PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT

by

Mrs R.H. MABITLA

STUDENT NUMBER: 31979017

Submitted in partial fulfilment for the degree of

MAGISTER EDUCATIONIS IN NATURAL SCIENCES

in the

Department of Science and Technology Education

College of Education

University of South Africa

Supervisor: Dr M.P. Rankhumise

MAY 2020
DECLARATION

I, Ramadimetje Hermina Mabitla, declare that *Pedagogical practices in a Grade 7 Science classroom: a case of primary schools in the Moroke circuit*, is my own work and has never been submitted in any institution. All the sources that I used or quoted have been indicated and acknowledged using complete references.
DEDICATION

I dedicate this achievement to my late mother, Lebee Sekonya, who departed during December 2019. I am a professional being because of your love for education and success. You understood the power of independence brought about by education. May your soul rest in peace.
ACKNOWLEDGEMENTS

My sincere gratitude and appreciation go to:

- My supervisor, Dr M.P. Rankhumise, for his unwavering support, guidance and counselling during my studies. His constructive criticism, guidance and positive encouragement gave me hope and motivation to soldier on;
- My very special children, Bokang, Reabetswe and Busang – you are my pillars of strength and my urge to move to higher heights;
- My darling husband for his continuous support and interest in my studies to achieve more;
- The Department of Education, Sekhukhune East District for conceding me permission to conduct research at schools. Teachers and learners who participated in the research study; and
- Lastly, to the Almighty God, who is my refuge and my fortress.
ABSTRACT

This study is based on an interpretive paradigm that is embedded in the philosophical ideology that revolves around the norms and culture of the subjects under scrutiny. Schools have operating standards that must be followed based on the policies in place. The purpose of this study is to investigate pedagogical strategies explored in the Grade 7 classroom from two Natural Sciences teachers conveniently selected from two schools in Sekhukhune East District. Qualitative research method was used. The research tools to collect data were an open-ended questionnaire and lesson observations. Findings indicated that Natural Sciences teachers fully understand what is required of them to construct Science Knowledge (SK) in the classroom but fail to implement it. Furthermore, it surfaced that contextual factors still hinder the provision of quality education in schools mostly situated in deep rural areas of the Limpopo Province. It is a fact that all schools do not have learners’ textbooks, but nevertheless learning and teaching occur. The dedication and determination portrayed by the teachers despite all the challenges they were exposed to at primary school level are commendable. The pedagogical practices utilised in the Science classroom in the construction of scientific knowledge compromise the acquisition of science process skills. Data collected in this study revealed that teachers still rely much on direct instruction in a learning and teaching situation. Finally, findings indicate that practical activities are not performed in classrooms for learners to learn by arriving at their own conclusions utilising scientific processing skills. The results of this study are informative and provide insight information into application of teaching and learning approaches in Science. A much more detailed study is needed to determine if the results are due to teachers’ experience, geographical area, subject specialisation or workload.
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### GLOSSARY AND KEY INFORMATION

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>CAPS</td>
<td>Curriculum and Assessment Policy Statement (CAPS) is the policy document that regulates the provision of education at primary and secondary level and it includes the content to be covered and an assessment programme for each subject offered at South African public schools.</td>
</tr>
<tr>
<td>CK</td>
<td>Content Knowledge (CK) refers to teacher’s knowledge about the subject matter that is prescribed to be taught in the classroom.</td>
</tr>
<tr>
<td>DoE</td>
<td>Department of Education</td>
</tr>
<tr>
<td>DoBE</td>
<td>Department of Basic Education</td>
</tr>
<tr>
<td>EPPs</td>
<td>Educational Pedagogical Practices (EPPs)</td>
</tr>
<tr>
<td>IKS</td>
<td>An Indigenous Knowledge System (IKS) embraces the cultural norms and standards of doing things that forms the foundation of knowledge for individuals and distinguishes communities from others.</td>
</tr>
<tr>
<td>IBT</td>
<td>Inquiry-based teaching (IBT) refers to the method of teaching done through experience using practical activities that allows learners to become critical thinkers and become more independent.</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology (ICT) at schools relates to the use of electronic gadgets (computers, smart phone, etc.) radio, television and social media to construct knowledge by learners.</td>
</tr>
<tr>
<td>KS</td>
<td>Knowledge system (KS)</td>
</tr>
<tr>
<td>LTSM</td>
<td>Learner-teacher supporting material (LTSM) includes and is not just limited to the stationery and textbooks used in the teaching and learning situation.</td>
</tr>
<tr>
<td>P</td>
<td>Pedagogy (P) is method and practice of teaching, particularly as an academic subject of theoretical concepts. It further allows the teacher to evaluate the appropriate strategy to use in teaching learners with different abilities.</td>
</tr>
<tr>
<td>TPK</td>
<td>Technological Pedagogical Knowledge (TPK) describes the relationship and interaction between the specific pedagogical practices and technological tools such as Internet and google.</td>
</tr>
<tr>
<td>PCK</td>
<td>Pedagogical Content Knowledge (PCK) refers to the ability of teachers to use readily disposable tools in a subject matter ensuring that the content matter is comprehensible to all learners despite their mental ability and diverse background. It is the relationship between the specific learning objectives and the pedagogical practices.</td>
</tr>
<tr>
<td>PP</td>
<td>Pedagogical Practices (PPs) relate to the best learning strategies that teachers could use in a classroom to construct knowledge, thus includes among others creation of a conducive learning environment, lesson planning, engaging resilient preconceptions and setting achievable objectives.</td>
</tr>
<tr>
<td>PBL</td>
<td>Project-based Learning (PBL) is an instructional framework that develops key 21st century skills as learners collaboratively work in groups to complete a project. It</td>
</tr>
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</table>
allows the learners to demonstrate his or her capabilities, builds team-work and group skills.

**SACE**  South African Council of Educators (SACE) is the professional council of educators that aims to improve the status of the teaching profession through registration.

**SPS**  Science Process Skills (SPS) are skills that underpin the scientific thinking and reasoning and are important in the Science curriculum. They include observing, measuring, sorting, inferring, predicting, experimenting, and communicating.

**SK**  Science Knowledge (SK) refers to what we learn from the scientific processes, which involve experimenting and collecting data and allows us to develop of new technologies, solve practical problems and make informed decisions.
CHAPTER 1
INTRODUCTION, BACKGROUND AND MOTIVATION TO PEDAGOGICAL PRACTICES IN THE TEACHING OF GRADE 7 SCIENCE

1.1 INTRODUCTION

Science is an applied knowledge and it has an undeniable impact on our daily activities (Ngema, 2016:1). Science Knowledge (SK) continues to be one of the imperative knowledge systems that is prioritised by South African government in the education sector. Wealth and economic development of the world is immensely reliant on the science workforce (Laugksch, 1999:88; Muzah, 2011:1). Science has a positive impact on both individuals and the world at large to survive; and meet the global economic requirements (Kibet, Mbunga, Muthaa & Nkonke, 2012:87). Science and technology can be used effectively to solve many challenges experienced like global warming, that poses a threat to humans’ survival on earth. This study deals with an in-depth qualitative investigation and the first chapter outlines the most salient aspects of the study. The background and motivation follow next.

1.2 BACKGROUND AND MOTIVATION

Educational Pedagogical Practices (EPPs) can be described as the diverse scientific ways used in a classroom situation to make teaching and learning effective and efficient. Different strategies are used by the educators during the lesson presentation to cater for the diverse learners. Science strategies (SS) used in a classroom situation promote initiation and sustainability of arguments for integration of the Content Knowledge (CK) with the culture within the society. Different instructional strategies are used to guide learners to understand. Educators have unique demographic characteristics as they originate from different backgrounds in different societal backgrounds. The Indigenous Knowledge System (IKS) plays a dynamic role in the knowledge construction of content in a learning and teaching situation.

The South African education system has changed over the years and teachers must be knowledgeable to always implement the curriculum. Outcome-Based Education (OBE)
introduced in 1997 prompted a shift from content based and teacher dominated approach to a learner-centred approach. Then Curriculum 2005 (C2005) which featured because of the review of OBE, and C005’s objectives was to foster independence in learners through their entire schooling period. The revised National Curriculum Statement (NCS) was built on the previous curriculum providing clearer specification of what must be taught and learned periodically. Curriculum and policy statement (CAPS) regards science as a discipline that sustains enjoyment and curiosity about the world in a natural phenomena (CAPS, 2012).

In my 22 years of experience after completing my studies and commencing to teach, I have realised that science has posed challenges to learners as they do not perform as expected. The changes experienced over the past 23 years brought about challenges to teaching and learning. Teachers were expected to implement all the policies successfully and it caused more frustration as the education system seemed to be forever changing.

Development of teachers was necessary to be acquainted with changes and to be the knowledge hub for learners to perform better. The Grade 12 results are far from desirable for the economy and the society at large in South Africa. Muzah (2011) indicated that poor performance in science subjects is a threat to the South African economy.

In the South African context pedagogy of teaching science involves engaging resilient preconceptions, organising knowledge around concepts, utilising supporting teaching strategies to enable learners to take charge of their learning and co-operative learning. The continuous changes in the curriculum affected educators negatively to such an extent that some became confused and stressed not being acquainted with what was expected of them. However, training was provided to assist the teachers (Pellegrino & Hilton, 2012).

Development of skills that include innovative and critical thinking are key (Pellegrino & Hilton, 2012). Teachers’ intervention in children’s learning is of the utmost importance, although the quality of teacher-learner interaction is deemed crucial in learning (Gallimore & Tharp, 1998 cited by Verenikina, 2010). The research seeks to
investigate how teachers teach using scientific practices, and the challenges encountered in implementing the changes as outlined in the CAPS document.

Educators are supposed to establish and maintain a conducive learning environment by unpacking the content from simple to complex contexts. Learners are then expected to relate what they already know to what is learnt. So, the Indigenous Knowledge System (IKS) becomes more vital. Ibrahim (2017) claims that students do not copy the educators’ capabilities but instead transform what was taught during the processes of appropriation, trying to find out how it fits into the real world.

Vygotsky refers to both the educators and learners as active agents in children’s learning. It is important for educators to instil the right knowledge in the minds of learners using the best practices or methodologies. Children grow and develop with the assistance of a more knowledgeable peer or teacher as caregiver. South African Council of Educators (SACE), 2010 agrees that a problem in the quality of Science educators exist regarding subject knowledge and their teaching methodologies. Statistics show that there is a continuous decline in the number of students registering for science education (Dhuramraj, 2013; Makgato & Mji, 2006; Spaull, 2013).

1.3 THEORETICAL FRAMEWORK

Vygotsky’s theory assumes that learning arises not through interaction, but during interaction. Learners firstly succeed in performing a new task with the help of another person, and then they internalise this task so that they can perform it on their own (Adam, 2017). Constructivism is informed by interpretation and phenomenology of multiple socially-constructed practicalities. Values become an integral part of learners’ social lives and then no group’s values are erroneous. The nature of information originates from applying own thinking to interpret data. The truth of data depends on the context. According to Vygotsky’s theory (1978) social interactions are of the utmost importance; knowledge can be co-constructed between two or more people. Then self-regulation occurs through developing an internal representation of actions and mental operations that manifest in social interactions. Therefore, human development occurs through the cultural transmission of language and symbols.
1.4 PURPOSE OF THE STUDY

The purpose of this study was to explore different pedagogical practices used by the teachers in a classroom by providing learners with relevant and meaningful opportunities to relate Science with their personal experiences. It is hoped that this will encourage learners to become actively engaged and to participate during learning. The study examined implications of pedagogical methods in relation to a teaching and learning situation in a science classroom.

1.5 RATIONALE OF THE STUDY

The rationale of this research study is based on recurring poor results experienced in the Sekhukhune District. My own experience in teaching Life Sciences, Physical Sciences and Mathematics over the past 21 years clearly indicated that there is still more to be done. Prior 1994, Bantu education played a significant role in ensuring that the Africans are not fully exposed to science subjects. The South African curriculum changed numerous times ever since 1994 (Mugabo, 2012).

Successful implementation of any changes in the curriculum depends on the teachers’ acceptance and receptivity including their capabilities (Mugabo, 2012). The changes in the education system laid a proper foundation for researchers to investigate if the changes were worthwhile. Insightful synopsis of literature cited reasons of poor performance as directly proportional to the unprofessional attitudes of teachers (De Clercq, 2007), insufficient supply of experienced qualified science educators (Herseleman, 2002; Kriek & Grayson, 2009) and challenges such as a lack of necessary resources.

The culture of teaching and learning depends on the level of commitment and skills of educators who are responsible for implementation of educational changes to improve human capital wealth creation. A lack of necessary resources inhibits the ability of educators and learners to excel in their execution of their duties.
A significant number of studies were conducted on poor performance in science subjects at matric level and I realised that little has been done about the foundation laid at primary level. Moreover, most of the research done is on poor performance and not on the pedagogical practices utilised in a Science classroom. This proposed study draws largely on my own personal and contextual evidence throughout my teaching experience.

