the instructional strategy that was selected as the most effective and useful by the learners. For example, learner 5 commented that, he would like them as learners to work together with their teacher, when the teacher was teaching, he should not only focus on the board, but he should involve them in demonstrating what he was teaching, and the line of communication should be smooth between the teacher and learners and the teacher should be open to assist with any questions. Learner 6 said, when teaching Physical Sciences, he would like the teacher to try and slow down so that they all can understand what was being taught'. The findings of the study refute the claims made by Saskatchewan Education (1991) in terms of instructional strategy called independent study. This instructional strategy foster the development of the individual learner and self-reliance, although, learners will always require the guidance of their teacher, however, independent study promote learners to construct knowledge for themselves without the involvement of the teacher. The implication for this study is that learners prefer to learn Physical Sciences when their teacher is actively present in their learning, assisting and motivating them as well.

Another critical aspect that was noted during the interview was that learners prefer their teacher to integrate different teaching methods and be friendly and enjoy the lesson with them, in such a way that, when the teacher comes into class, he should use past exam papers in order to test learners' understanding and have fun while teaching. One learner was cited when she said, 'Sir, when you come into class, come with a smile and create other things that we can do so that the subject can be interesting'. Learner 6 also said that 'when teaching Physical Sciences, come to the classroom with past question papers so that we can try them and see how far we understand the subject, especially in Electricity, and the teacher should come up with different ideas to make us understand Physical Sciences since it is not an easy subject' (Chapter 4, p. 55). In this regard, learners have their own ways of learning Physical Sciences which are not far apart from what we call teacher's praxis. Furthermore, even in the preference of teacher guidance and practical work as stated earlier in this research, learners also emphasise the issue of employing IS such as teacher guidance and practical work in their learning of the subject. Learner 5 said, he would like to learn Physical Sciences through more examples and practical experiments. Learner 2 also alluded that she would like to be taught Physical Sciences under the guidance of the teacher and with practical experiments because in practical work they are taught things that they can easily remember in tests or exams and through teacher guidance, she can also remember what she learnt in class. This further highlights the need for more integration of IS such as teacher guidance and practical work in the classroom with the hope of better conceptual understanding in subject like Physical Sciences, especially in Electricity.

5.2.4.4 Element of Good Teacher Praxis: Learners' Views

Critical teaching in public schools requires change that has been set up within the school in order to maintain the status quo (Lima, 2013). As such, this critical teaching also requires support for learners to learn both to work towards change and to advance in the educational settings. Structuring practices and teacher-learner relationship as part of teachers' praxis needs to be kept positive so that learners can be able to engage fully with the content that is being taught in class. According to Awoniyi and Butakor (2021) critical teaching is an important role when it comes to teacher-learner relationship, more especially when it comes to the giving of formative feedback by teachers. It shows that teachers' good praxis is appreciated by learners when they are linked to their academic improvement. For example, learner 3 expressed generosity towards the practice implemented by the teacher in class when he said, he enjoyed the practical experiment that they did yesterday because he was able to physically see the circuit board and the brightness of the bulbs; it made a lot of sense to him. Learner 5 added that, he liked the way the teacher taught them because the teacher takes his time to explain what he was teaching and also avails himself for questions outside the classroom. Learner 1 also added a very insightful statement when he said, 'Sir, when you teach us, you make sure that homework is given and on the following day you also assist us with corrections for that home work to ensure that we understand Physical Sciences better and I like that (Chapter 4, p. 56). This in a nutshell suggests that through teachers' good praxis, learners are motivated to engage in the lesson. The findings of the current study support the claims made by Awoniyi and Butakor (2021) when they stated that in the event when learners felt safe and secure in the classroom with a trusted teacher, learners tend to feel free and comfortable to take risks and commit errors in their effort to learn.

As the study progresses, it was noted that learners' preferences are more inclined with teacher guidance and the engagement between them and their teacher in the classroom. When learner 2 was asked about how she would like Physical Sciences to be taught in the school, she said, she would like teachers to teach her while guiding her throughout the process because it easy when she interacted with the teacher, asking questions while taking notes as well, that allowed her to remember easily and understand better. Learner 5 said, he would like them to work with the teacher, when the teacher was teaching he should not focus on writing on the board, but he should engage with the learners to demonstrate what he is teaching. Again, the aspect of teacher guidance and engagement has emerged a lot to indicate that perhaps learners feel more secure when such teaching methods are applied. In terms of friendly classroom environment, this aspect also plays an important role simple because the participants of the study have been noted many times commenting about how they prefer their teacher to conduct himself when he comes to the class to teach. For example, learner 6 said, 'Sir, when you come to class to teach us, have fun with us while you are teaching so that we can enjoy the subject; do not be serious' (Chapter 4, p. 57). One may add that the findings suggest that learners prefer to learn Physical Sciences in a more favourable environment as perceived by them. This means that if learners can be granted their perceived classroom context, perhaps they can have less fear and more eagerness to learn the subject when they are in an environment they trust.

5.2.5 Conclusion

Instructional Strategies are mostly used to apply learning theories in a useful way and to obtain the target learning outcomes (Akdeniz, 2016). For instance, as the study explored three IS, data generated showed that learners prefer Physical Sciences to be taught everyday as compared to the stipulated notional time prescribed by CAPS document which indicates four periods per week. Learners, also, prefer to learn Physical Sciences through more examples and activities so that they can be exposed to different kinds of assessments. Furthermore, it was noted that learners prefer their teacher to come to class with different past year examination papers so that learners can try them and test their understanding. Practical experiments was the instructional strategy that was mostly favoured by the learners for better understanding of the subject as well as the use of computer simulations. Teacher guidance on the other hand was preferred by certain number of learners based on the fact that this instructional strategy allows learners to work with the teacher while demonstration is done as the lesson progresses and learners have the opportunity to be guided step-by-step in the activities that are given to them. To sum up the above argument, learners prefer their teacher to reflect a friendly classroom environment in a sense that when he or she comes to the classroom, he or she should have fun while teaching them.

5.2.6 Recommendation

It is apparent that IS are a combination of teaching and learning activities that determine the approach a teacher may take to achieve the learning objectives. The IS, by virtue of being strategies, are instructional methods that include specialised instructional phases in line with the particular purpose of the subject. Teachers should take note of learners' preferences of IS and also consider using IS in their content delivery for the benefit of learners. Moreover, subject advisors should instil the notion of IS in teachers' lesson plans for the purpose of implementation.

5.2.7 Why do Grade 10 Physical Sciences Learners prefer the Instructional Strategies in the way they do?

5.2.7.1 Factors that Shaped Learners' Choices of Practical Work and Teacher Guidance

In terms of factors that shaped learners' choices of practical work and teacher guidance, the current study showed that learners liked the way their teacher conducted practical demonstrations for them so that they can understand the subject content better.

The findings of the study indicate that the way the teacher conducted the exploration of IS through practical work has shaped the learners' choices of conveniently selecting practical work and teacher guidance.

Teachers play a very important role in fostering positive learner interaction. They do that by first, diagnose the progress of the group and intervene when necessary. Based on the fact that the current study is framed around collaborative learning (CL), research by Van Leeuwen and Janssen (2019) indicate that without adequate teacher guidance, the positive interactive between learners working together be it practical work or other forms of group work, is at risk. The study further adds that, when teachers do not identify problems in time and do not intervene enough, the quality of CL process and the resulting learning outcomes might be affected. For the current research, the teacher was able in time to ensure that learners are accommodated in the practical experiments, assisting them through demonstrations and more examples with the aim of ensuring conceptual understanding of the subject. Participants in this study were noted expressing factors that shaped their choices of practical work and teacher guidance as their preferred IS for better understanding of the subject content. Learner 5 said, 'Sir, if we do experiments as a group, the teacher is able to do more demonstrations for us so that we can be able to understand whatever we are learning, also, through practical work, I can see what the teacher is teaching us' (Chapter 4, p. 57). Learner 6 responded that, through teacher guidance, he had the opportunity to ask questions and get assisted without struggling or getting the task wrong. The findings above showed that learners have more confidence in their learning journey when they had the presence of their teacher in class. The findings of the study also concur with the claims made by Saskatchewan Education (1991) about the instructional strategy experiential learning in a sense that this strategy is more focus on the process of learning than the product. However, it should be noted that applying teacher guidance in guiding groups of collaborative learners in demanding tasks has positive results for teachers (Van Leeuwen & Janssen, 2019).

Another aspect that led learners to prefer teacher guidance as one of the most sought instructional strategy in learning Physical Sciences is the quality of teacher-learner interactions. In teacher-learner interactions, learners' engagement can be considered as an indicator of teacher effectiveness due to its role in explaining crucial academic outcomes such as achievement (Burić & Frenzel, 2021). Meanwhile, the teacher can critique learners specifically on the learning errors and mistakes with the aim of providing support and formative feedback that learners can use to improve their learning.

Learners finds more comfort when the teacher was available to assist them during the practical sessions and do more examples on the board so that they can have less struggle in the conceptual development. Apparently, the two IS selected by the learners had helped them through better understanding of the subject content and/or observation of phenomenon. In this regard, learner 2 said, she chose teacher guidance because she easily understood through it, and even in the exams it was easy to remember what her teacher taught her. From the evidence that was generated through the interviews, it was quite clear that learners chose teacher guidance simply because they appreciated the support their teacher was providing to them. As much as the current research indicates that teacher guidance has positive results, however, it was not always the case, for instance, the study by Van Leeuwen and Janssen (2019) argued that not all teacher guidance were positively associated better understanding of the content, more especially with learners' collaboration. For example, when learners experience too much of teacher dependence or teacher control.

Practical work, the instructional strategy that was chosen by the learners as the effective method of learning Physical Sciences. According to Pereira et al. (2020) practical work in a learner-centred approach, was considered to be the best strategy to promote scientific and technological education. The authors further add that practical work also allowed the building of some understanding, even though simplified about science, processes and its nature as well as developing a scientific attitude towards problem solving. Participants of the current study preferred this instructional strategy especially through the hands-in and minds-on aspect of it. When they were interviewed, learner 3 said, she chose practical work because she does not enjoy writing all the time, rather she loves doing things with her hands as it assists her to get a picture of what she is doing. The findings indicate that learners want to be actively involved in their learning through hands-on practical, engaging, involvement in academic and class activities, good teaching methods.

Good teaching methods had also captured learners' attention. Learner 2's response of the interview, shows she chose teacher guidance because she easily understands through it, and she was able to easily interact with the teacher while taking notes and asking questions and getting responses immediately. While learner 6 said, he chose teacher guidance because if they were given a task, they had an opportunity to ask questions and the teacher was also actively involved in assisting them so that they do not struggle and get the task wrong. Although, practical work had shown to yield positive results in this study, however, Pereira et al. (2020) also mention that not all practical work involves a laboratory bench as it is largely perceived. There is a lot of alternatives such as computerised interactive activities, exploring materials, case studies, interviews, debates and role-play, essay, posters and scrapbooks, library researchers, photo and video documentaries all of which are considered as practical work. Learners also valued the opportunity they were given to ask questions and the activities given to them for better understanding. For examples, learner 3 said, 'You too Sir, to me you are teaching very well because you allow us to ask questions where we don't understand after that I am able to do the activity by myself' (Chapter 4, p. 59). Learner 1 also commented that the teacher gave his time to explain everything and even ask them questions because when he asked them more questions that made them focus and be able to do the activities. With all that said, practical work yields positive results as part of science lessons, and it has contributed towards learners' positive attitudes.

5.2.7.2 Career Aspirations

Occupational aspirations are incorporated in the individual self-image developed during socialisation from the early childhood all the way to the adolescence stage (Makarova et al., 2019).

Participant of the study were motivated to choose Physical Sciences over other subjects based on the two reasons which are, enrolled in science subject as entry to medical fields and enrolled in science subject as opportunities for diverse jobs.

The findings of the study revealed that learners chose the science stream because they wanted to pursue science related careers and most of them were so convinced that Physical Sciences would open many doors for them in terms of career opportunities. The process embedded in the development of occupational aspiration is comparison of one's self-image with the image of an occupation and one's judgment about the match between the two. For example, it was noted when learner 1 said, she chose Physical Sciences because of her career she aspires to become; she wanted to be a gynaecologist. Learner 3 also said he love Physical Sciences and his father also told him that Physical Sciences has better job opportunities and he believe that by choosing Physical Sciences he would have a better chance of finding a job as compared to other non-science subjects. A possible interpretation of these findings was that learners had long made their choices about their career path they want to pursue before they even enrolled in grade 10 and parental support and motivation also reinforces these choices.