1.6 SIGNIFICANCE OF THE STUDY

The Moroke Circuit has schools with improper infrastructure in place. Over the years the matric results in the Limpopo, Sekhukhune District have been poor and recently students performed very poorly and attained the last position in the 2019 academic year. This study is embedded in an interpretive paradigm which is defined as a basic set of beliefs that guide action (Guba, 1990 cited in Creswell, 2017), and a distinct body of literature and unique issues will be discussed pertaining to the poor learner achievement (Cresswell, 2017). The usage of scientific process skills tends to be limited to what is at the teachers’ disposal and that really causes a constraint on the learners’ performance and in terms of accumulation of knowledge.

In my study the ontological assumption regarding pedagogical practices is that lack of necessary skills could lead to poor performance as outlined by Dlamini (2018). Hence in the study I looked at how teachers incorporated diverse pedagogical practices in a Science classroom. Regarding attainment in science subjects, there are multiple factors that contribute to poor performance. In this study I focused on multiple pedagogical practices utilised by educators in teaching scientific skills to learners. From the epistemological point of view, more interaction was done with the selected participants to gain insight and inside information regarding teaching and learning in a Science classroom.
1.7 RESEARCH PROBLEM

Educational Pedagogical Practice (EPP) is key to any Science educator to construct knowledge and skills and impart these to the learners. Curriculum is reviewed regularly and even changes are implemented to address the needs of both educators and learners. The poor performance of learners in Science subjects continues to threaten the society (Ngema, 2016). The later statement clearly shows that there might as well be a challenge regarding the knowledge content they have to grasp to perform better.

Curriculum and Policy Statement (CAPS, 2012) was introduced to redress imbalances of the past, including the assessment programme. CAPS (2012:15) aims to afford learners with prospects to make lucidity of concepts they have about nature, and further encourages the learners to become inquisitive; then that could lead to further research and investigation. Learners can only be able to excel in science only when they are conversant with the Science Process Skills. The skills outlines the concepts as they are learned in the classroom with the assistance from the teacher as the facilitator. Learners are still unable to grasp the scientific concepts based on the fact that they are not of English origin and as well difficult to pronounce. The later statement makes it more difficult for learners to be able to define the concepts as required in their assessments.

Performing experiments in the classroom allows learners to become more inquisitive and affords them the opportunity to think critically. Due to lack of resources or any other factor only experienced at that particular time, teachers are unable to demonstrate the concepts practically in the classroom. This denies the learners the opportunity to explore science without any hindrances, and also will not have a solid foundation of science knowledge. SPS are learned practically not theoretically.

Educators are bestowed the responsibility to teach learners to think critically and manage to solve their daily challenges using the knowledge they have acquired. The contextual factors at most public schools do not allow Science education to be explored. The implementation and integration of scientific investigation is not done per instruction, instead the old way of teaching is still practised at most schools.
I have taught at a secondary school before relocating to a primary school for more than five years; I taught Mathematics and Life Sciences, and was challenged in presenting some of the topics as there was insufficient or no support materials.

1.8 OBJECTIVES OF THE STUDY

The objectives of the study were to investigate:

- diverse pedagogical practices which teachers use engaging science learners in learning;
- the influence of Science process skills on teachers’ approaches to planning for their teaching; and
- the construction of Science Knowledge (SK) using process skills.

1.9 RESEARCH QUESTIONS

The formulation of research questions should be framed in a way that sets the immediate agenda for the research (Mugabo, 2012). The research question should facilitate the responses to drive the entire research project towards the correct destination by clarifying some underlying factors that called for the initiation of the research. The search should then bring about solutions to the challenges encountered within the system. This study focused on the ability of educators unfolding curriculum as stipulated in CAPS.

The main research question of this study was:

- What pedagogical practices do teachers use in a Science classroom?

The sub-questions for this research study were:

- What is the influence of science process skills on teachers’ approaches to planning for their teaching?
• How do process skills influence the construction of scientific knowledge in science?

1.10 METHODOLOGY

The proposed study used a **qualitative method** that involves a detailed account of experiences, activities or events. This study adopted a case study design approach of Grade 7 Science teachers teaching in the Moroke Circuit. A case study refers to an in-depth, detailed study of a small group of individuals. A case study is typically qualitative in nature; resulting in a narrative description of character or experience. The pedagogical practices used by different educators were described in detail.

This study was embedded in an interpretive paradigm. A paradigm is informed by philosophical assumptions about, the nature of reality, ways of the known, ethics and value systems (Patton, 2002). This paradigm is concerned with understanding the world as it is from subjective experiences of individuals. Subsequently an interpretivist research paradigm was used.

1.11 SAMPLE AND POPULATION

A population can be defined as a finite or infinite established items under consideration; from which researcher sample must be drawn (Taherdoost, 2016). My population in this research study comprised of Grade 7 Natural Sciences teachers in Moroke Circuit. In this study a small number of participants were used (Cresswell, 2013). A sample of teachers from two primary schools in Moroke Circuit was incorporated with specific reference to teaching Natural Sciences in Grade 7. The two schools selected were within the researcher’s geographical area so it was easier to access the target population.

Sampling refers to a process in which a sample is extracted from a group of people. According to Alvi (2016) it is impossible to access every element of a population on the basis that data can be obtained from selected people, and inferences drawn for an entire population. The sampling technique can encounter a problem of systematic errors
or sampling bias. Systematic errors could be caused by over-representation of one characteristic or under-representation of a particular characteristic.

Sampling bias occurs when the selected sample does not entirely represent the characteristics of the whole population caused by the researcher’s subjective judgment. Sampling does not need to be random or representative, however a clear rationale is needed to include certain individuals in the research sample. In this study, convenience sampling was applied as it is inexpensive, hence I used teachers that were within my geographical proximity. Generally, convenience sampling tends to be a favoured sampling technique among researchers as it is inexpensive and an easy option compared to other sampling techniques (Ackoff cited by Taherdoost, 2016). Convenience sampling (also known as haphazard sampling or accidental sampling) is a type of non-probability or non-random sampling. Individuals of the target population meet a particular criteria, such as geographical proximity, availability at a given time, or the willingness to participate to fulfil the purpose of the study (Etikan et al., 2016).

So, only two schools not far from my workplace were sampled for this study. The population size for this research study was two Grade 7 Natural Sciences teachers from two schools in Moroke Circuit, thus one educator from School A and School B respectively.

1.12 DATA GATHERING

Data collection can be described as the process of gathering information and quantifying the data collected. The collection of data involved field work that takes into consideration observation of teachers in a classroom and completion of a questionnaire (MacMillan & Schumacher, 2010). As outlined by Ngema (2013) the method includes description and interpretation of a cultural or social group activities within its natural setting.

Educators were observed during the lesson presentation with specific reference to the pedagogical practices used. The two methods of collecting data to be used in this study will be open-ended questionnaire and lesson observation. The main aim of collecting
data is to create factual theoretical data that could contribute meaningfully to the existing theories on the same aspect (Ngema, 2013).

The instruments used to collect data were questionnaires that were distributed to two teachers from two conveniently selected schools in Moroke Circuit. Natural Sciences teachers from these schools were requested to complete the questionnaires at the convenient time arranged with them and these were later collected for further analysis.

Then the teachers were observed whilst presenting a lesson in the classroom. The lesson observation took place in a classroom where the educator presented a Science lesson on the relationship between the Moon and the Earth for the duration as stipulated on their timetable. Considering the national state of disaster due to the outbreak of Corona Virus Disease of 2019 (COVID-19), the 2019 academic year programmes were disrupted leading to the urgent unexpected closure of schools during the month of March 2020. The later statement led to national lockdown wherein people including learners and teachers were not allowed to get out of their houses unless if it was necessary.

The South African education system was adversely affected by the outbreak of COVID-19 and new methods of learning were employed. When schools reopened during June 2020, the phasing in system was introduced to enable the learners and teachers to be acclimatised to the new conditions they were expected to adhere to. The rules and regulations prescribed to prevent the spread of COVID-19 at schools were, including and not limited to social distancing, wearing a mask, sanitising, and washing hands with soap and water for about 20 seconds very often. Prior arrangements were made to ensure that Personal Protective Equipment (PPE) was in place before any observations are done in the classrooms.

A debriefing on what would happen during the lesson observation would be held to put the teachers at ease. A recording device was used during lesson observation to capture all the information and to ensure that not any was incorrectly coded. Immediately after the lesson observation, a briefing session happened to reflect on how the lesson must have been presented; gaps identified and what needed to be improved.
1.13 DATA ANALYSIS

This study followed a qualitative research approach. Data analysis refers to the process of systematically searching and arranging interview transcripts, field-notes, questionnaires’ responses, and any other materials gathered in the field to increase understanding of them and to be able to present what was found by others. Creswell (2013) indicates that there is no procedure to be followed for reporting data in case study report. Thematic analysis was utilised to analyse the collected data for it identifies, analyses and reports themes from within the collected data. This method enables proper organising and description of collected data in detail. Moreover, it even helps with the interpretation of data collected for various aspects of the research topic (Braun & Clarke, 2006).

Themes are main products of data analysis that create practical results in the field of study (Vaismoradi et al, 2016). According to Vaismoradi et al.’s study (2013), many similarities between qualitative content analysis and thematic analysis exist. Thus cutting across data, philosophical background, attention to both description and interpretation in data analysis, consideration of context of data, and searching for themes. A theme captures something crucial about the data in relation to the research question and then signifies a level of patterned response or meaning within the data set (Braun & Clarke, 2006). The definition, similarities and differences of qualitative content analysis and thematic analysis have been defined. The researcher has to be creative in presenting the data by forming a story line. Data must be categorised based on how they relate to each other, and themes are identified.

The process is descriptive in nature as it requires the researcher to outline in detail what happened and thereafter summarise the events as they unfold. Creswell (2013) specifies that qualitative data analysis is a continuous and interactive process as data collection, processing, analysis and reporting are intertwined.

The recorded data were listened to carefully and analysed properly thinking back on the observations made during the lesson presentations. The usage of the audio recorder afforded the researcher the opportunity to concentrate on all aspects during the lesson presentation as lesson note-taking continued. The completed questionnaires were
compared with what was done during the lesson presentation observation. At times it happens that what we say it is not really what we do. The data analysis process includes organising data by breaking these up into manageable units, synthesising data, searching for patterns in the data analysed, discovering what is vital and deciding what to report to others.

Transcription of collected data was afforded appropriate levels of detail and accuracy. Thorough, inclusive and comprehensive coding where all data were given equal attention was a priority. All relevant extracts for each theme was collated and then themes were checked against each other and the original data set (Braun & Clarke, 2012). Then themes were coherent, consistent, and distinctive for smooth analysis. Analysis of collected data was interpreted or analysed rather than just paraphrased or described.

1.14 TRUSTWORTHINESS OF THE STUDY

Quantitative studies test the reliability and validity of the research whilst qualitative studies conduct a process that is known as trustworthiness of the study. This process is conducted in a bid to ensure that the findings gathered within the research are accurate and that if the same study is conducted, the same set of results can be achieved. Methodological techniques such as member-checking and triangulation have also been proposed to ensure dependability, credibility, and transferability in qualitative studies. Reflexivity is an integral part of ensuring the transparency and quality in qualitative research. I attempted to ensure trustworthiness of the research study by focusing on credibility, transferability, dependability and conformability (Hadi & Closs, 2016).

1.14.1 Credibility

The confidence that can be placed in the truth of the research findings embraces credibility. Credibility establishes whether the research findings represent plausible information drawn from the participants’ original data and if these were correct
interpretation of the participants’ original views (Lincoln & Guba, 1985). It requires the researcher to give sufficient details about settings, criteria, sample characteristics, and data collection and analysis methods. The reader can evaluate the extent to which the conclusions made by the researcher are transferable to other settings, situations and populations (Hadi & Closs, 2015).

1.14.2 Transferability

Researchers facilitate the transferability judgment by a potential user by thick description. Lincoln and Guba (1985) describe transferability as the degree to which results of qualitative research can be transferred to other contexts or settings with other respondents. Provision of rich and thick description is used to obtain external validity. It requires the researcher to give sufficient details about settings, criteria used in including or excluding certain information, sample characteristics, and data collection and analysis methods, so that the study can be evaluated as to which extent the conclusions made by the researcher are transferable to other settings, situations and populations.

1.14.3 Dependability

Dependability involves participants’ evaluation of the findings, interpretation and recommendations of the study and that these are supported by the data as received from participants of the study. The stability of findings over time confirms dependability of data. Dependability refers to being trustworthy or reliable by following correct procedures to draw up conclusions (Lincoln & Guba, 1985). This can be achieved by doing member-checking. Member-checking refers to checking of study findings and conclusions drawn from the responses from participants as revealed by the answers to open-ended questions of the questionnaire and lesson observation.
The aim of member-checking is to ensure dependability and credibility of qualitative studies. However, some methodologists have raised concerns about the usefulness of member-checking as qualitative data do not only consist of interview or observational data but also include field notes. Furthermore, study results are often synthesised from data obtained from observing several participants, making it difficult for individuals’ views to be recognised. Therefore, member-checks should not be a verification strategy to judge accuracy of data analysis but to correct interpretation and challenge the wrong interpretation.