The study had revealed Grade 10 learners' views and preferences of Instructional Strategies in Electricity. The exploration of the three IS such as *teacher guidance, practical work and computer simulations* have successfully managed to assist learners make an informed decision to express their views and preferences regarding the IS in question. Learners view their teacher as applying good teachers' practice in class in terms of helping them understand the subject better. This includes assisting learners by providing more examples when teaching and guiding them throughout the activities in class. As a result, learners appreciated the way Physical Sciences was taught at school. Also, the exploration of the IS shaped the learners' choices in selecting the IS. For instance, learners preferred to be engaged with the subject most of the time and carried out practical experiments. The implications of the study suggested that learners prefer to work in groups by sharing knowledge and ideas through social interactions.

5.2.8 Conclusion and Recommendations

The teacher-learner interactions were one of the aspects that played a significant role for learners to prefer teacher guidance and practical work as two of the IS in the learning of Physical Sciences. According to Burić and Frenzel (2021) teacher-learner interactions is the effectiveness of the teachers' presence in learners' academic engagement. The evidence presented indicate that learners preferred practical work simply because in practical experiments the teacher is able to do more demonstrations for them which helped them understand the subject better and also comprehend what the teacher is teaching. Moreover, learners prefer practical work more so because they do not enjoy writing all the time; they prefer doing things with their hands which also assists them to get a deeper understanding of what they are doing. In terms of teacher guidance, learners indicated that through this IS they had an opportunity to ask questions and get assisted immediately without struggling or getting the task wrong. Teacher guidance also provided learners with the opportunity to interact with the teacher while asking questions and getting responses instantly. The findings in Figure 4.12 in Chapter 4 also reinforce the findings about the factors that shaped learners' choices of practical work and teacher guidance as their preferred IS in the learning of Electricity as compared to computer simulation. Also, this section has provided evidence in terms of what motivated learners to prefer the two IS (i.e., practical work and teacher guidance) as learners' preferences in Physical Sciences.

Fostering a positive learner interaction can be quite challenging for science teachers (Van Leeuwen & Janssen, 2019). However, through proper intervention and diagnosis of the progress in group discussions, learner interaction can be achieved. Teachers should also ensure that teacher guidance is provided to the learners from the beginning of the lesson. This will not only help learners solidify learner interaction but also sustain collaborative learning amongst them as well. The study has revealed that learners prefer to work on their activities in the presence of their teacher while assisting them. Therefore, teachers should constantly supervise their learners progress in class in order to unsure successful teaching and learning.

5.3 Limitations of the Study

The aims of the present research have been achieved, but with some limitations as discussed below:

The findings of the study were limited to Grade 10 Physical Sciences learners in an under-resourced school. Results of the study were obtained from a sample of twenty-five learners. The sample was small hence the results cannot be generalised. Data generation tool such as the questionnaires were administered in class by the subject teacher. The fact that learners answered the questions in the presence of their subject teacher could have some impact on the study. The research was conducted in Umlazi township. It will be therefore unfair to generalise for all high schools in other parts of the country. The study was also limited to the fact that it had investigated learner' views and preferences of Instructional Strategies in Electricity and did not consider the effect of learners' different cultural background views that they bring into the classroom.

5.4 Recommendations for further Research

Electricity as a topic in Physical Sciences is a challenge, not only to South African learners, but across the globe. The research found that Grade 10 Physical Sciences learners prefer teacher guidance and practical work as the instructional strategies (IS) for Electricity, however, the study did not reveal whether or not these IS will be sustained for a long period of time. Therefore, the researcher recommends that the Department of Basic Education (DBE) must escalate the implementation of policies that addresses the issue of considering learners' preferences of IS in the teaching and learning context. The provision of science laboratory equipment to schools should be a matter of urgency to ensure that learners learn about the topics of Physical Sciences the way they should be. The DBE should also ensure that the school management team (SMT) allocate more time for Physical Sciences as a subject in their composite timetables so that more contact time is provided to the learners.

Department of Basic Education should use the preferred IS these learners have indicated as an advantage to reach out to many schools that are under resourced but in pursuit of Physical Sciences and science-related careers for their learners. Teachers of the subject Physical Sciences should use these IS to make sure that learners are able to comprehend the abstract concepts of the subject. All the stakeholders in schools including the school governing body (SGB), and parents should come on board to assist teachers in the implementation of these IS by ensuring that all learners do participate in the lessons that uses these IS as teaching methods.

The findings of the study clearly indicated that learners preferred teacher guidance and practical work as the most IS in learning Electricity. Learners further shown that through group discussions and constant interaction with the teacher they understand better the concepts of Physical Sciences. These findings have highlighted the elements of constructivism and social constructivist theories discussed in Chapter 2 in a sense that knowledge is constructed through social interaction. Thereafter, through knowledge construction, an active learner emerges (see Figure 2.1).

Future studies could make use of this research as reference and also similar studies could be conducted in other grades to obtain a more comprehensive picture both in the application of well-resourced and under-resourced schools. The findings also suggest that future research should be conducted on the design and implementation of an ICT-based method as we teach our learners through the methodology of the 21st century. Currently, learners in schools are technologically savvy, yet classroom discourse and practice still remain the same as traditional teaching. Most learners are computer literate, with the use of technology in schools and as such as computer simulations would help teachers achieve conceptual understanding in Electricity through guided activities.

5.5 Concluding Comments

The chapter has provided a detail discussion on the answers to the study research questions. This was done based on the themes of the research that were formulated from the interviews transcripts.

This section was framed around providing answers to three research questions. Firstly, it sought to investigate Grade 10 Physical Sciences learners' views on instructional strategies (IS) used in Electricity. The study showed that learners view their teacher as an active facilitator that support them throughout the learning journey and ensures that they are guided and as they comprehend the concepts in Electricity. Furthermore, learners view their teacher as a caring educator that avails himself when learners require assistance. Secondly, the study sought to investigate Grade 10 learners' preferences of IS in Electricity. The study reveals that learners prefer Physical Sciences to be taught through more examples and activities so that it can make sense to them. Learners also prefer their teacher to use different past year examination papers when teaching them concepts like Electricity. Thirdly, the sought to investigate factors that shape learners' choices to prefer the IS the way they do. The study indicated that learners preferred teacher guidance and practical work as the most IS to learn Physical Sciences. The findings further indicate that learners feel more comfortable through the activities that guided and collaborative work like practical work as they enjoy working as a group. This section further provided the recommendations and conclusions per each research question answered. Lastly, the limitations of the study and recommendations were discussed.

References

Adam, I. (2017). Vygotsky's social constructivists theory of learning. *Unpublished Research Paper*. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Vygotsky%E2%80%99s+Social+Constructivists+Theory+of+Learning&btnG=

Agarkar, S. C. (2019). Influence of learning theories on science education. *Resonance*, *24*(8), 847-859.

Aidoo, B., Boateng, S. K., Kissi, P. S., & Ofori, I. (2016). Effect of problem-based learning on students' achievement in chemistry. *Journal of Education and Practice*, *7*(33).

Akdeniz, C. (2016). Instructional strategies. In. Education Faculty. S. Demirel University. https://doi.org/10.1007/978-981-10-2519-8_2

Akuma, F. V., & Callaghan, R. (2019). Teaching practices linked to the implementation of inquiry-based practical work in certain science classrooms. *Journal of Research in Science Teaching*, *56*(1), 64-90.

Al-Kadi, A. (2018). Language teaching and educational research. *Educational Research*, *1*(1), 1-12.

Alexandrovsky, D., Putze, S., Bonfert, M., Höffner, S., Michelmann, P., Wenig, D., Malaka, R., & Smeddinck, J. D. (2020). Examining design choices of questionnaires in vr user studies. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1-21.

Alharahsheh, H. H., & Pius, A. (2020). A Review of key paradigms: positivism vs interpretivism. *Global Academic Journal of Humanities and Social Sciences.*, *2*(3), 39-43. https://gajrc.com/gajhss

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages*, *1*(1), 9-16.

Apriyani, R., Ramalis, T. R., & Suwarma, I. R. (2019). Analyzing students' problem solving abilities of direct current electricity in stem-based learning. *Journal of Science Learning*, *2*(3), 85-91.

Aspers, P., & Corte, U. (2021). What is Qualitative in Research. *Qualitative Sociology*, *44*(4), 599-608.

Awoniyi, F. C., & Butakor, P. K. (2021). The role of teacher-student relationship on performance in mathematics of the eleventh graders in the Cape Coast metropolis: Critical friendship perspective. *Cogent Education*, *8*(1), 1908690.

Bada, S. O., & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education*, *5*(6), 66-70.

Badem-Korkmaz, F., & Balaman, U. (2020). Third position repair for resolving troubles in understanding teacher instructions. *Linguistics and Education*, *60*, 100859.

Barak, M. (2017). Science teacher education in the twenty-first century: A pedagogical framework for technology-integrated social constructivism. *Research in Science Education*, *47*(2), 283-303.

Bhaw, N., & Kriek, J. (2020). The alignment of the Grade 12 physics examination with the CAPS curriculum:(November 2014–March 2018). *South African Journal of Education*, *40*(1).

Bradley, J., & Moodie, P. (2021). A systemic approach to teaching and learning about electrical cells and circuits using two big ideas of science. *African Journal of Chemical Education*, *11*(1).

Burde, J.-P., Weatherby, T. S., & Kronenberger, A. (2021). An analogical simulation for teaching electric circuits: a rationale for use in lower secondary school. *Physics Education*, *56*(5), 055010.

Burde, J.-P., & Wilhelm, T. (2020). Teaching electric circuits with a focus on potential differences. *Physical Review Physics Education Research*, *16*(2), 020153.

Burić, I., & Frenzel, A. C. (2021). Teacher emotional labour, instructional strategies, and students' academic engagement: a multilevel analysis. *Teachers and Teaching*, *27*(5), 335-352.

Coffelt, T. (2017). Confidentiality and anonymity of participants. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&as_ylo=2011&q=Coffelt%2C+T.+%282017%29.+Confidentiality+and+anonymity+of+participants.&btnG=

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education (8th ed.)*. Routledge Falmer.

Cohen, R., Eylon, B., & Ganiel, U. (1983). Potential difference and current in simple electric circuits: A study of students' concepts. *American Journal of Physics*, *51*(5), 407-412.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.)*. Thousand Oaks.

Department of Basic Education. (2011). *National Curriculum Statement for Grade 10-12 (General): Physical Sciences*. Pretoria, South Africa: Government Printer. Retrieved from https://www.education.gov.za/Portals/0/Documents/Reports/2021%20NSC%20Reports/Diagnostic%20Report%202020%20-%20Part%201.pdf?ver=2021-03-25-105406-000

Department of Basic Education. (2021). *2021 NSC examination report*. Pretoria, South Africa: Government Printer. Retrieved from https://www.education.gov.za/Portals/0/Documents/Reports/2021%20NSC%20Reports/Diagnostic%20Report%202020%20-%20Part%201.pdf?ver=2021-03-25-105406-000

Department of Basic Education: DBE. (2011). *National Curriculum Statement for Grade 10-12 (General): Physical Sciences*. Pretoria, South Africa: Government Printer.

Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists*. Routledge.

Dey, I. (2003). *Qualitative data analysis: A user friendly guide for social scientists*. Routledge.

Dhurumraj, T. (2013). *C*ontributory factors to poor learner performance in Physical Sciences in KwaZulu-Natal Province with special reference to schools in the Pinetown District. South Africa: University of South Africa.

Djajalaksana, Y. M. (2011). *A National survey of Instructional Strategies used to teach information system course: An exploratory investigation* [(Published doctoral dissertation). University of South Florida].

Fischer, J., He, J., & Klieme, E. (2020). The structure of teaching practices across countries: A combination of factor analysis and network analysis. *Studies in Educational Evaluation*, *65*, 100861.

Flick, U. (2014). *Qualitative data analysis*. SAGE Publications Ltd.

Fries, L., Son, J. Y., Givvin, K. B., & Stigler, J. W. (2020). Practicing connections: A framework to guide instructional design for developing understanding in complex domains. *Education Psychology Review*.

Fuzani, N. C. (2018). Teaching electrical circuits in grade 10 physical science using a conceptual change approach. Faculty of Education. University of Western Cape.

Gaigher, E., Lederman, N., & Lederman, J. (2014). Knowledge about inquiry: A study in South African high schools. *International Journal of Science Education, 36(18), 3125-3147.*

Gholami, K. (2011). Moral care and caring pedagogy: Two dimensions of teachers' praxis. *Pedagogy, Culture & Society*, *19*(1), 133-151.