1.14.4 Conformability

This is the degree to which the findings of the research study could be confirmed by other researchers. Conformability is concerned with establishing that data and interpretations of findings are not mere products of the researcher’s imagination, but clearly obtained from the data collected and rigorously analysed (Pratihari & Uzma, 2019).

Hadi and Closs (2015) indicate that self-description and self-reflection are very important in qualitative research to acknowledge and reduce researcher bias, a common criticism of qualitative research. Self-reflection will enable qualitative researcher’s own position within the study indicating how personal beliefs and experience have influenced the research findings. Correctly captured field notes by maintaining a reflective journal to recognise and make explicit personal biases were crucial when obtaining accurate data. Self-description promotes credibility and conformability of research findings indicating that the research study came from the research participants and not from the researcher.

1.15 ETHICAL CONSIDERATIONS

According to the Helsinki Declaration of 1972, it is imperative to obtain clearance from the ethics committee when human (or animal) subjects are involved in any kind of research of an empirical nature. Hence, University of South Africa (UNISA); College
of Education (CEDU) Ethics Review Committee granted me the permission to collect data since my research ethics had been approved. Permission to conduct the research from two primary schools in Moroke was granted (permission letter is attached as Appendix J). The School Principals and the School Governing Bodies (SGBs) allowed me to collect data from the schools.

1.16 CONCLUSION

This chapter covered introduction to the study and elucidated the problem statement, which included lack of research and information on teaching Science in the primary school. The research questions and objectives were provided and a brief introduction of aspects to be covered in the study were shared. It was stated that the study followed a qualitative research approach. The next chapter deals with the literature review.
2.1 INTRODUCTION

The previous chapter introduced the rationale of this study. I provided the background of the study and explained the choice of the research topic. Literature review on the pedagogical practices in a science classroom will be presented in this chapter. Literature provides benefits to the research world and education system (Houseal, Abd-El-Khalick & Destefano, 2013) for more factual data are added to the existing data. Pedagogical Content Knowledge (PCK) refers to type of knowledge that teachers need to possess and involves not only the content knowledge but the methods, practices and processes of learning and teaching of a particular content (Li, 2018). The importance of the PCK of teachers regarding the teaching of Science in primary school is also included in this chapter.

The main objective of the review of literature is to summarise and critically analyse relevant journals and studies on the topic under study (Hart, 1998). Available documents were selected based on the title which consists of relevant information that has different perspectives related to the topic to achieve the aims and objectives of this study. The values of peoples’ writings will be evaluated effectively and put to proper use. Creswell (2013) points out that reviewing literature creates a picture of what already exists about a certain study and results of other closely related studies presented. All that exists in the world is ever-changing and teachers and educational specialists need to keep updated through the contributions made by researchers.

The theoretical lens in this study was based on Vygotsky’s theory involving a social constructivist approach which puts more emphasis on social context that learning and recognising that knowledge is mutually built (Vygotsky, 1978). Vygotsky’s theory is based on Piaget’s theory which considers a child being an active participant in the construction and development of knowledge individually (Jones and Araje, 2002 cited by Adam) whilst
Vygotsky incorporates the social and cultural influences by society as impact on child development. Children do not exist in isolation and are always influenced by all factors found around them and that does not exclude their teachers at school.

Learning is an important human development which is an ongoing phenomenon (Adam, 2016). As outlined by Acosta (2016) education has progressed over the years from one phase of improvement to the other with its distinctiveness and encounters, and that culminated in a chain of improvements, approaches and guidelines established on the modifications in society. Researchers in education for different philosophies of life contribute to improvement of teaching and learning through their new findings.

The aim of this research is to explore pedagogical practices in teaching Natural Sciences in Grade 7. Natural Sciences taught at a senior phase level lays the foundation for further studies in more specific disciplines such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences (CAPS SP Natural Sciences, 2012). If teachers carefully select content and use different approaches to augment teaching and learning Science, learners will develop the love and interest in science.

Furthermore, interest in Science will enable them to pursue science-related studies. The difference emerges if teachers are unable to convey content in such a way that it scaffolds learners’ development properly. According to the CAPS document (2012: 8-9) learners become active participants within society that values the fellow learners, preserve their own environment and actively partake in the issues that concern their well-being.

In this chapter, the review of literature incorporates the Pedagogical Practices (PPEs) in a Grade 7 classroom that influence teaching and learning. The approaches and process skills utilised by the teachers in teaching and learning in the Science classroom are crucial to successful learner progress in Science.
2.2 PEDAGOGICAL PRACTICES IN SCIENCE TEACHING

Pedagogical Practices in education (PPs) refer to the methods or ways of teaching and the application thereof that facilitates the knowledge retention in a learning situation (Janssen, Knoef & Lazonder, 2019). PPs in Science teaching are any activities that support teaching and learning in a classroom. They are simply the methods, strategies or styles of instruction teachers utilise to instil skills in learners to the best of their ability.

Diverse PPs in teacher’s provision of education promote meaningful learning (Koh & Chai, 2014). The instructional approach such as active learning, learner engagement, teaching multiple learning styles and using a variety of assessment are vital in assisting teachers and learners to develop knowledge. Pedagogy in Science can be classified as an academic discipline wherein knowledge and skills are exchanged in an educational context, and then interactions encountered during learning.

Theories of pedagogy consider learners as agents and teachers as facilitators. Effective teachers use diverse teaching and learning tools that can be drawn upon and used in the classroom situation to assist learners to develop academically. Intuitive innovation is of importance for effectiveness and efficiency in teaching and learning. Teachers’ Content Knowledge (CK) is of utmost importance in ensuring that curriculum is delivered as expected per specific subject (Janssen, Knoef & Lazonder, 2019).

For effective learning to occur, a teacher must not only be competent in the subject matter but must also have effective pedagogical skills to communicate knowledge to the learners. Dlamini (2004) argues that drastic changes are required to comprehend information and be able to process it logically.

South African education system like many other developing countries has changed several times to enable the country to compete successfully with the global world. Priority must be given to teaching different scientific skills as it is useful in life even if one is not working in a
Achievable objectives enable the classroom to be conducive for learning and teaching, and further ensure determination in realising the objectives and continuous evaluation (Kalu-uche, 2015).

In the light of attempting to achieve the objectives teachers will employ diverse Pedagogical Practices (PPs) in the classroom situation, however research has shown in accordance with SACE (2010:23) that teachers are often struggling in selecting the relevant teaching methodology for lessons to be presented. Teachers can make necessary decisions on which method of teaching and what additional resources to use during the planning process of the lesson to be presented (Janssen et al., 2019). Teachers must be certain of the methods of teaching to use for lessons to cater for all learners in their classroom.

Science is a systematic way of reporting correctly on observations and analysing the information by making connections with what already exists (DoBE CAPS, 2012). The later statement simply implies that learners and teachers have acquired indigenous knowledge of what exists around them, however they need to carefully reconsider before drawing conclusions.

A relationship between variables must be established and proved beyond reasonable doubt in a Science laboratory that enables the teachers and learners to debate and discuss all factors to reach the correct conclusion to render the experiment valid. This event enables the learners to think and reason objectively having valid facts to contribute to the science world.

Dlamini (2004) cites that many writers link scientific inquiry and process skills in Science teaching however according to my knowledge there is little that has been done to find out to what extent and how teachers choose a particular process skill. According to Hedges, Shymansky and Woodworth (1990), a curriculum that puts more emphasis on inquiry enhances the performance of learners rather than the traditional textbook method.
Modern society requires development of the 21st century that includes amongst others the ability to work well with others, creativity and critical thinking as we experience information revolution (Tsybulsky & Oz, 2019). The usage of both Project-based Learning (PBL) and other Inquiry-based Pedagogies (IBP) could assist learners to develop necessary skills for this era of information revolution (Häkkinen et al., 2017). Moreover, it has become of the utmost importance for teachers to be on par with the recent developments by acquiring or developing the necessary scientific skills to instil this knowledge effectively and efficiently in the learners in the classroom situation.

Scientific process skills will foster authentic assessment and independence ensuring that learners become critical thinkers, thus thinking outside the box. All stakeholders must possess the inquiry skills to assist in the learning process as the education system is a tripartite structure. This simply implies that teachers, learners and parents must work together within the education system. Parental involvement plays a vital role in the education of learners, whilst learners and teachers too must do their part in ensuring that the education system does not collapse.

The DoBE CAPS document (2012) outlines the process skills that learners must develop in science as assessing and recalling information, observing, comparing, measuring, sorting and classifying, identifying problems and issues, raising questions, predicting, hypothesising, planning investigations, performing investigations, recording data, interpreting data and then communicating the data in a way that other people will understand it. In any scientific process, there are systematic steps to follow not to allow room for any misconceptions on information communicated to people.

2.3 METHODS OF TEACHING SCIENCE

There are multiple teaching methods that teachers could use to enable learners to formulate knowledge. Teachers expose learners to diverse instructional methods that make provision of multiple learning opportunities (Ozdemir et al., 2018). Different face-to-face teaching methods include, discussion, lecture and experimentation. Recently on-line learning has provided
learners with an opportunity to study in their own time and electronic gadgets are used (Yolon, 2016 cited by Ozdemir et al., 2018).

A face-to-face method can either be expository or an inquiry method depending on what activities the teacher does in the classroom. The face-to-face expository method is centred on the teacher as the source of information through lectures (Cetin, 2018). During the lecture method, the teachers basically do much explaining to the learners. Core concepts are clearly defined whereas the graphs, tables or figures are explained, thereafter the learners are given an opportunity to complete assessment tasks related to what was learned and further respond to questions raised by other learners (Cetin, 2018).

The literature points out that fundamental features of effective professional development include the following according to Lee et al. (2015):

- emphasis on content knowledge and how learners learn that content;
- prospects for teachers to participate in dynamic learning; and
- consistency with other activities for teacher learning and development.

Lee et al. (2015) assert that effective professional development could be realised if the structural features such as prescribed contact duration with learners is observed to the later, and all teachers be actively involved in the learning and teaching process.

In a face-to-face inquiry method, the teacher presents videos and/or photos to the learners or conduct experiments related to the lesson to stimulate interest and curiosity in learning. According to Cetin (2018) the face-to-face inquiry method can be presented in a 5E learning cycle that involves engaging, exploring, explaining, elaborating and evaluation. After viewing the videos and/or photos and experiments, learners are expected to respond to the questions, explaining what they have observed, and information gathered during the presentation.

The collected data will then be used to solve problems and form the basis of factual ideas to be used in the construction of scientific knowledge. The role of the teacher during this method is
clearly for guidance (assisting in conducting the experiment); the facilitators must encourage
learners to generate their own questions based on what is observed, and the motivators must
allow learners to actively participate in a discussion to draw conclusions on what was
experienced, for learners to be able to debate their thoughts (Cetin, 2018).

The teaching methods can further be classified as expository and inquiry methods centred on
how learners are acquiring knowledge. The later statement simply explains the fact that in the
process of acquiring knowledge learners are either passive recipients or active participants. The
teaching methods are often influenced by various factors such as the response from learners
during the lesson presentation, availability of learner-teacher supporting materials (LTSM) and
the prevailing situation in the classroom (Chia et al., 2020).

2.3.1 Expository methods

This method renders the learners inactive in the classroom situation. The expository method is
directly proportional to what teachers know about the subject matter. Expository method relates
to a divergent process of teaching that only concentrates on content and curriculum knowledge
(Li, 2018). The teachers present the subject matter to the learners without engaging them
actively. These particular methods are often used by the teachers experiencing shortcomings
that could emanate from no specialisation in science or rather lack of resources. The repetitive
use of these method deprive the learners of acquiring the relevant knowledge at their level of
education. These particular methods include lecture and demonstration methods.

2.3.1.1 Lecture method

The teachers resort to the traditional way of teaching where a textbook was the only source of
information at the disposal of the teachers. Basic concepts and processes are explained
theoretically in a learning and teaching situation. The Lecture method can also be referred to
as theory-based method.
The teacher becomes a subject specialist in unfolding the subject Content Knowledge (CK) to the learners and the information presented often is limited to what is found in the textbook. Any other related information not prescribed is null and void. There is no consideration of an Indigenous Knowledge System (IKS). In addition, any environmental information, cultural beliefs and norms and community values related to what is taught are not considered. The coding of information by learners is not discussed to verify if the content is grasped correctly.

2.3.1.2 Demonstration

Learners are expected to observe what the teacher is doing and are not allowed to manipulate and use whatever the teacher has brought to class to show them (Dlamini, 2008). Learners’ observation skills are sharpened, and they passively observe the educator performing an investigation in front of them. In a demonstration method, learners are not directly engaged in the teaching and learning situation, hence they have limitations.