Girard, A., Gal-Petitfaux, N., & Vors, O. (2021). The student's experience of teacher support in French vocational high-school classes with difficulties in school engagement in physical education: interest of mixed methods research. *Physical Education and Sport Pedagogy*, 1-16.

Grobler, H. B., & Wessels, S. (2020). Hear Their Voices: Self-configuration Experiences of Learners with Mild Learning Difficulties within the Learner–Teacher Relationship. *International Journal of Disability, Development and Education*, *67*(3), 243-262.

Gumede, M. B. (2020). Exploring understandings of key concepts in electric circuits: a case of 20 grade 11 Physical Sciences learners in uMgungundlovu District collaboratively constructing concept maps. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&as_ylo=2019&as_yhi=2021&q=Exploring+Understandings+of+Key+Concepts+in+Electric++Circuits%3A+A+Case+of+20+G

rade+11+Physical+Sciences+Learners+in++uMgungundlovu+District+Collaboratively+Constructing++Concept+Maps&btnG=

Habibi, H., Jumadi, J., & Mundilarto, M. (2020). Phet Simulation as Means to Trigger the Creative Thinking Skills of Physics Concepts. *iJET*, *15*(6), 166-172.

Haryadi, R., & Pujiastuti, H. (2020). PhET simulation software-based learning to improve science process skills. *Journal of Physics: Conference Series*, *1521*(2), 022017.

Hayes, K. N., Lee, C. S., DiStefano, R., O'Connor, D., & Seitz, J. C. (2016). Measuring science instructional practice: A survey tool for the age of NGSS. *Journal of Science Teacher Education*, *27*(2), 137-164.

Hesti, R. (2021). Analogy Educational Comics to Overcome Students' Misconception on Simple Electricity Circuit Material. Journal of Physics: Conference Series. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Hesti%2C+R.+%282021%29.+Analogy+Educational+Comics+to+Overcome+Students%E2%80%99+Misconception+on+Simple+Electricity+Circuit+Material.+Journal+of+Physics%3A+Conference+Series%2C&btnG=

Hobden, P. A. (2005). What did you do in Science today? Two case studies of Grade 12 Physical Science classrooms. *South African Journal of Science*, *101*.

Hodosyova, M., Útla, J., Vnukova, P., & Lapitkova, V. (2015). The development of science process skills in physics education. *Procedia-Social and Behavioral Sciences*, *186*, 982-989.

Hsu, P.-S., Van Dyke, M., & Chen, Y. (2015). Examining the effect of teacher guidance on collaborative argumentation in middle level classrooms. *RMLE Online*, *38*(9), 1-11.

Ismail, N., Ghaddar, N., & Ghali, K. (2018). Electric circuit analogy of heat losses of clothed walking human body in windy environment. *International Journal of Thermal Sciences*, *127*, 105-116.

Kácovský, P., & Snětinová, M. (2021). Physics demonstrations: who are the students appreciating them? *International Journal of Science Education*, *43*(4), 529-551. https://doi.org/10.1080/09500693.2020.1871526

Kallio, H., Pietila, A., Johnson, M., & Kangasniemi, M. (2016). Systematic methodology review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*. https://doi.org/10.1111/jan.13031

Kapelari, S. (2015). *Garden Learning: A Study on European Botanic Gardens' Collaborative Learning Processes*. Ubiquity Press.

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

Khan, Z. N. (2020). Role of ICT on the academic achievement of Madrasa students. *International Research in Education*, *8*(2), 23-32.

Kibirige, I., Rebecca, M. M., & Mavhunga, F. (2014). Effect of practical work on grade 10 learners' performance in science in mankweng circuit, south africa. *Mediterranean Journal of Social Sciences*, *5*(23), 1568.

Kitta, S., & Tilya, F. (2018). Assessment Status of Learner-centred Learning in Tanzania in the Context of the Competence-based Curriculum. *Papers in Education and Development*(29).

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, *6*(5).

Kock, Z.-J., Taconis, R., Bolhuis, S., & Gravemeijer, K. (2015). Creating a culture of inquiry in the classroom while fostering an understanding of theoretical concepts in direct current electric circuits: A balanced approach. *International Journal of Science and Mathematics Education*, *13*(1), 45-69.

Korganci, N., Miron, C., Dafinei, A., & Antohe, S. (2015). The importance of inquiry-based learning on electric circuit models for conceptual understanding. *Procedia-Social and Behavioral Sciences*, *191*, 2463-2468.

Kumar, R. (2011). Research methodology: A step-by-step guide for beginners (3rd ed.). Retieved from https://scholar.google.com/scholar?q=Kumar%2C+R.+%282011%29.+Research+methodology%3A+A+step-by-step+guide+for+beginners+3rd+edition&hl=en&as_sdt=0%2C5&scioq=Warnich+%26+Meyer%2C+2013&as_ylo=2011&as_yhi=

Kyngäs, H., Kääriäinen, M., & Elo, S. (2020). The trustworthiness of content analysis. In *The application of content analysis in nursing science research* (pp. 41-48). Springer.

Laher, S., & Kramer, S. (2019). *Transforming research methods in the social sciences: Case studies from South Africa*. Wits University Press.

Lee, M. C., & Sulaiman, F. (2018). The effectiveness of practical work in Physics to improve students' academic performances. *PEOPLE: International Journal of Social Sciences*, *3*(3), 1404-1419.

Leo, J., & Puzio, K. (2016). Flipped instruction in a high school science classroom. *Journal of Science Education and technology.*, *25*, 775-781.

Letsoalo, M. E., Masha, J. K., & Maoto, R. S. (2019). The overall performance of grade 12 mathematics and physical science learners in south africa's gauteng province. *Journal of Gender, Information and Development in Africa*, *8*(1).

Levy, M., & Moore, P. J. (2018). Qualitative research in CALL. *Language Learning & Technology*, *22*(2), 1-7.

Lima, J. C. (2013). The Possibilities and Constraints of Three Teachers' Perspectives and Enactment of Critical Praxis in Public Schools. *Journal for Critical Education Policy Studies (JCEPS)*, *11*(2).

Lin, J.-W. (2016). A comparison of experienced and preservice elementary school teachers' content knowledge and pedagogical content knowledge about electric circuits. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(3), 835-856.

Lombard, E. H., & Simayi, A. (2019). Academic engagement of Eastern Cape Grade 8 township learners with depictive representations of simple electric circuits: a focus on low-achieving learners with limited science self-confidence. *African Journal of Research in Mathematics, Science and Technology Education*, *23*(1), 40-51.

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*, *18*(1), 1-13.

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in STEM fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. Frontiers in Education. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=Warnich+%26+Meyer%2C+2013&q=Makarova%2C+E.%2C+Aeschlimann%2C+B.%2C+%26+Herzog%2C+W.+%282019%29.+The+gender+gap+in+STEM+fields%3A+The+impact+of+the+gender+stereotype+of+math+and+science+on+secondary+students%27+career+aspirations.+Frontiers+in+Education%2C&btnG=

Mancosa. (n.d.).

Manunure, K., Delserieys, A., & Castéra, J. (2020). The effects of combining simulations and laboratory experiments on Zimbabwean students' conceptual understanding of electric circuits. *Research in Science & Technological Education*, *38*(3), 289-307.

Maries, A., & Singh, C. (2018). Case of two electrostatics problems: Can providing a diagram adversely impact introductory physics students' problem solving performance? *Physical Review Physics Education Research*, *14*(1), 010114.

Mason, J. (2017). *Qualitative researching*. SAGE.

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Sage publications.

Miriam, S., & Salam, M. A. (2020). The effect of Instructional Strategies on student achievement in Physics: A meta-analysis study viewed from topics of Physics and kinds of students achievements. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Miriam%2C+S.%2C+%26+Salam%2C+M.+A.+%282020%29.+The+effect+of+Instructional+Strategies+on+student+achievement+in+Physics%3A+A+meta-analysis+study+viewed+from+topics+of+Physics+and+kinds+of+students+achievements.+&btnG=

Mitchell, B., Ekey, R., McCullough, R., & Reitz, W. (2018). A fan-tastic quantitative exploration of Ohm's law. *The Physics Teacher*, *56*(2), 75-78.

Mkandawire, M. (2009). Physical science activities and skills development in the school curriculum of Namibia. A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Education with specialization in natural science education. University of South Africa.

Mkandawire, S. B. (2019). Selected common methods and tools for data collection in research. *Selected Readings in Education*, *2*, 143-153.

Mkimbili, S. T. (2018). Learner-centred science teaching in community secondary schools in Tanzania. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Mkimbili%2C+S.+T.+%282018%29.+Learner-centred+science+teaching+in+community+secondary+schools+in+Tanzania.&btnG= (Accessed: 7 April 2021).

Mngonyama, N. T. (2018). Comparing the teaching and learning of Ohm's law in Grade 10 Physical Sciences in resourced and underresourced schools. Retrieved from at:https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Mngonyama%2C+N.+T.+%282018%29.+Comparing+the+teaching+and+learning+of+Ohm%27s+law+in+Grade+10+Physical+Sciences+in+resourced+and+underresourced+schools.+&btnG=

Moddley, K., & Gaigher, E. (2019). *Teaching electric circuits: Teachers' perceptions and learners' misconceptions*.

Mulisa, F. (2022). When Does a Researcher Choose a Quantitative, Qualitative, or Mixed Research Approach? *Interchange*, *53*(1), 113-131.

Munje, P. N., & Jita, T. (2020). The impact of the lack of ICT resources on teaching and learning in selected South African primary schools. *International Journal of Learning, Teaching and Educational Research*, *19*(7), 263-279.

Mupira, P., & Ramnarain, U. (2018). The effect of inquiry-based learning on the achievement goal-orientation of Grade 10 Physical Sciences learners at township schools in South Africa. *Journal of Research in Science Teaching*, *55*(5).

Ngozwana, N. (2018). Ethical dilemmas in qualitative research methodology: Researcher's reflections. *International Journal of Educational Methodology*, *4*(1), 19-28.

Nxumalo-Dlamini, N. L., & Gaigher, E. (2019). Teachers' use of computer-based simulations in teaching electrolysis: a case study in Eswatini. *African Journal of Research in Mathematics, Science and Technology Education*, *23*(3), 320-331.

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

Olaniyan, A. O., & Govender, N. (2018). Effectiveness of polya problem-solving and target-task collaborative learning approaches in electricity amongst high physics students. *Journal of Baltic Science Education*, *17*(5), 765-777.

Özdem Yilmaz, Y., Cakiroglu, J., Ertepinar, H., & Erduran, S. (2017). The pedagogy of argumentation in science education: science teachers' instructional practices. *International Journal of Science Education*, *39*(11), 1443-1464. https://doi.org/10.1080/09500693.2017.1336807

Pelanek, R. (2020). A classification Framework for Practice Exercises in Adaptive Learning Systems. *Transactions on Learning Technologies*, *3*(4), 734-747.

Pereira, S., Rodrigues, M. J., & Vieira, R. M. (2020). Scientific literacy in the early years–practical work as a teaching and learning strategy. *Early Child Development and Care*, *190*(1), 64-78.

Perkins, K., Moore, E., Podolefsky, N., Lancaster, K., & Denison, C. (2012). Towards research-based strategies for using PhET simulations in middle school physical science classes. *AIP Conference Proceedings*, *1413*(1), 295-298.

Phanphech, P., Tanitteerapan, T., & Murphy, E. (2019). Explaining and enacting for conceptual understanding in secondary school physics. *Issues in Educational Research*, *29*(1), 180-204.

Ponto, H. (2020). Methods of Learning the Concept of Basic Electric Circuits: A Comparative Study between Lecture, Discussion and Collaboration. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Methods+of+Learning+the+Concept+of+Basic+Electric+Circuits%3A+A+Comparative+Study+between+Lecture%2C+Discussion+and+Collaboration&btnG=

Popat, Y. (2021). Ohm's law: Misconceptions of the students at secondary and senior secondary level. *International Journal of Engineering Applied Sciences and Technology*, *5*(12), 88-91.

Prastyaningrum, I., & Pratama, H. (2019). Student conception of Ohm's law. *Journal of Physics: Conference Series*, *1321*(2), 022028.

Pun, J. K., & Cheung, K. K. C. (2021). Meaning making in collaborative practical work: a case study of multimodal challenges in a Year 10 chemistry classroom. *Research in Science & Technological Education*, 1-18.

Rahi, S. (2017). Research design and methods: A systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics & Management Sciences*, *6*(2).

Ramnarain, U., & Hlatswayo, M. (2018). Teacher beliefs and attitudes about inquiry-based learning in a rural school district in South Africa. *South African Journal of Education*, *38*(1).

Ramnarain, U., & Moosa, S. (2017). The use of simulations in correcting electricity misconceptions of grade 10 South African physical sciences learners. *International Journal of Innovation in Science and Mathematics Education*, *25*(5), 1-20.

Rankhumise, M. P. (2012). The effect of activity-based instructional approaches in ameliorating alternative conceptions about electric circuits held by students from the national curriculum statement and the old school curriculum. University of Zululand. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=Warnich+%26+Meyer%2C+2013&q=Rankhumise%2C+M.+P.+%282012%29.+The+effect+of+activity-based+instructional+approaches+in+ameliorating+alternative+conceptions+about+electric+circuits+held+by+students+from+the+national+curriculum+statement+and+the+old+school+curriculum.+University+of+Zululand.&btnG=

Rehman, A. A., & Alharthi, K. (2016). An introduction to research paradigm. *International Journal of Educational Investigations*, *1*(18), 51-59.

Ricci, L., Lanfranchi, J.-B., Lemetayer, F., Rotonda, C., Guillemin, F., Coste, J., & Spitz, E. (2019). Qualitative methods used to generate questionnaire items: A systematic review. *Qualitative health research*, *29*(1), 149-156.

Risdianto, E., Dinissjah, M. J., & Nirwana, M. K. (2020). The Effect of Ethno Science-Based Direct Instruction Learning Model in Physics Learning on Students' Critical Thinking Skill. *Universal Journal of Educational Research*, *8*(2), 611-615.

Samuel, P. (2017). Investigating how Grade 10 Physical Science teachers help learners to make sense of concepts of electromagnetism using easily accessible materials in under-resourced schools. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Samuel%2C+P.+%282017%29.+Investigating+how+Grade+10+Physical+Science+teachers+help+learners+to+make+sense+of+concepts+of+electromagnetism+using+easily+accessible+materials+in+under-resourced+schools.&btnG=

Saskatchewan Education. (1991). *Instructional approaches: A framework for professional practice*. Regina, SK: Author.

Schildkamp, K., van der Kleij, F. M., Heitink, M. C., Kippers, W. B., & Veldkamp, B. P. (2020). Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. *International Journal of Educational Research*, *103*, 101602.

Seechaliao, T. (2017). Instructional strategies to support creativity and innovation in education. *Journal of education and learning*, *6*(4), 201-208.

Seel, N. M. (2017). Model-based learning: A synthesis of theory and research. *Educational Technology Research and Development*, *65*, 931-966.

Shah, R. K. (2020). Concepts of Learner-Centred Teaching. *Shanlax International Journal of Education*, *8*(3), 45-60.

Shipstone, D., Rhöneck, C. v., Jung, W., Kärrqvist, C., Dupin, J.-J., Johsua, S. e., & Licht, P. (1988). A study of students' understanding of electricity in five European countries. *International Journal of Science Education*, *10*(3), 303-316.

Simelane, T. T. (2019). Barriers to high performance in physical science among learners: a case of selected Township secondary schools in South Africa. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=Warnich+%26+Meyer%2C+2013&q=Simelane%2C+T.+T.+%282019%29.+Barriers+to+high+performance+in+physic

al+science+among+learners%3A+a+case+of+selected+Township+secondary+schools+in+South+Africa.+Masters+thesis%2C+University+of+South+Africa.&btnG=

Stefaniak, J. E., & Tracey, M. W. (2015). An exploration of student experiences with learner-centered instructional strategies. *Contemporary Educational Technology*, *6*(2), 95-112.

Supeno, S., Subiki, S., & Rohma, L. W. (2018). Students' ability in solving physics problems on Newton's law of motion. *Journal Ilmiah Pendididikan Fisika Al-BiRuNi*, *7*(1), 59-70.

Taber, K. S. (2019). Constructivism in education: Interpretations and criticisms from science education. *Early childhood development: Concepts, methodologies, tools, and applications*, 312-342.

Takase, M., Niitani, M., Imai, T., & Okada, M. (2019). Students' perceptions of teaching factors that demotivate their learning in lectures and laboratory-based skills practice. *International journal of nursing sciences*, *6*(4), 414-420.

Taylor, S. P. (2018). Critical realism vs social constructionism & social constructivism: application to a social housing research study. *International Journal of Sciences: Basic and Applied Research*, *37*(2), 216-222.

Thanh, N. T., & Thanh, T. T. L. (2015). Using instructional strategies to enhance student achievement. *National Forum of Teacher Education Journal*, *25*(3).

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., & De Cock, M. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education*, *3*(1), 2.

To, J., & Carless, D. (2016). Making productive use of exemplars: Peer discussion and teacher guidance for positive transfer of strategies. *Journal of Further and Higher Education*, *40*(6), 746-764.

Tsakeni, M. (2018). Inquiry-based practical work in physical sciences: Equitable access and social justice issues. *Issues in Educational Research*, *25*(1).

Tsakeni, M. (2022). STEM Education Practical Work in Remote Classrooms: Prospects and Future Directions in the Post-Pandemic Era. *Journal of Culture and Values in Education*, *5*(1), 144-167.

Ukata, P. F., & Nmehielle, E. L. W. (2021). Roles of Direct and Indirect Instructional Strategies in Teaching and Learning Courses in Rivers State Universities: The Conflict and Resolution. Retrieved from https://scholar.google.com/scholar?q=direct+and+indirect+instruction&hl=en&as_sdt=0%2C5&as_ylo=2018&as_yhi=2021

Van Leeuwen, A., & Janssen, J. (2019). A systematic review of teacher guidance during collaborative learning in primary and secondary education. *Educational Research Review*, *27*, 71-89.

Von Korff, J., Archibeque, B., Gomez, K. A., Hechendorf, T., McKagan, S. B., Sayre, E. C., Schenk, E. W., Shepherd, C., & Sorell, L. (2016). Secondary analysis of teaching methods in introductory physics: A 50 k-student study. *American Journal of Physics*, *84*(12).

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Warnich, P., & Meyer, L. (2013). Trainee teachers' observation on learner-centered instruction and assessment as applied by History and Social Sciences teachers. *Journal of Yesterday & Today*, *9*, 13-44.

Wei, B., Chen, N., & Chen, B. (2020). Teaching with laboratory work: the presentation of beginning science teachers' identity in school settings. *Research Papers in Education*, *35*(6), 681-705.

Wei, B., & Li, X. (2017). Exploring science teachers' perceptions of experimentation: implications for restructuring school practical work. *International Journal of Science Education*, *39*(13), 1775-1794.

White, B. (2011). *Mapping your thesis: the comprehensive manual of theory and techniques for masters and doctoral research*. ACER Press.

Wilson, C., Marks Woolfson, L., & Durkin, K. (2020). School environment and mastery experience as predictors of teachers' self-efficacy beliefs towards inclusive teaching. *International journal of inclusive education*, *24*(2), 218-234.

Wilson, M. L. (2011). *Students' learning style preferences and teachers' instructional strategies: Correlations between matched styles and academic achievement.* Liberty University. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=Warnich+%26+Meyer%2C+2013&q=Wilson%2C+M.+L.+%282011%29.+Students%27+learning+style+preferences+and+teachers%27+instructional+strategies%3A+Correlations+between+matched+styles+and+academic+achievement.+Liberty+University.&btnG=

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science education*, *96*(5), 878-903.

Yin, R. K. (2018). *Case study research and application: Design and methods (6th ed.)*. SAGE Publications, Inc.

Yuliati, L., Riantoni, C., & Mufti, N. (2018). Problem Solving Skills on Direct Current Electricity through Inquiry-Based Learning with PhET Simulations. *International Journal of Instruction*, *11*(4), 123-138.

Yunzal Jr, A. N., & Casinillo, L. F. (2020). Effect of physics education technology (PhET) simulations: evidence from stem students' performance. *Journal of Education Research and Evaluation*, *4*(3), 221-226.

Appendices

Appendix 1: Questionnaire-1…………..……………………………...…...101

Appendix 2: Questionnaire-2……………………………………...…….104

Appendix 3: Questionnaire-3………………………………….……...…106

Appendix 4: Learner Interview Questions……………………….....…....108

Appendix 5: Interviews Transcripts……………………………...……...109

Appendix 6: Electricity Conceptual Test……………..……...……………122

Appendix 7: Physical Sciences Learners' Misconceptions in Electric Circuits……………………………………………….…………………..129

Appendix A: Gatekeeper Consent Letter from the Principal…………...….134

Appendix B: Learner Consent Form…………………………...………..138

Appendix C: Parent Consent Form……………………………….....……142

Appendix D: Language Clearance Certificate…………………..………146

Appendix E: Plagiarism Report……………………………..…………..147

Appendix 1

QUESTIONNAIRE 1: INSTRUCTIONAL STRATEGIES

Your Name: ____

Your School: ____

Grade: ________

You are invited to complete the details in your own handwriting in the spaces in the Tables provided below about Instructional Strategies in Physical Sciences at school.

1. **You are invited to rank from 1 to 15 (1 – most favoured and 15 – least favoured) the Instructional Strategies in terms of their *effectiveness and usefulness* in Physical Sciences at school.**
2. **You are also invited to provide reasons for the ranking of each of the 15 Instructional Strategies.**

NOTE: Please note that your name will be kept anonymous. No teacher or member of the school will see your name.

Instructional Strategy	Definition	Rank	My reason(s) for the rank
DIRECT INSTRUCTION			
Demonstration	It is a process of teaching through examples and experiments.		
Didactic questioning	Questioning is used to effectively diagnose recall and comprehension and to draw on prior learning experiences. It often begins with "what", "where", "when" and "how".		
Teaching/ Lecture	It is a process in which a teacher gives spoken explanations of the subject that is to be learned to learners. Visual aids are used to maximize learning.		

Instructional Strategy	Definition	Rank	My reason(s) for the rank
INDIRECT INSTRUCTION			
Problem solving	It is a search strategy in which the problem solver looks for or decides on a particular strategy before solution procedures are implemented. As learners gain more knowledge in a subject area, they are better able to deal with problems without engaging in search strategies.		
Enquiry to investigate	Process of exploration where learners ask relevant questions and develop ways to search for answers and generate explanations. Provides opportunities for learners to experience and acquire processes through which they can gather information about the world.		
Concept mapping	It is a process that provides an opportunity to explore ideas by making connections and seeing relationships between items of information and also assist in developing and refine the abilities to recall.		

Instructional Strategy	Definition	Rank	My reason(s) for the rank
INTERACTIVE INSTRUCTION			
Discussion	The action or process of talking about something in order to reach a decision or to exchange ideas. This action help learners build a positive classroom climate and lead to learner interest in a school subject.		

Co-operative learning groups	The experience that promote higher achievement, greater motivation, more positive interpersonal relations among learners, more positive attitude towards the subject area.		
Brainstorming	A group problem-solving technique that involves the spontaneous contribution of ideas from all members of the group.		

Instructional Strategy	**Definition**	**Rank**	**My reason(s) for the rank**
INDEPENDENT STUDY			
Homework	The assigned work to be done outside the classroom.		
Research project	A studious inquiry or examination, especially investigation or experimentation aimed at the discovery and interpretation of facts and revising of accepted theories.		
Assigned questions	Questions prepared by the teacher to be answered by individuals or small groups of learners.		

Instructional Strategy	**Definition**	**Rank**	**My reason(s) for the rank**
EXPERIENTIAL LEARNING			
Field trips	A trip by learners to gain first-hand knowledge away from the classroom, as to a factory, geological area or environment of certain plants and animals.		
Conducting experiments	A test under controlled conditions that is made to demonstrate a known truth, to examine the validity of a hypothesis or to determine the efficacy of something previously untried.		
Simulations	It is a process where learners become active participants in the learning process and also promote and develop critical and creative thinking which develop interpersonal and social skills, attitudes and values.		

Appendix 2

QUESTIONNAIRE 2: ONE MOST EFFECTIVE & USEFUL INSTRUCTIONAL STRATEGY

Your Name: ____

Your School: ____

Grade: ________

You are invited to complete the details in your own handwriting in the spaces in the Tables provided below about Instructional Strategies in Physical Sciences at school.

3. **You are invited to tick (✓) ONLY (1) Instructional Strategy that you think is MOST *effective and useful* in Physical Sciences at school.**
4. **You are also invited to provide a reason for your selection of the Instructional Strategy**

NOTE: Please note that your name will be kept anonymous. No teacher or member of the school will see your name.