There is only a single flow of information in a demonstration method which is from the teacher to the learners. The teacher prepares the subject matter to be presented to the learners and the method to use to equip the learners with the necessary information as decided during lesson planning. The following diagram illustrates the flow of information from the teacher to the learners:

![Diagram](image)

**Figure 2.1: Illustration of the pathway of information in a demonstration**

According to Li (2018) content and syllabus knowledge have a positive impact on teaching. SACE (2010) clearly states that there is relationship between the teacher’s knowledge of curriculum and academic performance of learners. So, teachers must be trained regularly on
changes in the curriculum and new methods that could enhance teaching and learning processes. Teachers are expected to attend workshops for academic development on learning areas they offer at school. According to Lee et al. (2015), workshops provide inside information and insight into the science curriculum and the limitations of content knowledge. Furthermore, the possible intervention strategies to assist in the learning and teaching situation to be able to achieve the expected objectives for science instruction and assessments can also make a difference. Workshops afford teachers a chance for networking. They share good practices that help them overcome challenges at their schools and that could somehow assist other teachers who were unable to resolve their own challenges. Teachers can develop on their own and draw on common goals based on the experiences arising from contextual phenomena and furthermore share the available resources.

2.4 INQUIRY METHOD

Scientific investigations are taught in the classroom for effective and efficient learning and teaching mainly using Inquiry-based Teaching (IBT) (Dlamini, 2006). IBT has its limitations like any other method of teaching and learning due to external factors that could affect the teaching and learning situation. According to Arabacioglu and Unver (2016); Berg, Bergendahl, & Lundberg, (2003); Crawford, 2000; Crockett, 2002; Dewi, Poedjiastoeti, & Prahani, 2017; Luft, 2001 cited by Limatahu (2018) IBT has the following benefits:

- teaches learners;
- motivates learners;
- enables learners to think critically about any ideas, problems and questions;
- affords learners opportunities to actively participate in and out of the classroom;
- encourages innovation;
- promotes collaboration amongst learners;
- creates a better understanding of basic science process skills and integrated process skills; and
- conscientises learners of the interaction between their environment and knowledge constructed through education.
Research conducted over the years showed that IBT in teaching and learning has challenges even though it is rated highly in creating a better understanding of science process skills. The method to be implemented in the classroom effectively depends entirely on the teacher because all the lesson planning decisions are the teacher’s priority. If the teacher is not well conversant with a particular method of learning and teaching, chances are that it may not feature in the planning process or rather the process will be flawed. Alkan (2016) argues that prior implementation of the inquiry learning method, teachers must be well acquainted with all the details regarding these methods. Teachers must always reflect on how their lessons were presented and check if learners understood what was taught. This will enable them to do remedial work on lesson presentation and even review method of teaching and learning to assist learners with challenges. Teachers are used to making use of multiple resources at a time to address diversity that exist amongst the learners.

Utilising the IBT makes it possible for learners to be active participants in their journey to acquire knowledge. Moreover, technology has found its base in the education system. Teachers use ICT in their classrooms to reinforce the pedagogical practices in learning and teaching. Inquiry in science aids not only as an assessment used to validate end of Science learning, but also as a technique to construct and outspread learners’ knowledge of science concepts (Lee et al., 2015).

Enhanced meaningful learning occurs whenever certain pedagogical methods are linked and introduced in line with ICT (Chai et al., 2010). The inclusion of technology in a teaching and learning situation relies on the availability of support within the lesson plan preparation (Janssen et al., 2019). Teachers need to be technologically advanced to introduce ICT in their lesson planning.

Technological Pedagogical Knowledge (TPK) is of utmost importance in integrating technology in teaching to enhance the learners’ science inquiry skills (Kewalramani et al., 2019). According to Mishra and Koehler (2016) content and technological knowledge are crucial in an effective use of ICT when teaching Science.
A pedagogue demonstrates capability during the lesson planning process wherein different factors are taken into consideration in the construction of a comprehensible lesson presentation. According to Shulman (1987) cited by Li (2018) the following facets improve the specific contextual knowledge of the teachers, namely, knowledge of the subject matter, learners, pedagogical knowledge and teacher’s own beliefs:

- **Knowledge of the subject**: It refers to the ability to unfold the curriculum as expected; using the necessary instructional tools in teaching and learning;

- **Knowledge of learners**: This aspect refers to the fact that learners already have specific information about their environment and everything that relates to it. It relates to the learners’ cognition of the matter;

- **Pedagogical Knowledge (PK)**: These are specific pedagogical methods and scientific skills that can be applied in a learning and teaching situation to create a conducive environment; and

- **Teachers’ own beliefs**: All the cultural and traditional norms and standard that prevail in different communities are based on their societal practices’ influences and the unpacking of the Content Knowledge (CK).

Projects in Science help learners to become innovative and creative when conducting investigations. Loyens et al. (2010) define project-based learning as a distinctive modification of co-operative inquiry-based learning. Learners are actively involved in this method of teaching and learning as they work through a problem by discussing ideas, stating hypothesis, designing the experiment, collecting data from their observations, drawing conclusions and then communicating their own findings to others (Blumenfeld et al, 1991 cited Tsybylsky et al., 2019). There is a dire need for the teachers to have Specialised Pedagogical Content Knowledge (SPCK) in order to construct relevant scientific knowledge to the learners. The later statement requires teacher to be professionally qualified in Science Education.

Learners are given an opportunity to become critical thinkers and reason logically based on facts. Furthermore, they develop interpersonal skills as they collaboratively work together to achieve set objectives in the project. Project-based learning incorporates experimentation and collaborative methods as learners are grouped and afforded a chance to debate ideas based on their own observations.
2.5 PROCESS SKILLS IN SCIENCE TEACHING

Scientific process happens only when process skills developed are used in conducting inquiries or investigations to solve a science problem using innovative and creative ideas (Prayitno et al., 2017). Process skills in Science are classified into basic process skills and integrated skills as follows by Prayitno et al (2017):

<table>
<thead>
<tr>
<th>Basic process skills</th>
<th>Scientific process skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>Controlling variables</td>
</tr>
<tr>
<td>Inferring</td>
<td>Defining operationally</td>
</tr>
<tr>
<td>Classifying</td>
<td>Formulating hypothesis</td>
</tr>
<tr>
<td>Communicating</td>
<td>Interpreting data</td>
</tr>
<tr>
<td>Measuring</td>
<td>Experimenting</td>
</tr>
<tr>
<td>Predicting</td>
<td>Formulating models</td>
</tr>
</tbody>
</table>

Table 2.1: Classification of process skills

Individuals that are able to master both basic process skills and integrated Science process skills are expected to portray certain scientific attitudes to be successful as scientists. The behavioural
attitudes relate to integrity, honesty, consciousness, responsibility and creativity (Hamilton & Swortzel, 2007). Teachers should have the characteristics of a scientist including the behavioural attitudes to be able to teach the process skills and achieve the objectives in a learning and teaching situation. The later will encourage learners to develop curiosity and interest in scientific processes and further model real scientists in conducting their investigations.

The ancient way of learning in Science and other subjects was through recitation and memorisation of concepts, laws, and theories, and not through the application of theories in scientific processes. Learning was ideologically clustered by the fact that a teacher was the main source of knowledge having total control of all activities in the classroom (Prabowo, 2015). The level of competency and knowledge acquired in Science was clearly measured by how many concepts, theories and laws learners could remember. According to Karsli and Avas (2014) cited by Limatahu (2018), Science process skills are utilised by scientists to construct knowledge, discover problems and draw up conclusions.

The inclusion of process skills in teaching Science urge teachers and all stakeholders in the educational fraternity including the community to understand the fundamental basis of Science and how it can be used in a classroom situation. This is a driving factor in the entire world as more people strive to understand the natural world. Technology is advancing at a high speed around the world and that prompts people to resolve some of the challenges or problems encountered to meet human needs. In trying to explain the cause and effect of the modern revolution scientists and researchers engage in process skills to acquire knowledge of the natural world.

According to Kennedy (1997) cited by Ngema (2016) explained that teachers should inspire and role-play skills in scientific inquiry to learners including allowing learners to become curious in sharing ideas and analysing data following the scientific processes. Science is driven by the dire need to comprehend the natural world and technology trying to solve human problems.
The level of difficulty in resolving societal problems differentiate the processing skills into basic and integrated depending on the process skill to be utilised (Dlamini, 2004). The basic processing skills make an inclusion of predicting, classifying, observing, measuring, recording, drawing conclusions, displaying data and engaging in communication (CAPS, 2012). Science processing skills include basic processing skills and integrated skills. Furthermore, they involve the ability to observe, classify, communicate, measure, and predict and are used as the indicators of basic process skills mastery (CAPS, 2012). In addition, it involves the ability to identify variables, control variables, make operational definitions, form hypotheses, design and conduct experiments, and draw conclusions as they are the indicators of integrated process skills mastery.

Science processing skills start with a problem statement that requires to be resolved. In the process of becoming creative and innovative to resolve a scientific problem, diverse scientific processes are followed depending on the objectives of the study. Learners make observations by hearing, viewing, touching, smelling and tasting, thus using the different senses to collect information on a specific phenomenon (Rebza et al., 1995) as explained below:

- A sense of touching involves the texture of an object, pressure or temperature. Learners become able to differentiate between objects based on how smooth or rough, soft or hard and how hot or cold that particular object is;
- A sense of sight enables the learners to use their eyes effectively and efficiently to make inferences of what is happening at different levels of an inquiry process. This involves taking note of the changes in an object when exposed to diverse conditions;
- A sense of hearing allows learners to identify different sounds made at different occasions during an investigation whenever the inquiry is manipulated;
- A sense of taste enables learners to use their tongue to identify substances. This can be dangerous at some stage due to the different chemicals used in the laboratory. So, learners must take necessary precautionary measures in place before tasting anything in the laboratory; and
- A sense of smell involves identification of substances using the nose based on their odour produced.
In any learning and teaching process, observation of a certain incident automatically leads to the use of the observed information in acquiring other process skills like predicting, classifying and reporting of data (Ngema, 2016). The process skills are explained underneath.

2.5.1 Classification

This involves the utilisation of the underlying characteristics that differentiate objects. Classification can be based on similar properties shared amongst objects or the difference thereof. Martin (2006) indicated that classifying means grouping and ordering objects into diverse classes.

2.5.2 Prediction

Prediction refers to the statement that explains what could happen in an event based on what is observed. The statement can either be wrong or right. No prediction is deemed correct until an investigation is completed. Failure to perform practical investigations results in incapability to attain the aim of teaching learners critical thinking skills (CAPS 2011), then innate ability to be intuitive in analysing processes becomes restricted. Dlamini (2008) clearly states that whenever learners are faced with a problem, they could utilise their pre-existing experience to predict the outcome of their situation.

2.5.3 Measurement

Refers to the size, amount, or length of something as established by measuring. Measurement describe the particular dimensions of an entity, an occasion or occurrence (Martin: 2006). The procedure or method of investigating requires learners to make accurate measurement to draw up the correct conclusions.
2.5.4 Drawing conclusions

Rebza et al. (1995) refer to drawing conclusions as inferences meaning that learners become able to make a calculated guess based on the trends observed from the beginning of the investigation until the end. The conclusions are based on information that can be used to verify the validity of the hypothesis statement made.

2.5.5 Communication

Experiments conducted in Science can be reported using words, tables or graphs for further interpretation by other people. The patterns and trends observed can be recorded thoroughly using a table that can be further transcribed into a graph. People can use the graph to understand the observations made during the investigation.

Teachers are expected to have conceptual knowledge of scientific process skills for effective and efficient teaching and learning. Effective professional development affords teachers the opportunity to apprehend the objectives of curriculum and make use of the curriculum as it scaffolds to promote teacher learning in addition to student learning (Remillard, 2005 cited in Lee et al., 2015).

Learners are further exposed to integrated process after mastering basic process skills allowing them to engage in solving problems by engaging in scientific investigations (Arena, 1996 and de Jager et al., 2003 cited by Ngema (2016). Integrated process skills involve interpreting data, manipulating variables and designing an experiment.

Inquiry and investigation are used to explain and connect the general ideas and the Science knowledge taught at schools has been tested and known since the 18th century (CAPS, 2014:8). Any investigation done has to be examined and debated before it can be accepted as a fact.
The fact that things are not static as they keep on changing, researchers must always keep on researching and investigating to always remain relevant. Teaching Science sustains curiosity, allows integration of other learning areas, develops indigenous knowledge, and afford learners an opportunity to use scientific knowledge to benefit the society at large.

2.6 ELECTRONIC LEARNING (E-LEARNING)

Educational modifications necessitate a technological approach which typically poses trials because the country could be not equipped and incapable to instantly deal with each educational challenge promptly (Acosta, 2016). Electronic learning can also be referred to as online learning which integrates learning and technology (Aparicio et al., 2016). It has become very difficult for universities to provide admission of new students physically at their institutions due to the high number of students in need of admission at the institutions of higher learning, so they too opted for on-line application. The University of South Africa (UNISA) has been offering Open and Distance Learning (ODL) for many years, and have assisted many students from poor backgrounds to study and acquire different qualifications whilst working to pay for their own studies.