Instructional Strategy	Definition	Tick	My reason(s) for selecting (ticking) the Instructional Strategy
Teacher guidance	To direct, directions and instructions from the teacher to help learners understand, navigate, and complete tasks in the classroom.		
Practical work	Teaching and learning method that involves at some point the learners in observing or manipulating real objects and materials.		
Simulations	The imitation of the operation of a real-world process or technique for practice and learning.		

Appendix 3

QUESTIONNAIRE 3: ONE LEAST EFFECTIVE & USEFUL INSTRUCTIONAL STRATEGY

Your Name: ____

Your School: ____

Grade: ________

You are invited to complete the details in your own handwriting in the spaces in the Tables provided below about Instructional Strategies in Physical Sciences at school.

5. **You are invited to tick (✓) ONLY (1) Instructional Strategy that you think is LEAST *effective and useful* in Physical Sciences at school.**
6. **You are also invited to provide a reason for your selection of the Instructional Strategy**

NOTE: Please note that your name will be kept anonymous. No teacher or member of the school will see your name.

Instructional Strategy	Definition	Tick	My reason(s) for selecting (ticking) the Instructional Strategy
Teacher guidance	To direct, directions and instructions from the teacher to help students understand, navigate, and complete tasks in the classroom.		
Practical work	Teaching and learning method that involves at some point the learners in observing or manipulating real objects and materials.		
Simulations	The imitation of the operation of a real-world process or technique for practice and learning.		

Appendix 4

Learner Interview Questions

1. Tell me about your school in general?
2. (a) What motivated you to choose Physical Sciences over other subjects?
   (b) How would you like Physical Sciences to be taught in the school?
   (c) What are the many things that your teachers are doing well when teaching Physical Sciences in the school?
3. Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.
4. Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?
5. Why did you choose:
   (a) X as the most effective and useful IS in learning Physical Sciences?
   (b) Y as the least effective IS in learning Physical Sciences?
6. If you were to change anything in the Physical Sciences class, what would that be?
7. What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Appendix 5

Interview Transcripts

Data Transcription: Recorded audio interview

Learner 1

Researcher: Tell me about your school in general?

Learner: *Teachers at the school are really doing their work because the way they are teaching us very well even though some of them we don't understand because they are very fast but it better when they give us homework so we can understand the subject better. When I was still at primary school, the principal of my current school came to my previous school to tell us more about this school and how it will improve from how it was, so I came here to prove that myself and that's what motivated me to come to this school. When I arrived here, I can see that the school is improving.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *I chose Physical Sciences because of my career, I want to be a gynecologist, and in grade 9 I passed well in Mathematics and Natural Sciences and that made me decide to do Physical Sciences.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *If teachers are teaching us Physical Sciences, they must give us home works to research everyday so that we can understand and get more information.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *Sir, when the teacher is teaching, he makes sure that the homework is given and in the following day also assist in correcting that homework to ensure we understand Physical Sciences.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No, because we don't do practical work, we just relay of the textbook and taking notes on the board.*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *Yes, because if we do practical work some learners are helping you to understand what is happening on that session, for instance in a group work we call up with ideas and share them amongst the group in a form of helping each other and we understand better. If am doing a practical work alone it not helpful because no one can help me, and I cannot share ideas.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I chose practical work because when I was in grade 9 doing work as a group and go to the libraries and share ideas and get more information, it helped me so much.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *I chose simulations because we don't do it more often and I don't get to know it better.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *There is nothing much to change, just that if we can have equipment for Physical Sciences for practical work we can pass because many learners are lacking Physical Sciences.*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *To have all the practical equipment and we should get more home works.*

Data Transcription: Recorded audio interview

Learner 2

Researcher: Tell me about your school in general?

Learner: *Umbelebele is a high school where you learn from grade 8 to 12, the school have girls and boys learners, it a general school. Umbelebele is a no fees school and when I came to Umbelebele I wanted to be a prefect so I can facilitate change in the school in terms of many learners who are on drugs.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *Something that motivated me to do Physical Sciences, I like medicine actually, I want to be a doctor, so I chose science because it offers subjects that are required in medicine i.e., Physical Science and Life Sciences, so these subjects are prerequisite at the university for medicine. I also like Mathematics and Life Sciences because in Life Sciences the subject talks about the things that we have and using in life.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *I would like to be taught Physical Sciences through teacher guidance and practical work, because in the practical work we taught things that we are able to remember in the exams and teacher guidance helps me to remember what Sir has taught me in class, then I am able to write in the exams. Also, practical work is good although it has some negative factors, because it difficult sometimes as we experiment something and, in the exams, we get something different, and it's contradict with what Sir taught me during the practical. Therefore, I prefer teacher guidance.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *Teacher guidance, because when we are learning in class the teacher will write on the board and we are given a chance to ask questions and the teacher responds to your questions, also we have an opportunity inquire more information to the teacher even outside the classroom i.e., staffroom, for a further assistance on a one on one.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No, we do not have enough resources, because we don't have a laboratory that we can do practical experiments and the new books that are recently available in Physical Sciences we don't have because we're a government school.*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *Yes, because when we do practical experiment, we see that we're learning something theoretically and also doing it in hands on practical, therefore it makes sense to us.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I like teacher guidance because I easily understand through it, even in the exams it easy to remember what my teacher taught me in class in order for me to be certain about my answers in the exam.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *Simulation, I don't like internet mostly, internet is too bitter for me, so I selected it because internet is not my thing, my thing is books only.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *In Physical Sciences, firstly I'll listen to other learners' views, what the learners would like the subject to be, then we'll inform teachers how we would mostly like the subject to be taught. Physical Sciences, something that I'll change is that I would like teachers to teach me using teacher guidance because in teacher guidance it easy to interact with the teacher, asking questions to the teacher and taking notes as well which makes it easier to remember in the exam what Sir taught me in this question.*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *The advice that I'll give you is that teachers must listen to learner's views because some learners like to learn Physical Sciences with some games and some rhythms attached to the concepts* *so that it easy to remember what we learnt the previous day. Some days we would like to go on a trip and see the things that we learn at school and see them in the real world how people are using them.*

Data Transcription: Recorded audio interview

Learner 3

Researcher: Tell me about your school in general?

Learner: *Umbelebele is a good school because the principal is very strict and discipline. The school no longer has misbehaving learners, that's why my father who is the security guard in this school motivated me to come and study here.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *Because I love Physical Sciences and my father also told me that Physical Sciences has better job opportunities and I also believe that by choosing Physical Sciences I will have a better chance of finding a job as compared to other subjects like tourism.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *I would like to learn Physical Sciences everyday even during the study so that it can be easy for us as learners to understand since learning that subject for an hour. I am also a slow learner so I need more time to study even if there is an upcoming exam, I need to start my revision earlier so that I can understand.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *You too Sir to me, you are teaching well because you allow us to ask questions where we don't understand and am not afraid to ask and also to make jokes during the lesson it makes us as learners to relax and enjoy the lesson especially to me as a slow learner.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No Sir because yesterday was my first time using that practical equipment for experiments*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *Yes, because sometimes when you write on the board, I don't get a full picture of what is being taught, so the practical experiment that we did yesterday was right since I can physically see the circuit and the brightness of the bulbs, it made a lot of sense to me.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I chose practical work because some of the learners do not like to write, they like to do practical and see things happening, and me too I love doing things by my hands it assists me get a picture of what I'm doing.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *I chose teacher guidance because in teacher guidance the teacher kept on telling me things that I'm supposed to do which I can easily forget sometimes.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *The school should give more time to Physical Sciences so that we can understanding it better, also teachers should assist us step by step because learners are not the some in class some are fast learners others are slow learners and I'm one of those that are slow learners and again, Sir don't get irritated when we ask too many questions.*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *Sir, when you come to class, come with a smile and be happy so that we can be able open up ask you questions freely that's all.*

Data Transcription: Recorded audio interview

Learner 4

Researcher: Tell me about your school in general?

Learner: *The first time I came here at the school, I did not like to come here based on the past experiences the school has and when I get here, I can see that the school is improving. I came to the school because I believe I can change the school the way it was in terms of learners' bad behavior.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *I chose it because of my career because I want to be a doctor and I like it because I enjoy it.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *The way I would like it to be taught…just like you did, what do you called it? Sima…. Simulations because it makes me gain trust and confidence and I have also experienced it. I find simulations simple.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *Just that you give your time to explain everything and even ask questions to the learners. Because it even makes us get more information when you ask questions and make us focus.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No, because even chemistry is not done since we lost the practical equipment. In my own view the school doesn't have resources.*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *No, I don't, because sometimes we as learners when the teacher is teaching, we sometimes scared to ask questions – other fellow classmates makes jokes about it.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I chose simulations because they make me understand better and have confidence about what we have learnt because I have even experienced it.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *I chose practical work because us as learners we like to concentrate on making jokes at each other end up being scared of asking questions. Also, when you do group work, others are having their different views and end up arguing, I mean I like to work on my own.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *I think what I can change is the way we learn Physical Sciences and the way we do practical because of the loss of computers we cannot do experiments. I think we need to do practical using computers - simulations*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *I like the way it is – the teachers are explaining very well and even the way they are teaching it enjoyable and they make jokes so we can feel free.*

Data Transcription: Recorded audio interview

Learner 5

Researcher: Tell me about your school in general?

Learner: *The school, when I come here it was like a broken school but now it's an improving school, because now I can see change. It was not my choice to come here to the school, my parents insisted I should come here due to financial constraints. I would have chosen a different school because the past experiences of the school. Now that there is a new principal the situation is improving.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *I chose physical Sciences because there are many job opportunities and as for me I want to be a Vet (animal doctor), so for me choosing this stream I can be able study for my career and since Physical Sciences provides many job opportunities if I do not qualify to be a Vet I can also do engineering as an alternate.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *I would like us …… if we learn should do experiments more often and also when we learn there should be more examples as well.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *Sir, when you teach us, you take your time to explain what you're teaching and also avail yourself for question outside the classroom.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No, because when we learn, we learn only using textbooks there are no other methods of learning that we are using and no practical experiments, so the school doesn't have resources.*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *Yes, because I can see what the teacher was teaching us on the board when we do practical experiments, I can understand better.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I chose practical work because it easy to understand and learning from the chalkboard is sometimes difficult while in practical it easy because we see real events.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *I chose teacher guidance because sometimes I feel nervous to ask questions and other learners complain about that as a result I 'm scared to ask.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *I would like the class of Physical Sciences to have experiment when we are learning, and the teacher should do demonstrations for us so that we can be able whatever we are required.*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *Sir, I would like us to work together with the teacher, when the teacher is teaching he should not only write on the board, but he should engage with the learners individually to demonstrate what he's teaching. The line of communication should be smooth between the teacher and learners, and the teacher should be open to assist an any questions.*

Data Transcription: Recorded audio interview

Learner 6

Researcher: Tell me about your school in general?

Learner: *The school Umbelebele is great, we learn a lot, teachers have taught us a lot as well. We have passed and progressed to the next grades and today we are in grade 10. Umbelebele is a great school, although there are problems here and there, sometimes we need to focus on education so that we can progress to other classes.*

Researcher: What motivated you to choose Physical Sciences over other subjects?

Learner: *I chose science stream because I want to become a paramedic or fire fighter and make my family proud of me and change the situation at home. Also, science has more job opportunities.*

Researcher: How would you like Physical Sciences to be taught in the school?

Learner: *I would like to learn Physical Sciences in a simplest way like the way we do when we learn Electricity and explain thorough all the concepts so that we can understand. Have some examples on the boards as well like you did yesterday when you taught us Electricity, we learn a lot by that.*

Researcher: What are the many things that your teachers are doing well when teaching Physical Sciences in the school?

Learner: *When you teach us you make an example and that makes a lot of sense in mind, because without examples we get confused a lot. It's better to make examples so that we understand Physical Sciences and as us questions that will help reinforce understanding.*

Researcher: Tell me about the resources that are used to facilitate learning in Physical Sciences at school. Do you think the school has enough resources? Please explain.

Learner: *No, we do not have. The community is also the problem because they vandalise the school including our laboratory taking all the equipment and we are left with nothing.*

Researcher: Do you find practical experiments useful in developing the skills and concepts that were taught in the classroom, as well as your attitude towards Physical Sciences?

Learner: *Yes, it's great because even though Physical Sciences is difficult but through examples and practical it's understandable and we learn it better. So, practical experiments are useful.*

Researcher: Why did you choose X as the most effective and useful IS in learning Physical Sciences?

Learner: *I chose teacher guidance because if we are given a task, we have an opportunity to ask questions and we get assisted without struggling and getting the task wrong.*

Researcher: Why did you choose Y as the least effective IS in learning Physical Sciences?

Learner: *I chose simulations because I believe we must focus more on our textbooks to study Physical Sciences in order to understand it.*

Researcher: If you were to change anything in the Physical Sciences class, what would that be?

Learner: *When teaching Physical Science, try and slow down so that we all can understand the concepts.*

Researcher: What advice do you have, for teachers to engage their learners better and to make the subject more interesting, enjoyable and fun?

Learner: *When you come to class, bring a long past question papers so that we can try them to see how far we understand Physical Sciences especially in Electricity. Also, have fun with us while you are teaching so that we can enjoy the subject, do not be too much serious.*

Appendix 6

Electricity Conceptual Test

Instructions

Answer all test questions

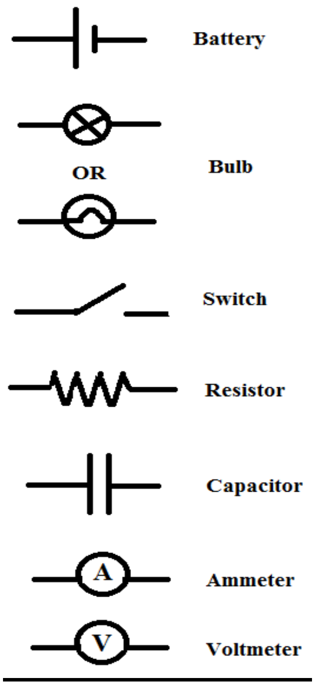
Circle the correct answer where applicable

All conductors are assumed of negligible resistance

All bulbs, battery cells, resistors and conductors are considered identical

Assume all cells have negligible internal resistance

Symbols



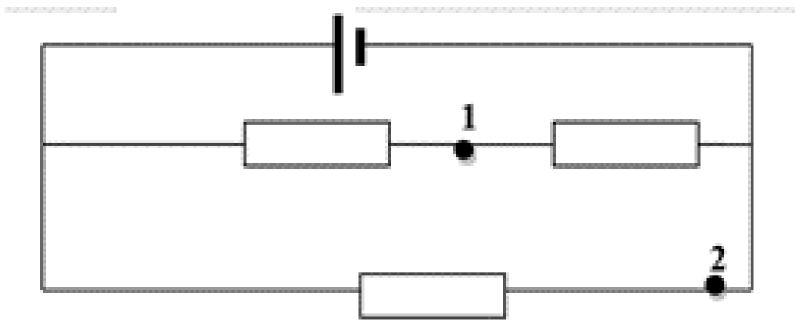
Part A: Multiple Choice Questions

1. Are charges used up in a light bulb, being converted to light?
   A. Yes, charges moving through the filament produce ‘friction’ which heats up the filament and produces light.
   B. Yes, charges are emitted.
   C. No, charge is conserved. It is simply converted to another form such us heat and light.

D. No, charge is conserved. Charges moving through the filament produce 'friction' which heats up the filament and produces light.

2. Why do the lights in your home come on almost instantaneously?
   A. Charges are already in the wire. When the circuit is completed, there is a rapid rearrangement of surface charges in the circuit.
   B. Charges store energy. When the circuit is completed, the energy is released.
   C. Charges in the wire travel very fast.
   D. The circuits in a home are wired in parallel. Thus, a current is already flowing.

3. Study the circuit diagram showing resistors in a circuit. Which of the options below is true about the current passing through point 1 and 2?

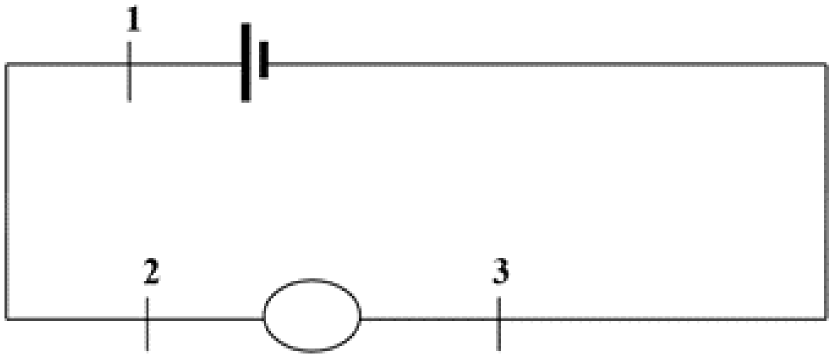


   A. Current at 1 is greater than current at 2.
   B. Current at 2 is greater than current at 1.
   C. Current at 1 is equal to current at 2.
   D. Current at 2 is less than current at 1.

4. In an electric circuit, a battery is a source of:
   A. Electrical power.
   B. Electrical energy.
   C. Electrical charges.
   D. Electrical field.

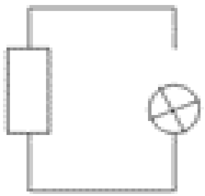
5. Which of the following statements is **TRUE** about charges in an electrical circuit?
   A. It is protons moving from positive terminal to negative terminal.
   B. It is electrons moving from the positive terminal to the negative terminal.
   C. It is water like fluid flowing from positive terminal to negative terminal.
   D. These are charged electrons which move when the electrical circuits is. complete.

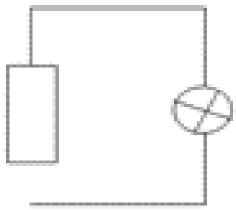
6. Current is measured at the three points 1, 2 and 3. Which of the statements below is correct concerning the amount of current at points 1, 2 and 3?

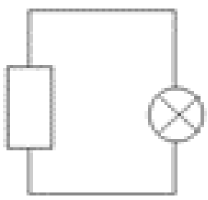


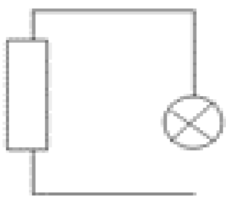
A. Current at 1 is greater than current at 2.
B. Current at 1 is greater that current at 3.
C. Current at 1 is greater that current at 2 and 3.
D. Current at 1 is equal to current at 2 and 3.

7. Which of the following connection will the bulb light up?


A.


B.


C.

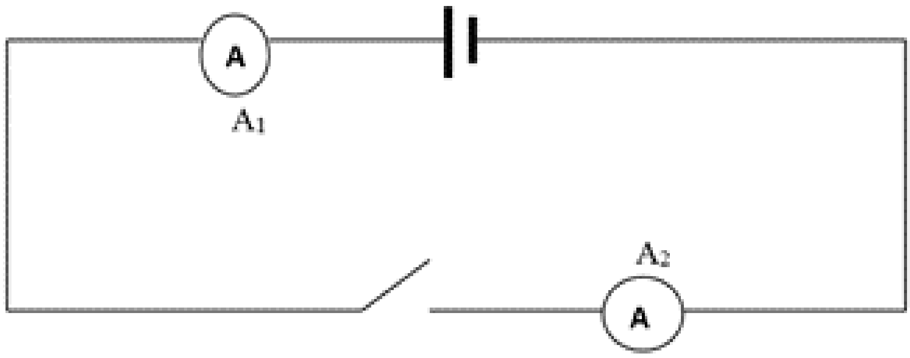

D.

8. A battery cell goes 'flat'. What is the reason?

A. All electrical power in the cell is used up.
B. All charges in the cell are used up.
C. All chemicals in the cell are used up.

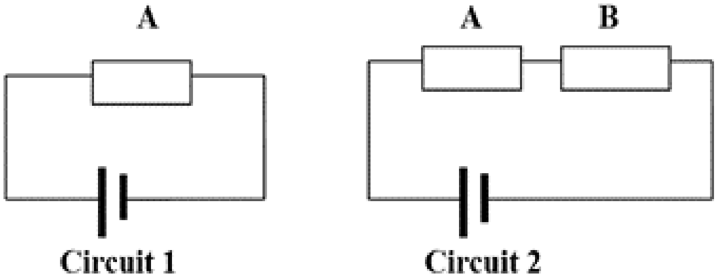
D. There is no more electrical field.

9. Study the circuit below. Which of the statements below is **TRUE** about the reading of ammeter A_1, and ammeter A_2?



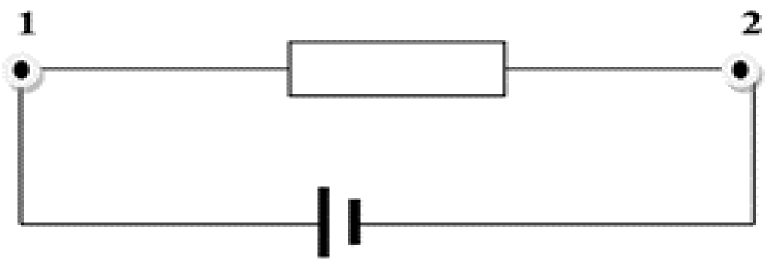
A. Reading A_1 is greater than zero.
B. Reading A_1 is less than zero.
C. Reading A_1 is equal to A_2 equal to zero.
D. Reading A_1 is greater than A_2.

10. How does the power delivered to resistor **A** change when resistor **B** is added as shown in circuit 1 and 2 respectively?



A. Increase.
B. Decrease.
C. Stay the same.

11. Compare the current at point 1 with the current at point 2. Which point has the larger current?

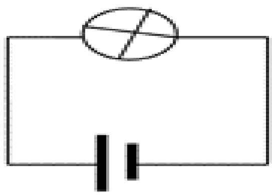


A. Point 1

B. Point 2

C. Neither they are the same.

12. Is the electric field zero or non-zero inside the tungsten bulb filament?



A. Zero because the filament is a conductor.

B. Zero because there is a constant flowing.

C. Non-zero because the circuit is complete, and a current is flowing.

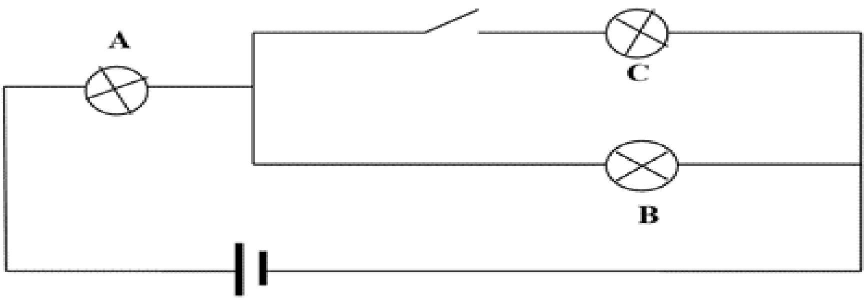
D. Non-zero because there are charges on the surface of the filament.

13. If you double the current through a battery, is the potential different across a battery doubled?

A. Yes, because Ohm's law says $V=IR$.
B. Yes, because as you increase the resistance, you increase the potential difference.
C. No, because the potential difference is a property of the battery.
D. No, because the potential difference is a property of everything in the circuit.

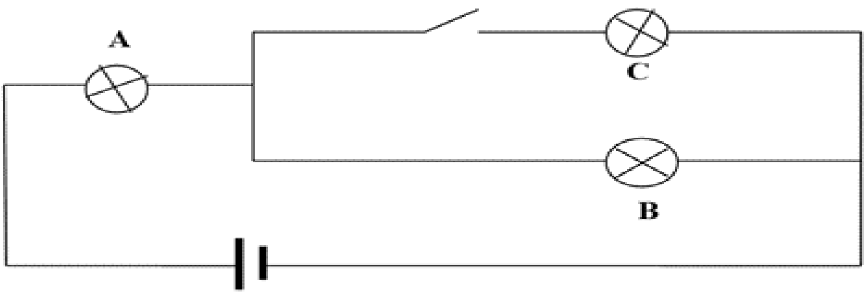
14. Which one of the following forms of energy is found in an electrical circuit that is open?
A. Heat.
B. Light.
C. Electrical.
D. Electrostatic.

15. Study the circuit below. What will happen to the brightness of bulb **A** and bulb **B** when the switch is closed?



A. A stay the same and B dims.
B. A is brighter and B dims.
C. A and B increase brightness.
D. A and B remain the same.

17. What will happen to the brightness of bulb **A** and bulb **B**, if bulb **D** were added to the parallel circuit and the switch is closed?



A. B & C stay the same and D dims.
B. B & C is brighter and D dims.
C. B & C and D increase brightness.
D. B & C and D remain the same

Part B: Problem Solving Questions

Question 1: The three cells (batteries) shown in the following two diagrams are identical. Each cell has an emf of 1.5V.