Recently, the outbreak of the Covid-19 virus (corona virus) resulted in lockdown with stringent regulations that restricted free movement of people and unnecessary gatherings. There are model modifications in diverse scopes of e-learning and the environment around it. The government of South Africa called for the closing of all institutions of learning and teaching including schools. Furthermore, it was anticipated that learning should not be brought to a standstill and radio broadcasting, on-line learning and other related measures for provision of continuous learning. Some of the students are unable to keep up with their studies due to lack of facilities that will enable them to access materials from their institutions wherein the issues of equity and access became more obvious (Pittman et al, 2020).

The use of a chalkboard is fading slowly as technology advances at schools. E-learning requires acquisition of many technological tools like over-head projectors, computers, and many other resources for it to really be implemented. Otherwise, if all the resources are not in place it might become frustrating to the teaching and learning situation. Learners are motivated to be at the
fore-front of the vehicle for their own learning by using electronic gadgets (Oliver, 2002 cited by Acosta, 2016).

ICT has advanced as an instructional tool preferred mostly by both teachers and learners for its effectiveness in a teaching and learning process. In the early years of the emergence of Internet connections that could assist learners to learn on-line, many people especially teachers thought that they would be easily replaced. Otherwise, ICT is used to assist teachers to provide knowledge in the classroom to teach learners. The usage of Internet by the teachers in a classroom situation led to the emergence of a special instructional mode widely known as online learning or e-learning (Cetin et al., 2018).

Acosta (2016) argues that the teachers and learners who are the main users of ICT resources in the educational system need to acquire knowledge on how to use computers to sustain and reassure current enthusiasm or model modification for proper implementation of ICT in e-learning education. Teachers prepare using their technological devices and then upload them onto the website. Furthermore, he points out that accessibility to systematic data and communications is significant from social as well as environmental outlook since learners are not restricted to a classroom situation but are learning from diverse settings. As much as culture is dynamic, technologies should be made well-suited with the cultural dominion of learners and society.

The lesson presentations uploaded on the system become available to the learners at their most convenient times to learn and furthermore assessment tasks can even be completed on the website. Unlike face-to-face instructional method, e-learning is flexible enough allowing learners accessibility continuously regardless of time and place. The later statement is more evident recently during the lockdown experienced globally as ICT was used to teach learners on television or websites. Different broadcasting corporations joined hands with stakeholders to ensure that learning and teaching continue.
It is an important instructional tool for parents who prefer home schooling for their children. The provision of home schooling is made possible as per education act, NEPA (National Education Policy Act) where it clearly states and is further confirmed by SASA (1996), that all the necessary requirements have to be satisfied before permission is granted for home schooling. Since not all parents are professionally qualified to guide their children to acquire the knowledge through education, they rely mostly on the website for assistance.

Differentiation in the instructional tools in a classroom situation enables teachers to cater for the diversity in the learners so that the set objectives can be achieved. The diversity in instructional tools affords learners learning opportunities at different settings (Cetin et al., 2018). The effectiveness of the method of instruction used in a teaching and learning situation could be confirmed in the performance of learners when assessed. Assessment tasks or activities must be administered after every lesson presentation based on the set objectives of the lesson so check if they were achieved.

There is no way of assessing the knowledge acquired by the learners but it could be done either orally or in written form. As the lesson progresses teachers often pause to ask questions to actively involve the learners throughout the presentation. At times, a written task is given to the learners in the form of classwork, homework, or a project. These activities are deemed informal as they do not form part of the tasks considered for learners’ progression.

2.7 THE LANGUAGE USED BY THE TEACHERS IN TEACHING SCIENCE

Teachers use academic language to engage learners in a learning and teaching classroom situation (Schleppegrell, 2012) and teachers must support the learners in acquiring scientific academic language. The later statement will help learners to develop the ability in using academic language pertaining to Science authentically and fully in the Science classroom (Jung, 2017).
In science subjects like any other learning area has vocabulary, terms and concepts (Smith-Walters, Mangione & Smith Bass, 2016) that are given specific meanings that may differ from their normal meanings (Michaels, Shouse & Schweingruber, 2018). Science language requires teachers to be comprehend the concepts before getting deeper into the subject content. Science as a learning area presents particular encounters and prospects for learners to engage with language (Buxton & Lee, 2014; Gee, 2005 cited in Jung, 2017). It is extremely imperative that teachers comprehend the language of Science and how they can foster Science language acquisition within their learners (Smith-Walters, Mangione & Smith Bass, 2016). Teachers must develop ways of identifying keywords in the definition of concepts to unpack them to support the learners. Science as a subject requires one to grasp the concepts and be able to communicate them in writing (Ngema, 2016:33).

As learners learn the Science concepts in context, new semantics are acquired in a co-operative way (Smith-Walters et al., 2016). As highlighted by Li (2009) the Science concepts require entrenchment as scientific vocabulary is not learned in isolation but has to be creatively represented in text that are substantial. Learners studying English as their second language need to try to acquire the Science concepts and vocabulary so that it can be used creatively in texts that are scientifically meaningful. As outlined by Melor et al. (2017) individuals who can express themselves clearly and proficiently in English are at an advantage and enjoy more privileges than their counterparts who lack good command in English.

The language used in Science is Latin as most of the terminologies are of Latin origin. Learners’ indigenous knowledge of naming things either in native language or English have only a slightest effect on learning the language of Science. Competent teachers use learners’ home language as instructional support in a learning and teaching situation (Goldenberg, 2013).

Learners must master the Science concepts to learn successfully. The later statement creates a stumbling block for learners because more time will be spent on trying to become familiar with the concepts and they will not have ample time to sharpen their language to be represented in a meaningful text. Rooted in the semantic consciousness is the fact that there is an academic
language that must be learned (Poza, 2016), besides the most preferred language, English which is used in the corporate world.

Hlabane (2014:25) indicates that analytical ability is of utmost importance in analysing data from the diagrams and communicate them in words. The language of Learning and Teaching (LOLT) refers to the language medium in which learning and teaching, including assessment take place. Schools are given the responsibility to draft policies at school level and those policies include the language of teaching and learning although SASA already prescribes what should be regarded as LOLT at schools. Mastering English is of utmost importance in assisting state to advance to its ultimate altitude and thus, to maintain its outstanding competitiveness and efficiency in worldwide confidently (Melor, 2017). Learners from native communities are compelled to learn in the language that they are not very conversant in, to be able to compete successfully within the global world.

All policies drafted and agreed upon at school level should be in line with the Constitution of South Africa and South African Schools Act (SASA) 84 of 1996. Language policy for public schools is subject to the Constitution of the Republic of South Africa no. 108 of 1996, Chapter 2: 29 (2b) which states that everyone has the right to receive education in the official language or languages of their choice considering the need not to discriminate against others based on their race.

Science teachers must develop concepts that build the language of Science. Special concepts acquired by the teachers in Science are far different from LOLT in a classroom. According to Poza (2016) the linguistic consciousness in Science consists of scientific disciplines that are dependent on specific concords, terminology, and conversational norms in their epistemologies, methodologies of investigation, and discussions.

Learners are expected to reason scientifically in their deliberations using the appropriate language in Science and furthermore are able to present comprehensive, investigative reports. Language is the foundation of Science and that implies that Science and language teaching are
inter-related. Teaching Science and teaching language is closely interwoven (Lee et al., 2013; Rosebery & Warren, 2008 cited in Lee et al., 2016).

The Science concepts must feature in the texts for meaningful scientific reports. Learners must be supported in the developmental process of acquiring the relevant science language and skills (Poza, 2016). Teachers are expected to be knowledgeable about the subject matter to support learners in achieving their goals in the learning process (Lee et al., 2015). The later statement is supported by Diamond, Maerten-Rivera, Rohrer, & Lee, 2014; Heller, Daeler, Wong, Shinohara, & Miratrix, 2012) indicating that teachers with a prestigious Science content knowledge successfully construct knowledge to the learners and that is shown in their performance.

Teaching Science requires an experienced teacher who is capable of promoting active participation from the learners. Unfortunately, support needed by learners remains a challenge for many teachers (Baecher, Farnsworth, & Ediger, 2014). Jung (2017) argues that teachers must receive professional development that supports their skills to provide instruction that supports and scaffolds learners’ science academic language use and development.

Lack of experience is an obstacle to teaching science in a way that it promotes creativity and critical independent thinking (Harris & Rooks, 2010). Effective teachers aim at advancing the learners’ proficiency in English and fast-tracking their accomplishment in Science (Melor et al., 2017).

SASA Chapter 2:6 (1-4) clearly states that, “as the School Governing Bodies (SGBs) determine the language policy; no racial discrimination may be practised.” So, taking into consideration the diversity of the South Africans, English is declared as the language of teaching and learning in most public schools in the country. English language is regarded as a tool influential for the development and most significantly for the survival of the country for years to come (Melor et al., 2017). This will facilitate the provision of a quality workforce that competes successfully with the global world.
Experienced teachers incorporate the second language to a minimal and indigenous knowledge system to assist the learners in acquiring more knowledge to engage successfully in inquiry activities and investigation reports related to science education. Lee et al. (2015) point out that reading for understanding in science enables learners to participate actively in scientific activities and provides scaffolding science language, critical and logical thinking in science.

2.8 RESOURCES

The definition of resources in the education sector includes all the materials that enhance learning and teaching in a classroom situation. Availability of resources creates a conducive learning environment for learners and enables teachers to achieve their intended goals. Resources such as infrastructure, textbooks and laboratory equipment ensure that effective learning occurs where learners’ interest in science and their manipulative skills are enhanced (Ngema, 2016). Dhurumraj (2013) emphasises that for effective teaching and learning of Science; enough and proper resources must be made available as they are very critical in a science classroom. As the learning expertise is escalating and becoming economical and broadly accessible, the means of teaching, learning and education delivery are going through significant changes (Acosta, 2016).

Availability of adequate resources creates a platform for good performance in both learners and teachers. Resources that are critical for a school to run effectively and efficiently could be characterised as material, human and social resources (Gamoran, Secada & Marrett, 2006). According to Lee, Llosa, Jiang, O’Connor and Haas (2016) material resources refer to equipment’s, time and funding, then human resources are the human capital whilst the social resources relate to human relations that exist amongst educators and between educators and other stakeholders.

One critical resource that might have been omitted which is very under resourced in the South African schools is infrastructure that is well-resourced with the material resources as mentioned
by Lee et al (2016). Demands for resources at schools are high as many schools are under resourced more especially public schools. The relevant stakeholders in public funded schools are responsible for the provision of resources that will aid schools to function properly. Davis and Krajcik (2005) propose the concept of “educative curriculum materials” that stimulate modifications in teachers’ knowledge and practices to make instructional decisions about their methods of teaching and expedite teachers’ development of broad knowledge that could be useful in the learning and teaching situation (Davis et al., 2004).

Teachers need to be supplied with policy documents that have detailed information of how curriculum could be unpacked to allow acquisition of knowledge through teaching and learning. Accurate information is provided in the policy documents regarding content knowledge, assessments and time allocation per subject for different grades. Compared to languages and Mathematics, Science’s instructional time in the senior phase is less (CAPS, 2012). Lee et al. (2016) agree that allocation of instructional time for science is less than that of language Arts and Mathematics.

In Science education, it is crucial that schools should have a Science laboratory where different investigations will be conducted to enable learners to acquire necessary process skills in Science (Smith et al., 2013). Allocation of norms and standards is dependent on the number of learners. School A which has smaller number of learners, referred to as a small school will never have the same funding as School B that has more learners. The cost of securing the necessary resources and the service thereof should be measured by doing cost-benefit analysis not just considering the economic viability (Acosta, 2016).

Teachers are expected to have relevant content knowledge, skills and character to effectively teach learners to construct knowledge in Science education. Teacher development programmes in place, such as Integrated and Quality Management System (IQMS) used for the appraisal of teachers encourages teachers to continuously develop themselves through workshops, and upgrading qualifications to effectively and efficiently perform their duties.
As outlined by Lee et al. (2016) the influence of specialised teacher development relies partly on the accessibility of resources such as apparatus to perform scientific investigations for implementation. Human relations are of paramount importance for every teacher as teachers interact with different stakeholders in performing their duties. Teachers are expected to be able to relate to people from diverse socio-cultural backgrounds in their working environment.

The resources’ availability is necessary for both the learners and teachers although a greater impact is on the performance of the learners as they are assessed. Not every textbook can be used at the schools and the DBE has a list of prescribed books that could be used at schools. And the selection thereof is left in capable decision-making skills of the School Management Team (SMT) and the subject teachers involved based on the user friendliness of the textbook.