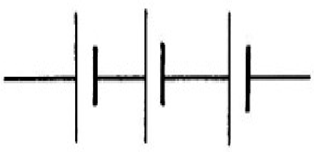
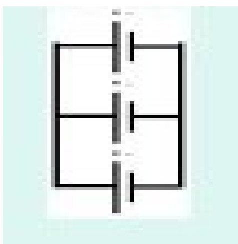
Diagram A 

Diagram B 

1.1 Which diagram (A or B) shows the three cells connected in series?

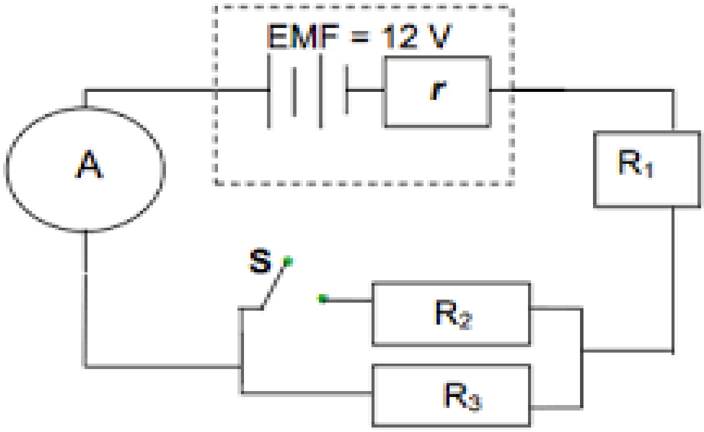
1.2 Explain what is the emf of the cell.

1.3 Calculate the total emf of the battery of three cells connected in series.

1.4 Calculate the total emf of the battery of the three cells connected in parallel.

1.5 Give one advantage of connecting cell in parallel.

Question 2: Study the diagram below and answer the questions that follow



2.1 Based on your understanding of electricity, describe what is happening in the circuit diagram when S is switched on.

2.2 Which direction is taken by the current in the circuit diagram from the battery terminals?

2.3 What do you understand about the reading 12V for this circuit diagram?

2.4 Briefly explain what affects the ammeter reading and why?

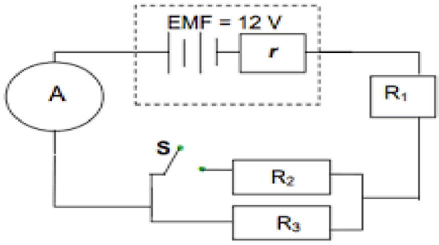
2.5 Would the ammeter reading change if R_3 is removed from the circuit and why?

Appendix 7

Physical Sciences Learners' Misconceptions in Electric Circuits

I. ***Theme:*** Current Consumption Model

Misconception: The current is consumed by components in the circuits; the cell is a tank that stores current until it runs empty (Bradley & Moodie, 2021, p. 10).



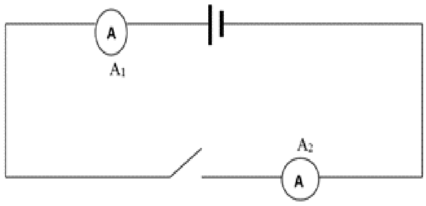
Question: Based on your understanding of electricity, describe what is happening in the circuit diagram when S is switched on.

Source: Grade 10 Provincial (KZN) common paper (end of year).

Theme: Short Circuit Preconception Model

Misconception: Learners think that wire connections without devices attached to the circuit are irrelevant and can be ignored (Shipstone et al., 1988).

Question: Which of the statements below is **TRUE** about the reading of ammeter A_1, and ammeter A_2 when the switch is closed?



E. Reading A_1 is greater than zero.
F. Reading A_1 is less than zero.
G. Reading A_1 is equal to A_2 equal to zero.
H. Reading A_1 is greater than A_2.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Current Consumption Model

Misconception: The current is the cuase of the potential difference across a resistor. If there is no current through a part of the circuit, then the PD across that part is zero (Bradley & Moodie, 2021, p. 10).

Question: If you double the current through a battery, is the potential different across a battery doubled?

E. Yes, because Ohm's law says $V=IR$.
F. Yes, because as you increase the resistance, you increase the potential difference.
G. No, because the potential difference is a property of the battery.
H. No, because the potential difference is a property of everything in the circuit.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Clashing Current Model

Misconception: Learners often think that positive electricity moves from the positive terminal and that negative electricity moves from the negative terminal of a power supply; thereafter, the positive and negative electricities meet at a device and clash, thereby powering the device (Heller & Finley, 1992).

Question: Which of the following statements is **TRUE** about charges in an electrical circuit?

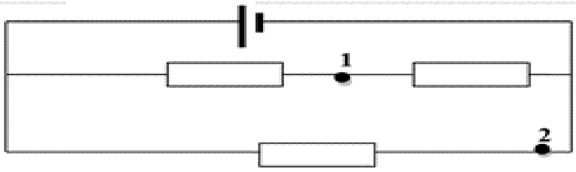
E. It is protons moving from positive terminal to negative terminal.
F. It is electrons moving from the positive terminal to the negative terminal.
G. It is water like fluid flowing from positive terminal to negative terminal.
H. These are charged electrons which move when the electrical circuits is. complete.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Shared Current Model

Misconception: In most cases learners think that current is the same at all points in the circuit regardless of connection types and that all devices in the circuit have the same amount of current; however, less current returns to the power supply than originally leaves (Chambers & Andre, 1997; Heller & Finley, 1992).

Question: Study the circuit diagram showing resistors in a circuit. Which of the options below is true about the current passing through point 1 and 2?



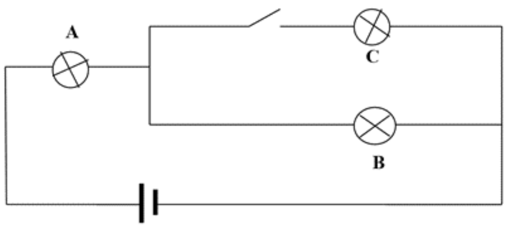
E. Current at 1 is greater than current at 2.
F. Current at 2 is greater than current at 1.
G. Current at 1 is equal to current at 2.
H. Current at 2 is less than current at 1.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Attenuation Model

Misconception: The current/electricity is consumed, and it is thus attenuated at each resistor in sequence, so that very little returns to the cell (Bradley & Moodie, 2021, p. 10).

Question: Study the circuit below. What will happen to the brightness of bulb **A** and bulb **B** when the switch is closed?



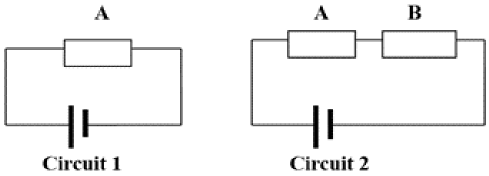
E. A stay the same and B dims.
F. A is brighter and B dims.
G. A and B increase brightness.
H. A and B remain the same.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Power Supply as a Constant Current Source Model

Misconception: Learners also think that power supply release the same fixed amount of current to every circuit (Cohen et al., 1983; Johsua, 1987).

Question: How does the power delivered to resistor **A** change when resistor **B** is added as shown in circuit 1 and 2 respectively?



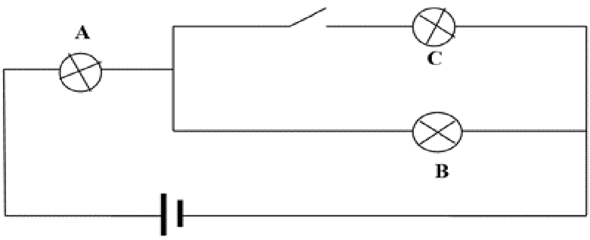
D. Increase.
E. Decrease.
F. Stay the same.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Parallel Circuit Misconception Model

Misconception: In terms of parallel circuit, learners believe that adding a resistance in a new parallel path to a circuit increase the total resistance of the circuit (Cohen et al., 1983; Johsua, 1987).

Question: What will happen to the brightness of bulb **A** and bulb **B**, if bulb **D** were added to the parallel circuit and the switch is closed?



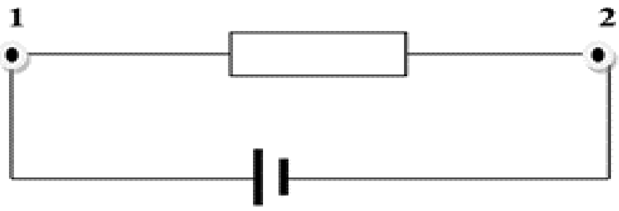
E. B & C stay the same and D dims.
F. B & C is brighter and D dims.
G. B & C and D increase brightness.
H. B & C and D remain the same.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Sink Model

Misconception: To some extent, learners think that single wire connection allows electricity to sink from the power supply to the electrical device, powering the device (Chambers & Andre, 1997).

Question: Compare the current at point 1 with the current at point 2. Which point has the larger current?



D. Point 1

E. Point 2

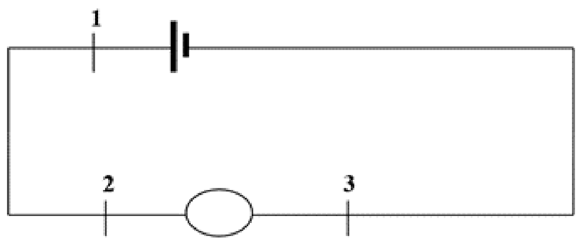
F. Neither they are the same.

Source: Physc PORT-DIRECT TEST version 1.0

Theme: Empirical Rule Model

Misconception: Learners think that the further away the bulb is from the battery, the dimmer the bulb will be (Heller & Finley, 1992).

Question: Current is measured at the three points 1, 2 and 3. Which of the statements below is correct concerning the amount of current at points 1, 2 and 3?



E. Current at 1 is greater than current at 2.
F. Current at 1 is greater that current at 3.
G. Current at 1 is greater that current at 2 and 3.
H. Current at 1 is equal to current at 2 and 3.

Source: Physc PORT-DIRECT TEST version 1.0

Appendix A

UNIVERSITY OF KWAZULU-NATAL INYUVESI YAKWAZULU-NATALI

The Principal
Umbelebele Secondary School

Dear Mr. Khanyile

I am a Masters student studying at the University of KwaZulu-Natal, Edgewood Campus. I have registered for MEd (Science Education) under the Science and Technology Education Cluster/Department. My supervisors are Dr Leonard Molefe and Professor Nadaraj Govender. Dr Molefe can be contacted on the e-mail – molefe@ukzn.ac.za.

The title of my thesis is:
Exploring Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity.

I am kindly requesting your permission to conduct my research at your school as I am a teacher here (persal number: 64344924) and my familiarity with the context of the school will facilitate my data collection. The study involves Exploration of Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity. As you are aware, learners' performance in Physical Sciences has been poor in the past and I am confident that my research may assist in developing strategies to improve the pass rate in Physical Sciences. The aim and purpose of the study is to expose learners to different instructional strategies in Physical Sciences for the topic electricity and learners will have an opportunity to choose the best instructional strategy that suits their learning needs. The study will involve completion of three questionnaires relating to their preferred instructional strategy to science especially in electricity. Learners will be required to conduct a practical experiment and a video recording will be used to capture the session. Some of the learners will be interviewed. Video recording is expected to complement interview data and give a much deeper understanding of the topic. All these activities will take place during the afternoon study time, normal school timetable will not be affected for physical sciences lessons and this research is expected to last for 3 weeks because of the attendance rotation of learners at school.

The study involves learners in high school at FET level between 15 and 17 years. The major risk is learners participating in the study without their knowledge and consent. The identities of all learners who participated

The study involves learners in high school at FET level between 15 and 17 years. The major risk is learners participating in the study without their knowledge and consent. The identities of all learners who participated in this study will be protected in accordance with the code of ethics as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and all learners will be free to withdraw from the research at any time without negative or undesirable consequences to them. However, parents will be asked to complete a consent form as well on behalf of the learners to participate in the research. The names of learners and the name of the school will not appear in my report, or in any papers or presentations that I make after the study. Furthermore, the records as well as other items associated with the research will be held in a password-protection file accessible only to me and my supervisors. After a period of 5 years, in line with the rules of the university, it will be disposed by deleting it permanently from all storage devices. Another risk is the exposure to Covid 19 to the study participants. Thus, Covid 19 protocol must be abserved during the study. Additional information on Covid 19 can be found on this link Safety in the workplace | South African Government (www.gov.za) as well as Education - Coronavirus COVID-19 | South African Government (www.gov.za).