The resources, learners’ book, and teacher’s guide, provide information on content knowledge to be acquired and the arrangement of the chapters in such a way that prior knowledge serves as a basis for new knowledge to be acquired (Lee et al., 2015). At the beginning of every chapter new Science concepts (referred to as key words) are introduced and defined and throughout the chapter those words are highlighted in bold. This is done in such a way to capture the attention of the learners as they read through the chapter.

The imbalance caused by the inequalities in life plays a greater role in discriminating against learners based on their household background. Learners from a less privileged home background are likely to receive less support through their learning process compared to those from privileged homes as they get support for their learning such as proper infrastructures, more physical resources at home and highly educated parents (Lee et al., 2016). Lack of resources is a challenge experienced at schools particularly in teaching science (Smith et al., 2016).

Insufficient institutional preparations and capability to carry on educational accomplishments without outside supports may be damaging to the determination of ensuring sustainability of results achieved (Mangstl, 1998 cited in Acosta, 2016).
2.9 THEORETICAL FRAMEWORK

An education system includes many aspects that interact on several occasions for knowledge to be constructed. Teachers, learners, and parents or rather the community with its cultural beliefs and values have a direct impact on education system. The whole process of teaching and learning is an activity that can be viewed as socio-culturally constructed (Vygotsky, 1978).

The teaching and learning situation is influenced by environmental norms and beliefs. In the process of constructing knowledge, both the teacher and learners must take into consideration what happens around the environment they exist in. The selection of instructional strategies in the classroom is influenced by what prevails within that environment. According to Chia et al. (2020), pupil’s responses, the classroom situation, availability of resources and resources directly influences how knowledge is constructed.

The reasons for choosing certain pedagogical practices have not been researched and range from resources at the teacher’s disposal, pupils’ ability, teachers’ philosophy and beliefs on teaching and learning, subject matter, and teacher’s content knowledge (Chia et al., 2020). No specific theory is available to explain in detail how teachers prefer to use certain pedagogical practices over the others. There is always continuous interaction of the teacher with a learner and/or the environment. In the process of constructing knowledge and communicating it to learners, teachers consciously or unconsciously engage; choosing the correct method of teaching and learning involves the resources within their working environment.

According to Vygotsky’s approach cited by Verenikina (2010) in his social constructive theory the mind of human beings is constructed continuously through subjects’ collaborations with the world and is a feature of the association between subject and object. Humans play a crucial role in construction of knowledge by understanding themselves and the world that exists around
them. The humans’ own understanding forms a basis of constructing knowledge about what exists and how they must interact with all that is in existence.

As indicated by Turuk (2008), humans form artefacts influenced by specific cultural and historical conditions based on their own values and beliefs. Learners are dependent on teachers to construct knowledge that will enable them to develop constructively within their environment upholding their values and cultural beliefs. Vygotsky (1978) in his theory maintains that children depend on other people for guidance and assistance as the environment keeps on engaging the children with diverse activities in their world.

Learners in their journey of acquiring knowledge interact with different teachers with diverse socio-cultural beliefs that influence their thinking and ways of interacting with their environment. Learning occurs when learners successfully interact with the world without the assistance of teachers after internalising what was taught (Turuk, 2008).

Learners gradually develop skills to enable to interact successfully with society through zonal proximal developmental stages as described by Vygotsky in his socio-constructive theory (Schunk, 2012). The later statement indicates the notion of collective activity to promote cognitive development. The Zone of Proximal Development (ZPD) is the variance between what children can do on their own and help brought in through interactions with other people (Adam, 2017).

The collaborative method used in learning Mathematics, Science and languages recognises the impact of the social environment as learners complete tasks working together, sharing ideas to solve activities (Adam, 2017). Collaboration amongst learners confirms Vygotsky’s ideas of the ZPD. In a classroom situation, teachers and learners interact to understand each other’s cultural beliefs; thereafter establish their own working cultural connection.

Teachers must be knowledgeable of the socio-cultural values and beliefs of the society they operate within to construct knowledge to the learners. The history, ways of doing things and
practical skills involved in their daily problem-solving activities are of utmost importance to assist the teachers in understanding the society at large (Bada, 2015).

According to Vygotsky’s theory, learners are active participants in the learning process and construct meaning on what is learnt from the existing social environment. The teacher facilitates and organises information for the learners to ascertain their own learning (Liu & Chen, 2010 cited in Bada, 2015). Tam (2000) considers the following characteristics in constructivism:

- Sharing of knowledge between the teacher and learners;
- Sharing of authority in learning; and
- Existence of diversity in the learners.

One of the main goals of education is to construct knowledge and understanding of the foremost notions that have moulded our cultural background (Osborne, Borko, Busch, Fishman, Million, & Tseng, 2016). According to this theory, learners’ knowledge will be constructed accordingly taking into consideration their cultural and societal background that forms the basis of the foundation of their natural world.

2.10 CONCLUSION

This chapter covered the literature review and underscored the importance of teaching and learning in science. The role of the teacher as informative resource by equipping learners with the needed science knowledge was underscored. Vygotsky’s principles of learner support in building and scaffolding onto the learners’ prior knowledge by supporting the learner was highlighted. Learners grow and develop by drawing on teacher and learner support when adding to their existing knowledge. The next chapter covers the research methodology used in the study.
CHAPTER 3
RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

The previous chapter dealt with literature review and covered the theoretical principles implemented in the study. This chapter presents the research design, methods of data collection, sampling methods, data analysis, issues of reliability and validity, and ethical considerations. The research design and research methodology will be explained in an attempt to answer research questions focusing on pedagogical practices teachers use in a science classroom. It underscores the influence of science process skills on teachers’ approaches to plan for their teaching and highlights the process skills and their influence on the construction of scientific knowledge in science.

3.2 RESEARCH DESIGN

Research design is a set of methods and procedures used in collecting (Cresswell, 2013) and analysing measures of the variables specified in the problem statement (Vogt, 2007). The research design refers to an overall approach that a researcher selects to incorporate the diverse mechanisms of the study in a rational and logical technique, to address the research problem successfully.

The research design can be regarded as the blueprint for collecting, measuring, and analysing data in a research study. The type of the research design depends on the research problem under investigation (Vogt, 2007). It outlines in detail, the procedures followed in this study, sampling techniques, sample size, data collection instruments and data analysis methods. The nature of problems posed by the research aims as the determinants of the accurate choice of the research design in any research study. Each research design has a variety of research methods that are normally used to gather and analyse the data collected during the investigations (Walliman, 2011).
Commonly used research designs have specific characteristics that differentiate them from each other. They can be descriptive, historical, correlation, comparative or experimental. A list of some of the more common research designs, with a short explanation of the characteristics of each follows next. A descriptive design depends on observation as a mode of collecting data and endeavours to observe conditions to institute what can be predicted to occur again under the same conditions. Observation can take many forms depending on the kind of information pursued: people could be interviewed, questionnaires could be distributed and visual records made. The most crucial aspect about observations is keeping records of the data collected using field notes, a journal or recordings that later are analysed. The analysis is influenced by the scope and level of difficulty of the study.

Educational research is an organised and systematic disciplined approach for answering questions about our observations and experiences in the world (Walliman, 2011). It is a structured approach to gathering and interpreting information that allows researchers to understand, realise about or explain experience. Educational research draws on tools of behavioural sciences and social sciences. Therefore, the researcher utilises own view of what constitutes the truth and knowledge.

There are two types of research designs in educational research are qualitative and quantitative methods. These two methods differ as they address the different philosophical problems that arise from diverse philosophical views in our lifetime. They are implemented to achieve different goals and they use different methods and design. According to Walliman (2011) research methods are procedures researchers use to do research and they signify the tools of the line of work, and offer you with methods to collect, categorise and evaluate data so that you can draw some conclusions.

The usage of the right method for a specific kind of study research, convincing other researchers about the validity of the conclusions will enable the researcher to contribute fruitfully to create new reliable knowledge. Qualitative and quantitative research methods are often found to be used in dissimilar disciplines of education such as sociology, psychology, history, and others (Rahman, 2017).

According to Queirós et al. (2017), qualitative methods differ from quantitative research on the
fact that qualitative methodology aims to understand complex reality and connotation of activities in certain situations whereas on the other hand, quantitative methodology seeks to acquire precise and reliable measurements that allow statistical analysis. A qualitative method is used to uncover trends on thoughts whereas a quantitative method focuses on comparing numerical data. It focuses on creating meaning and understanding in different settings. It can be a particularly useful approach to study any educational problem that require developing an understanding of complex social environments and the meaning that people within those environments bring to their experience.

In these two research methods exist paradigm wars wherein researchers belong to the two diverse camps, thus interpretivism and positivism. Rahman (2017) further explains that positivistic researchers’ belief that the social world consists of concrete and unchangeable realities which could be quantified objectively. Positivists base their argument on ontological assumption about reality knowable within a setting using standardised tests, systematic observation, experiment, survey data, and statistical analysis. Contrary to that, interpretive researchers’ belief of reality is informed by hermeneutics and phenomenology based on Vygotsky’s theory and is from multiple socially-constructed realities by humans which can be changed over-time, furthermore understood subjectively in a specific setting (Kroeze, 2012). The provision of primary education has always been similar in terms of the objectives the Department of Education require to achieve despite the challenges that certain schools experience and that is a reality that could not be changed. The provision of education differs as per different backgrounds or social realities schools find themselves operating under. Information related to the curriculum could at times not be accessible to all the learners to experience practically.

Qualitative research is consequently concerned with facets of reality that cannot be quantified, focusing on indulgent and description of the dynamics of social associations (Queirós et al., 2017). Maxwell (2013) advocates that qualitative research works with the universe of meanings, motives, aspirations, beliefs, values, and attitudes which correspond to a deeper space of relationships, processes and phenomena that cannot be reduced to the operationalisation of variables.

Qualitative research utilises questions which are not specific (no particular response is deemed the best response), that warrants a deeper understanding of a particular phenomenon. So,
predictions or assumptions cannot be deduced from the findings. Qualitative research tries to describe the understanding of the nature of human experiences, and integrates more subjective human interactions rather than just objective external reality and generates a hypothesis or theory from the observations and experiences in the research study (Walliman, 2011). Quantitative research involves social and physical phenomena that are independent of the observer and fairly stable over time and place. Participants could objectively be observed and quantified, and moreover data utilised to test or confirm the hypothesis is expressed in numerical form.

The table below summarises a comparison between the two research designs:

**Table 3.1: A comparison between qualitative and quantitative research designs** (Queirós et al., 2017)

<table>
<thead>
<tr>
<th></th>
<th>Qualitative method</th>
<th>Quantitative method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus</strong></td>
<td>Quality meaning of an experience</td>
<td>Quantity, frequency magnitude (measurable questions answered)</td>
</tr>
<tr>
<td><strong>Philosophical roots</strong></td>
<td>Constructivism, interpretivism</td>
<td>Positivism</td>
</tr>
<tr>
<td><strong>Goals of investigation</strong></td>
<td>Discover, understand, describe</td>
<td>Predict, control, confirm, test</td>
</tr>
<tr>
<td><strong>Design characteristics</strong></td>
<td>Flexible, evolving, emergent</td>
<td>Structured, predetermined</td>
</tr>
<tr>
<td><strong>Data collection</strong></td>
<td>Researcher</td>
<td>Tests, surveys</td>
</tr>
</tbody>
</table>

The flexibility in qualitative research does not imply that the method is less disciplined, easier to design or rather to implement. The researcher is the primary instrument as a personal perspective and meaning are used to the selection and interpretation of data collected. Qualitative research aims to explore, and its goal is to identify patterns, themes and models that provide initial understanding of the phenomenon (Queirós et al., 2017).

According to Queirós et al. (2017) a qualitative method includes the following:

- Observation is a systematic process of collecting data in which researchers observe a given phenomenon in its natural environment. It is based on a phenomenon that is relatively unexplored to understand;
- Ethnography relates to a method of observing a particular situation and conducting interviews with its participants. Nurani (2008) cited in Queirós et al. (2017) indicates
that in ethnography the observation occurs in a natural setting and the researcher has to
get a clear perception and interpretations from the people within the area where the
event takes place. In this research data was collected through prolonged field work
which involved observation of the participants and completion of questionnaires
(McMillan & Schumacher, 2010);

- Field research gives the researchers an opportunity to have a clearer perception of
  humans and processes over a prolonged period;
- Focus groups are a very popular and useful method where the researcher interacts with
  the participant to investigate complex behaviour;
- Case studies afford ways to examine multifaceted circumstances through several
  variables under analysis. It is used very often in applied sciences such as social sciences,
  education and health. Data are collected in depth over a certain period in a particular
  setting (McMillan & Schumacher, 2010);
- Structured interviews are an assessment method design wherein the responses from
  interviewees are about their past experiences that are compared;
- In-depth interviews are unstructured and personal individual interviews where the
  researcher affords the participants freedom of speak on a particular issue.

The table below depicts the advantages and disadvantages of each methodology in qualitative
research:

**Table 3.2: The advantages and disadvantages of each methodology in qualitative
research**

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| In-depth interviews | • Adjusted to get detailed and insightful information on a given domain and they need only few participants to provide useful and relevant insights; and
  • Can be performed in informal environments. | • Time-consuming and relatively costly;
  • Longer verification process to extract compared information;
  • Participants should be carefully chosen to avoid bias; and
  • Not generalisable. |
| Structured interviews | • Well-structured and easy to compare participants’ answers;
  • Can reach a large sample, is | • Very rigid;
  • Low flexibility in the response's choice; |
<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>• Collection of data occurs simultaneously with the event occurrence;</td>
<td>• Is very time-consuming;</td>
</tr>
<tr>
<td></td>
<td>• Collection occurs unobtrusively, and is not dependent on someone's response;</td>
<td>• Is dependent on the observer's impartiality;</td>
</tr>
<tr>
<td></td>
<td>• Collection is flexible and oriented towards knowledge discovery.</td>
<td>• Requires significant preparation; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Is difficult to collect in real time.</td>
</tr>
<tr>
<td>Field research</td>
<td>• Adequate to get very detailed data; and</td>
<td>• Difficult to generalise and get data from a very large number of people or groups;</td>
</tr>
<tr>
<td></td>
<td>• The emphasis is on the role and relevance of social context.</td>
<td>• Dependent on the observer's impartiality;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Challenging process to document data.</td>
</tr>
<tr>
<td>Case studies</td>
<td>• Provide detailed information about individuals;</td>
<td>• Are difficult to establish cause-effect connections;</td>
</tr>
<tr>
<td></td>
<td>• Offer a good opportunity for innovation and change current theoretical assumptions; and</td>
<td>• Are hard to generalise from a small number of case studies;</td>
</tr>
<tr>
<td></td>
<td>• Can be a good alternative or complement to focus groups.</td>
<td>• Require consideration of ethical issues, especially of confidentiality; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are difficult to create a case study that suits all subjects.</td>
</tr>
<tr>
<td>Focus groups</td>
<td>• Adequate to get detailed information about personal and group;</td>
<td>• Are hard to control and manage;</td>
</tr>
<tr>
<td></td>
<td>• Offer opportunity to seek clarification; and</td>
<td>• Are difficult to get the participation of people; and</td>
</tr>
<tr>
<td></td>
<td>• Involve lower costs and time when compared to individual interviews</td>
<td>• Cannot be representative of entire population.</td>
</tr>
</tbody>
</table>

easy to replicate and conducting an interview is fairly quick.

Difficult to obtain detailed data; and
Preparing an interview can become time-consuming.
This study adopted qualitative research methodology using a case study design that explored the pedagogical practices of Science teachers in a classroom. Merriam (1998) supports general approach to qualitative case studies in the field of education. A case study was deemed appropriate as it explores reality over a period and in-depth data were collected using multiple sources (Creswell, 2013). In this study, I gathered information from the Grade 7 Science teachers in the Moroke Circuit using open-ended questionnaires and observations of lesson presentation.

A case study deals with a small group of selected participants from whom the data was collected about their own experiences and behaviour, and then interpreted in detail. The pedagogical practices used by different educators were then described in detail. This study was embedded in an interpretive paradigm based on individual experiences and behaviour observed. The researcher’s own interpretation of the data becomes very crucial to come to factual conclusion/s that could solve the research problem identified in this research.

3.3 METHODS OF DATA COLLECTION

Data collection is the most crucial process that researchers embark on during a research study and forms the foundation of the success of any research study. There are tools that could be used to collect data required for the study as there are numerous phases in the process of collecting data as indicated by Creswell (2007). The activities identified include amongst others locating the site and participants, gaining access, purposeful sampling, collecting data, recording data, resolving field issues and storing data.

Due to the outbreak of Corona Virus Disease of 2019 (COVID-19), there are certain rules and regulations that must be adhered to at schools including and not limited to the control of people visiting the schools to safeguard the health and safety of the learners and all other stakeholders.
All necessary requirements, wearing of masks, maintaining social distancing, washing hands regularly with soap and water or using a sanitiser and other individual school control measures put in place must be implemented without failure for the benefit of the learners and entire population when data are collected at the two selected schools, whilst engaging with participants.

In this study I had to gain trust of the selected participants by ensuring that all misconceptions are cleared regarding the participation in the whole process. Participants were given the reassurance that they will remain anonymous and data collected would not be used to jeopardise their work or the image of their institution. The participants were conveniently selected due to their geographical proximity to the researcher, although variation was fully exercised to ensure that more relevant data are collected. All data collected during the process will be recorded and kept safe for data analysis.

3.4 RESEARCH INSTRUMENTS

In this study, a questionnaire and observation were considered to be appropriate as data collection tools.

3.4.1 Questionnaire

McMillan and Schumacher (2010) define questionnaires as tools used to gather data and consist of written questions that need to be responded to in a specific manner detailed by the researcher. Questionnaires cover a substantial amount of information that measure diverse criteria (Dlamini, 2008) and can be filled at a time convenient to the participants. Questionnaires have many advantages and are outlined below:

- Confidentiality and anonymity are highly guaranteed (Muijs, 2004);
- It covers a wide range of issues;
- It could be used to collect thick rich data within a short period of time (Vogt, 2007);
- Cost effectiveness is key as it will be delivered directly to the respondents who are within the geographical proximity with the researcher; and
- Participants could complete the questionnaire at their own convenient time, awarding
them the opportunity to think carefully about their responses.

There are two types of questionnaires, namely, open-ended and closed-ended that can be used in any research project. Open-ended questionnaires are more relevant in qualitative research whilst quantitative research mostly uses closed-ended questionnaires (Dawson, 2002). Closed-ended questionnaires follow a format wherein there are prescribed options as answers to choose from and are already included on the questionnaire (Pathak, 2008).

In this study, selected participants were required to respond to questions on teachers’ PCK and pedagogical practices they use in the Grade 7 Science classroom. There are multiple pedagogical practices that teachers could use in a learning and teaching situation to construct knowledge successfully for the learners. So, based on the latter statement, this study adopted the open-ended questionnaire. Open-ended questionnaires give the participants in the research the opportunity to express themselves freely and formulate their responses accordingly as they wish. The most important thing in an open-ended questionnaire is to formulate questions in such a way that they are easily interpreted by the participants.

The questionnaire consists of two parts, Section A and Section B that deals with biographical information and views on pedagogical practices in Science teaching. The questionnaire is attached as Appendix B. The first part of the questionnaire background information required from each participant includes:

- The participant’s gender;
- The participant’s age;
- Their experience in teaching (in years);
- Their highest qualification;
- Their workload per week; and
- The number of learners in their Natural Sciences classroom.

Then the second part of the questionnaire comprised of nine questions that sought to answer the research questions and are as follows:

- General understanding of science as a subject and the way science is taught;
• Teachers’ knowledge of IKS;
• The teachers’ methodology in the learning and teaching situation;
• Preservation of nature;
• Knowledge of science process skills in the classroom;
• Inquiry process skill knowledge for learners; and
• Knowledge of conducting experiments.

3.4.2 Observation

Observation of the lesson presentation was done. Observing is a unique skill that intends to deal with issues of deception that could occur when participants are interviewed, requested to fill up questionnaires and are uniquely designed by the researcher as an outsider as outlined by Hammersley and Atkinson (1995) cited in Creswell (2007). Observation is a very crucial management tool that could be utilised to verify the authenticity of the information gathered and again to gather thick rich information from participants.

This research study took place during a period where the world was faced with a pandemic. An outbreak of Corona Virus Disease of 2019 (Covid-19) during the first academic term of South African schooling calendar led to an abrupt closure of schools during March 2020. The South African government declared the outbreak a national state of disaster that led to the national lockdown. Schools were then re-opened using the phasing-in method that allowed certain grades to open whilst other grades remained closed. Stringent rules and regulations were put in place to safeguard the lives of the learners and all other stakeholders at schools. Provision of proper personal protective equipment for all public schools was prioritised. Schools were urged to comply with health protocols to curb the spread of covid-19 before any learning and teaching took place.

The researcher gathered field notes which would later be interpreted and put in the study report. There are several ways of getting the data collected for the study. Creswell (2007) indicates that data could be collected by conducting an observation on a participant as an observer or rather spending time with the participant being an insider and outsider. An insider is a person conducting research in their own settings whilst a researcher is regarded as an outsider when research is conducted in a different setting, not in the personal workplace. A series of events
unfolded as the process carried become dependent on the site and the role of the researcher. Proper recording of information is of utmost importance, so both descriptive and reflective notes were used. It is of the utmost importance to record aspects such as descriptions of participants, physical setting, precise events or activities, and own reactions (Bogdan & Biklen, 1992).

In this study two participants were observed presenting lessons to assess the level of consistency between teachers’ Science knowledge and teaching practices. In order to substantiate data, researchers have to realise any divergences between what is said and the actual actions observed (McMillan & Schumacher, 2006). The field notes and a digital voice recorder were used to gather and record data to deal with any discrepancies that may surface in the study (see Appendix D).

To eliminate any discomfort on the participant, a pre-observation interview was conducted to get information on how the teacher had planned to approach the lesson. The questions were asked in such a way that they did not cause any instability in the teacher’s confidence to present the lesson as planned. So, there must not be any room of ambiguity in what the researcher needed to achieve. The questions had to be very simple to answer and were straightforward, like responding to the question on which topic would be taught and how it would be taught.

All activities during the lesson presentation had to be carefully observed and field notes were taken although a digital recorder was utilised to record the voices as permitted by the participant. The voice recorder had to be functional and fully charged to avoid any disappointment that might arise. The emphasis was on the observation and the responses to questions as dated on the questionnaire to make a fair and just comparison on the information completed on the questionnaire and the lesson presentation.

A post observation informal session was held to ascertain the level of contentment or discontent and to ascertain whether the teacher was efficient or not. I paid much interest to the lesson presentation from the observed teachers. A what-went-well or wrong (www) process was conducted during the post observation interview, which serves as a post-mortem to find out what went well (www) or what went wrong (www) during the lesson presentation in the classroom. This was only done to find out if there was something that the teacher could have done differently in the planning of the lesson that was presented in order to achieve better
3.5 SAMPLING METHODS

Sampling is defined by Merriam (2002) as a choice of a research setting, people, events and time in study. Taheerdoost (2016) defines people in the research study as a population or entire set of cases from which research sample was drawn. Although there were multiple sampling methods in research, this study adopted convenience sampling due to geographical proximity of schools in Moroke Circuit. Convenience sampling is a type of non-probability or non-random sampling wherein individuals of target population meet a certain criteria, such as geographical proximity, availability at a given time, or the willingness to participate in the study (Etikan et al., 2016).

Sampling strategies used are critical cases, which offer explicit information about a problem. Convenience cases in sampling strategies represent sites or persons from which the researcher can gain entrance and easily gather data (Creswell, 2007). Creswell (2007) further indicates that population size is a similarly significant judgment to sampling strategy in data collection process in qualitative research that allows the researcher not only to study a few sites or individuals, but also to gather extensive detail about each location or individual studied.

My population in this study included all teachers from primary schools in Moroke Circuit, although just a limited number of participants were used (Creswell, 2013). An only sample of two teachers from two primary schools in Moroke Circuit were made with specific reference to teaching Natural Sciences in Grade 7. The schools selected were within my geographical area so that it becomes easier and inexpensive to access the target population.

Alvi (2016) highlights that it is difficult to evaluate every element of a population on the basis that information can be obtained from selected people and inferences be drawn for the entire population. Sampling bias occurs when selected sample does not truly represent characteristics of the entire population triggering the researcher’s subjective judgment. Sampling does not need to be random or representative, but a clear rationale is necessary to contain certain entities in the research sample.
3.6 DATA ANALYSIS

Data analysis in qualitative research consists of arranging and consolidating data, thus text information as in transcripts, or image data as in photographs for analysis, then forming themes from the data using coding, and subsequently demonstrating the data in figures, tables, or a discussion (Creswell, 2007). Researchers engage in interpreting data when they conduct qualitative research. Lincoln and Guba (1985) further eluded that interpretation of data involves formulating logic of data collected and knowledge constructed.

Differentiated ways on interpreting data exist to enable researchers to present data using the method fit for the study conducted. Huberman and Miles (1994), use more comprehensive phases in the process including writing marginal notes, drafting field notes, and noting interactions among the groupings. However, critical or feminist theoretical perspectives could be undertaken as outlined by Madison (2005). On the other hand, Wolcott (1994b) shows the importance describing the data in relation to literature, cultural themes and the value of culture.

Data analysis is the procedure of systematically searching and arranging interview transcripts, field-notes, questionnaires’ responses and any other materials gathered in the field to increase understanding and be able to present findings to others. Creswell (2013) argues that there is no precise technique to be followed when reporting data in a case study report. For this study the thematic analysis was used to analyse and report themes within data collected from the questionnaires and field notes during observations of lesson presentation (De Vos, Strydom, Fouche, & Delport, 2011). Thematic analysis simply organises and describes collected data in detail, further more it even interprets various aspects of the research topic (Braun & Clarke, 2006).