The study is expected to have benefits. A global trend is developing which reveals sharp decline in learners who are interested in the Physical Sciences. It is my desire to understand my learners' preferences of instructional strategies and possibly improve their interest through the introduction of relevant learning strategies. Such learning strategies may improve the performance of the higher achievers and help the under achievers.

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

You may contact my supervisor, should you have any queries or questions you would like answered.

Yours faithfully,

[redacted]

Mr. Thulani Z. Dhlamini

Date: 02-09-2021

UMBELEBELE SECONDARY SCHOOL

TELEPHONE
0735695930

FAX
031-906 4910

E-MAIL ADDRESS
Umbelebelesecondary@gmail.com

PHYSICAL ADDRESS
Q32 MANQO CLOSE
UMLAZI
4031

POSTAL ADDRESS
P.O. BOX 54410
UMLAZI
4031

Should you give permission for me to conduct research in your school, please complete the following:

I KHANYILE S. Principal of UMBELEBELE SECONDARY School have been informed about the study entitled: **Exploring Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity** by Mr. Thulani Z. Dhlamini.

I understand the purpose and procedures of the study.

I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that participation by learners in my school in this study is entirely voluntary and that they may withdraw at any time without affecting any of the benefits that they are entitled to.

I have been informed about any available compensation or medical treatment if injury occurs to participating learners as a result of study-related procedures.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at email: zakes.tz11@gmail.com cell number 071 044 9574.

If I have any questions or concerns about rights of a learner (participant), or if I am concerned about an aspect of the study or the researcher then I may contact:

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

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview / focus group discussion: (YES) / NO
Video-record my interview / focus group discussion: (YES) / NO
Use of my photographs for research purposes : (YES) / NO

Signature:

[redacted]

Date: 02/09/2021

[illegible] SECONDARY SCHOOL

2021 -09- 02

TEL: 031 907 5918 FAX: 031 905 4910
032 MANGO CLOSE UMLAZI

Appendix B

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

School of Education
December 2021

Dear Learner,

My name is Thulani Z. Dhlamini. I am a Masters student studying at the University of KwaZulu-Natal, Edgewood campus. I have registered for Med (Science Education) under the Science and Technology Education Cluster/Department. My supervisors are Dr Leonard Molefe and Professor Nadaraj Govender. Dr Molefe can be contacted on the e-mail – molefe@ukzn.ac.za.

You are being invited to consider participating in a study that involves Exploration of Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity. The aim and purpose of the study is to expose learners to different instructional strategies in Physical Sciences for the topic electricity and learners will have an opportunity to choose the best instructional strategy that suits their learning needs. The study will involve completion of three questionnaires relating to your preferred instructional strategy to science especially in electricity. You will also be required to conduct a practical experiment and a video recording will be used to capture the session. Some of you will be interviewed. Video recording is expected to complement interview data and give a much deeper understanding of the topic. All these activities will take place during the period for physical sciences and is expected to last for 3 weeks when the topic expected to be finished.

The study involves learners in high school at FET level between 15 and 17 years. The major risk is learners participating in the study without their knowledge and consent. The identities of all who participate in this study will be protected in accordance with the code of ethics as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and you will be free to withdraw from the research at any time without negative or undesirable consequences to yourselves. However, your parents will be asked to complete a consent form for you to participate in the research. Your names and the name of the school will not appear in my report, or in any papers or presentations that I make after the study. Another risk is the exposure to Covid 19 to the study participants. Thus, Covid 19 protocol must be observed during the study. Additional information on Covid 19 can be found on this link Safety in the workplace | South African Government (www.gov.za) as well as Education - Coronavirus COVID-19 | South African Government (www.gov.za).

The study is expected to have benefits. A global trend is developing which reveals sharp decline in learners who are interested in the Physical Sciences. It is my desire to understand my learners' preferences of instructional strategies and possibly improve their interest through the introduction of relevant learning strategies. Such learning strategies may improve the performance of the higher achievers and help the under achievers.

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

You may contact my supervisor, should you have any queries or questions you would like answered.

Yours faithfully,

____________________ Date: ____________________

Mr. Thulani Z. Dhlamini

If you agree to participate in my research, please complete the attached consent form and return it to me. I thank you for taking the time to read this letter.

I ____________________________________ have been informed about the study entitled: **Exploring of Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity** by Mr. Thulani Z. Dhlamini.

I understand the purpose and procedures of the study.

I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

I have been informed about any available compensation or medical treatment if injury occurs to me as a result of study-related procedures.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at email: zakes.tz11@gmail.com cell number 071 044 9574.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researcher then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview / one-on-one discussion: YES / NO

Video-record my interview / one-on-one discussion: YES / NO

Use of my photographs for research purposes : YES / NO

Signature of learner: Date:

____________________ ____________________

Appendix C

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

School of Education

December 2021

Dear Parent,

My name is Thulani Z. Dhlamini, I am a Masters student studying at the University of KwaZulu-Natal, Edgewood Campus. I have registered for MEd (Science Education) under the Science and Technology Education Cluster/Department. My supervisors are Dr Leonard Molefe and Professor Nadaraj Govender. Dr Molefe can be contacted on the e-mail – molefe@ukzn.ac.za.

I am kindly requesting your permission to allow your child to participate in my research at school. The study involves Exploration of Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity. There has been a sharp decline in learners' performance in Physical Sciences in the past and I am confident that my research may assist in developing strategies to improve the pass rate in Physical Sciences at school. The aim and purpose of the study is to expose learners to different instructional strategies in physical sciences for the topic electricity and learners will have an opportunity to choose the best instructional strategy that suits their learning needs. The study will involve completion of three questionnaires relating to their preferred instructional strategy to science especially in electricity. Learners will be required to conduct a practical experiment and a video recording will be used to capture the session. Some of the learners will be interviewed. Video recording is expected to complement interview data and give a much deeper understanding of the topic. All these activities will take place during the afternoon study time, normal school timetable will not be affected for physical sciences lessons and this research is expected to last for 3 weeks because of the attendance rotation of learners at school.

The study involves learners in high school at FET level between 15 and 17 years. The major risk is learners participating in the study without their knowledge and consent. The identities of all learners who participated in this study will be protected in accordance with the code of ethics as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of your child and he/she will be free to withdraw from the research at any time without negative or undesirable consequences to him/her. However, you are requested to complete a consent form as well on behalf of your child to participate in the research. The name of your child and the name of the school will not appear in my report, or in any papers or presentations that I make after the study. Furthermore, the records as well as other items associated with the research will be held in a password-protection file accessible only to me and my supervisors. After a period of 5 years, in line with the rules of the university, it will be disposed by deleting it permanently from all storage devices. Another risk is the exposure to Covid 19 to the study participants. Thus, Covid 19 protocol must be observed during the study. Additional information on Covid 19 can be found on this link Safety in the workplace | South African Government (www.gov.za) as well as Education - Coronavirus COVID-19 | South African Government (www.gov.za).

The study is expected to have benefits. A global trend is developing which reveals sharp decline in learners who are interested in the Physical Sciences. It is my desire to understand my learners' preferences of instructional strategies and possibly improve their interest through the introduction of relevant learning strategies. Such learning strategies may improve the performance of the higher achievers and help the under achievers.

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

You may contact my supervisor, should you have any queries or questions you would like answered.

Yours faithfully,

____________________ Date: ______________________

Mr. Thulani Z. Dhlamini

If you agree your child to participate in my research, please complete the attached consent form and give your child to return it to me. I thank you for taking the time to read this letter.

I____ have been informed about the study entitled: **Exploring of Grade 10 Physical Sciences Learners' Views and Preferences of Instructional Strategies in Electricity** by Mr. Thulani Z. Dhlamini.

I understand the purpose and procedures of the study.

I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that participation of my child in this study is entirely voluntary and that he/she may withdraw at any time without affecting any of the benefits that he/she is entitled to.

I have been informed about any available compensation or medical treatment if injury occurs to the participation of my child as a result of study-related procedures.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at email: zakes.tz11@gmail.com cell number 071 044 9574.

If I have any questions or concerns about rights of my child (participant), or if I am concerned about an aspect of the study or the researcher then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

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

Additional consent, where applicable

I hereby provide consent to:

Audio-record interview: YES / NO

Video-record interview / one-on-one discussion: YES / NO

Use of photographs for research purposes: YES / NO

Signature:

____________________ Date: _____________________

Parent

Appendix D

25 Maple Crescent
Circle Park
KLOOF
3610

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

Dr Saths Govender

11 JULY 2022

TO WHOM IT MAY CONCERN

LANGUAGE CLEARANCE CERTIFICATE

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

EXPLORING GRADE 10 PHYSICAL SCIENCES LEARNERS' VIEWSAND PREFERENCES OF INSTRUCTIONAL STRATEGIES IN ELECTRICITY, by Thulani Zakhele Dhlamini, student no. 206501484.

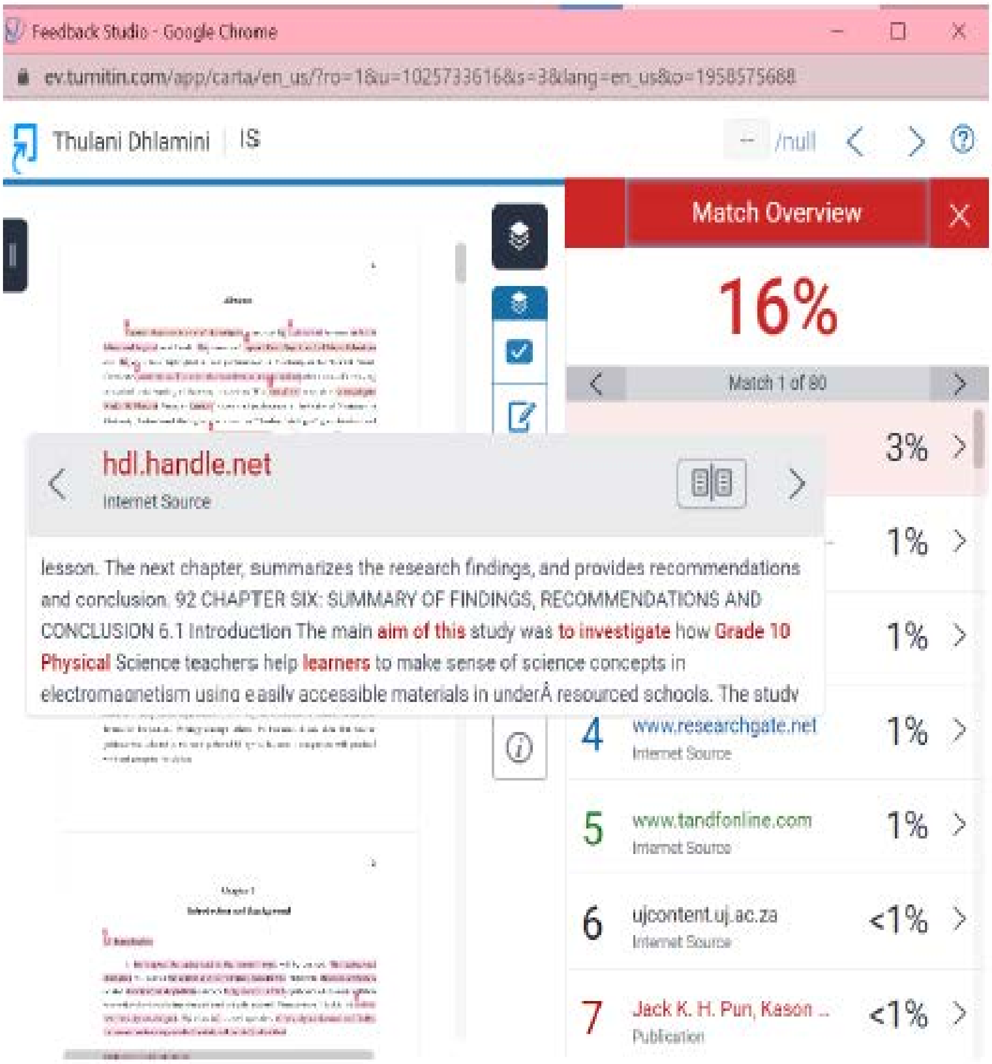
To the best of my knowledge, all the proposed amendments have been effected and the work is free of spelling and grammatical errors. I am of the view that the quality of language used meets generally accepted academic standards.

Yours faithfully

[redacted]

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

Appendix E



I have gone through the turn it in report. The 3% indicate common words selected, so in effect the % is 13%, which is acceptable with the maximum of 20% range. I could not find major plagiarism.

Prof N Govender 21 Nov 2022