The theme is the main product of data analysis that creates practical results in the field of study (Vaismoradi et al., 2016). The definition, similarities and differences of qualitative content and thematic analysis were defined. According to Vaismoradi et al.’s study (2013), many similarities between qualitative content analysis and thematic analysis exist, for instance, cutting across data, philosophical background, attention to both description and interpretation in data analysis, consideration of the context of data and searching for themes. A theme captures something crucial about data in relation to the research question and represents some
level of patterned response or meaning within the data set (Braun & Clarke, 2006). The researcher must be creative when presenting the data by forming a story line.

The process is descriptive in nature as it requires the researcher to describe in detail what happened and thereafter summarise the events as they unfold. Creswell (2010) indicates that qualitative data analysis is an ongoing and interactive process as data collection, processing, analysing and reporting are linked. The recorded data were listened to carefully and analysed properly reflecting on the observations made during the lesson presentations. The usage of the audio recorder affords the researcher the opportunity to concentrate on all aspects during the lesson presentation as lesson note-taking continues.

The completed questionnaires were compared with what was done during the lesson presentation observation. At times it happened that what participants responded was not really what happened and I had to transcribe the data. The data analysis process included organising data by breaking these up into manageable units, synthesising data, searching for patterns in the data analysed and discovering what is vital to decide what to report to others.

Transcription of collected data will be afforded the appropriate level of detail and accuracy. This requires a thorough, inclusive and comprehensive coding where all data were given equal attention. All relevant extracts for each theme had to be collated and then themes were checked against each other and the original data set. Themes surfaced as being internally clear, consistent and distinctive. The data analysed was interpreted, paraphrased or described.

### 3.7 METHODOLOGY

The researcher wrote a letter to the District Director: Sekhukhune East Department of Education requesting permission to conduct research at two selected schools. Upon receiving approval from the department, pilot testing was conducted at other schools to increase validity, credibility and practicality of the questionnaire as indicated by Cohen, Manion and Morrison (2000). The questionnaire was distributed to the Grade 7 teachers at other schools not targeted as participants to complete during their convenient time not to disrupt their academic activities during operational hours. All the rules and regulations were in place to deal with the COVID-19 pandemic and to adhere to in all the interactions within the schools. Prior arrangements were made to ensure that I was fully compliant with them.
This pilot study was conducted to verify validity of the questionnaire, eliminate ambiguity and get feedback on the appropriateness of the questions (McMillan & Schumacher, 2001). During the completion of the questionnaire the researcher closely observed if the teachers experienced any level of difficulty in answering the questions and later asked individuals if any problems were encountered in filling in the questionnaire. This exercise resulted in the rephrasing of the questions, addition of more questions and then correction of grammar.

The questionnaire was subsequently submitted to the ethics team at the University of South Africa (UNISA) for approval. After the questionnaire was approved, the researcher met with the principals of the schools to arrange for the time to meet the participants. The schools’ timetable was studied carefully in order to ensure that no disruptions of periods occurred during completion of the questionnaire and lesson observation. The questionnaire was then duplicated and distributed to the participating teachers at the targeted schools. The questionnaires had to be answered in the presence of the researcher to clarify any questions and ensure that all questionnaires were collected from participants.

The duration to complete the questionnaire was not more than an hour. The participants were informed of the date for the lesson observation centred on the participants’ earliest convenient time. Data from the questionnaires and lesson observations were examined individually and then intertwined during the discussion of results.

### 3.8 ISSUES OF RELIABILITY AND VALIDITY

Validity and reliability in research ensure that the researcher and the participants understand each other in a way that appropriate data will be presented (McMillan & Schumacher, 2010). To establish the "trustworthiness" of a study, Lincoln and Guba (1985) use distinctive terms, such as credibility, transferability, dependability and conformability, as compared to the naturalist's internal validation, external validation, reliability and objectivity.

Thick description of data is of utmost importance to ensure that findings are transferrable to other research studies in future. Instead of reliability, this research sought dependability ensuring that the findings were subject to modification and instability. The naturalistic
researcher relies more to conformability rather than objectivity in establishing the value of the data (Creswell, 2007). Both dependability and conformability could be established through reviewing the research process.

3.8.1 Member-checks

This technique is considered by Lincoln and Guba (1985) to be the most critical method for instituting credibility. Member-checking involves checking data, analyses, interpretations, and conclusions and confirming these with the participants giving them an opportunity to judge accuracy and credibility of the interpretation. According to Stake (1995), participants should play a key role directing case study research.

According to Lincoln and Guba (1985) the use of member-checking is a crucial technique for establishing credibility in qualitative research. The usage of this technique involves returning transcribed scripts from the individual observation protocol to participants to confirm that they are true reflections of their views. After every session in the study process that involves data collection, the researcher had to contact participants to validate the information captured. In instances where the researcher is unable to have face-to-face contact session with the participants, participants were called for verification of data kept on record.

Lincoln and Guba (1985) and Merriam (1988) indicate that continued engagement and tenacious observation in the field, building trust with participants, understanding the participants’ situation, and checking for misrepresentation of data curtail predispositions introduced by the researcher or participants. Decisions must be made about what is significant to the study, appropriate to the purpose of the study, and things of importance for focus (Creswell, 2007).

3.8.2 Piloting

I had to adapt my approach to suit the context of this research study prior the actual process. Furthermore, the adapted questionnaire was piloted and tested with teachers at other schools not selected as participants teaching Natural Sciences in Grade 7 and necessary changes were made before administering it to the study sample. This activity is embarked on to adapt clearer and user-friendly questions that could assist in collecting thick rich data to the study.
3.8.3 Triangulation

“Triangulation may be defined as the use of two or more methods to collect data” (Cohen, Manion & Morrison, 2011). Creswell and Miller (2010) view triangulation as a validating procedure to achieve integration among diverse sources of evidence to form themes or categories in a study. It is further illustrated that the greater the number of viewpoints on the same issue, the greater the chance of its validation.

In this study, multiple data sources, thus open-ended questionnaires and lesson observations were used. Multiple sources were utilised to triangulate qualitative information and better understand the development processes. Reliability and validity were ensured in the research by structuring the questions in an unambiguous manner and in the language that participants understood (McMillan & Schumacher, 2010:331). This meant the questionnaire was designed, then checked by different individuals to validate the credibility of the questions.

3.8.4 Self-reflection

Self-reflection contributes positively to the validation of the research study. The researcher interrelates with the events to co-create the reflections derived. Reviewing the previous literature assisted in validation of the study. Diverse interpretations by others were recognised to judge the trustworthiness of the findings concluded upon.

3.8.5 Debriefing

Debriefing gives provision for verification of the research process (Merriam, 1988). Lincoln and Guba (1985) further elaborate that debriefing needs not be a witch-hunting session, but an honest technique executed for the researcher to follow reliable procedures in conducting the study. The later statement will afford the researcher a chance to express feelings related to the research process, to create a conducive environment for the teacher to present the lesson successfully and sharing of scientific information. Other individuals’ views are crucial in the study for transferability in future similar contexts (Creswell, 2009).
3.9 ETHICAL CONSIDERATIONS

According to McMillan and Schumacher (2010) it is paramount to abide by the research ethics when conducting research that is deemed credible. Permission from relevant individuals must be granted in order to play a role in the study. Credible research is conducted with permission from the participants that their privacy and confidentiality are ensured and well-being is taken care of (Wallen & Fraenkel, 2011). Hence, the UNISA College of the Education Ethics Review Committee granted me permission to collect data since my research ethics had been approved. Permission to conduct the research from two primary schools was obtained from the District Director in Sekhukhune East District in Limpopo Department of Education (LDE) (permission letter is attached as Appendix J).

The governance structures, thus the school principals and the Schools’ Governing Body (SGB) allowed me to collect data from the schools. They were approached and the purpose of the study was clarified to them; then a consent form (see Appendix D) was provided so that they could sign it. Pseudonyms and coding were used to avoid disclosing participants’ identities and their schools.

The researcher observed the ethical guidelines for the University of South Africa (UNISA), as well as the DoE’s prerequisites for conducting research in public schools more especially during the COVID-19 outbreak. The research proposal and its tools were submitted for ethical clearance committee at UNISA and permission to conduct research was granted. I will solely abide by necessary security measures detailed on the approval letter for health protocols under new normal situation and for storing raw data collected from the participants.

3.10 CONCLUSION

This chapter explicitly focused on the research design and methodology followed conducting this study. A detailed explanation of the research design and collection instruments utilised was done. The techniques used in data collection and how the data was gathered were analysed and were qualitatively discussed. The chapter further dealt with the question of trustworthiness where validity and reliability of the study were ensured. The ethical considerations for the
collection of data were explicitly explained. The next chapter will discuss the presentation of data, analysis of the findings and conclusions derived from the collected data.
CHAPTER 4
DATA PRESENTATION, ANALYSIS AND FINDINGS ON THE PEDAGOGICAL
PRACTICES ON TEACHING GRADE 7 SCIENCE

4.1 INTRODUCTION
This section presents findings of the data presented and analysed which were centred on the following research questions:

- What pedagogical practices do teachers in a Science classroom use?

The sub-questions for this research study were:

- What is the influence of the Science process skills on teachers’ approaches to planning for their teaching?
- How does processing skills influence the construction of scientific knowledge in Science?

The background results of the targeted population will be presented to avoid clearly understand the investigated data collected from them in response to the pedagogical practices used in the classroom situation. The biographical data collected added value to the discussion of results and contributed to interpretation of observations made during the research study. Pseudonyms were used to protect the identity of the two participants as M1 and M2.

One could attest to the fact that the research was done during difficult times of the outbreak of Covid-19 wherein schools had strict health and safety measures in place to protect the learners from getting infected with the virus. The curriculum was trimmed to compensate for the lost time during lockdown and instructions were issued on how to deal with different topics per subject.

The responses were contained in the teachers’ questionnaires, and from the lesson-observation in the classrooms where teaching and learning occur. In this chapter results of the investigation
in respect of two teachers who participated in the investigation will be presented and discussed. As indicated by Fithriyyati et al. (2018) the data collection techniques were non-test methods, but embraced the combination of observation practices, and questionnaires.

The investigation made use of only three data collection instruments, thus observation sheets, questionnaire sheets and a checklists were included. Observation sheets were used to determine the conformability of the implementation of teaching and learning plans as organised and designed by the teacher. A questionnaire sheet was an instrument including the perceptions of Science teachers about pedagogical practices used and probed the influence of process skills in the Science classroom. The document checklist was utilised primarily to find out the pedagogical method used, availability of resources to enhance teaching and learning and other related issues that could have an impact on the construction of knowledge in a science classroom. Data presentation will be done in two sections, thus section A for the questionnaires and section B for the lesson observations; then the qualitative findings.

4.2. DISCUSSION OF THE DATA COLLECTED

From data collected utilising the questionnaire, it was evident that primary school teaching was dominated by female teachers. The two targeted schools proved to have female teachers offering Natural Sciences in Grade 7.

4.2.1 Questionnaire

There are three sections, thus Section A, B and C in the questionnaire that deal with biographical information, school profiles and views on pedagogical practices in Science respectively. The two questionnaires were distributed to Grade 7 Natural Sciences teachers at two conveniently selected schools in Moroke Circuit. Both School A and School B had one Natural Sciences teacher for Grade 7. All the questionnaires were returned and that made it possible for the researcher to get a 100% return rate on the completed questionnaires although not all questions were answered. The participants were not forced to answer the questions they were uncomfortable to respond to as this would be against the ethical considerations stated on the research study. The questionnaire is attached as Appendix H.
Section A of the questionnaire background information required from each participant was done to ascertain the impact of their profile in education in a learning and teaching environment. It included the following:

- The participant’s gender;
- The participant’s age;
- Their teaching experience in years;
- The highest qualification they possess;
- The subjects of specialisation;
- The subjects they teach at school;
- Their workload per week; and
- The number of learners in Grade 7 Natural Sciences classroom.

Participant M1 from School A is a 57 year-old female teacher who has been teaching for about twenty-five (25) years. She has a Senior Primary Teacher’s Diploma (SPTD) qualification with specialisation in Sepedi Home Language (SEPHL), English First Additional Language (ENGFAL), Biology and Biblical Studies. She has quite an extensive list of subjects allocated specifically to her and they include Sepedi, English, Social Sciences, Natural Sciences and Technology, Natural Sciences, Technology and Creative Arts. The number of learners ranges from 24 to 30 per grade. She works an average of 31 hours a week.

Participant M2 from School B is a thirty (30) year-old female teacher in possession of Bachelor of Technology (BTech) in Engineering with just one year’s teaching experience. She specialised in Mathematics and is currently offering the following subjects in different grades: Natural Sciences, Natural Sciences and Technology, and Mathematics. It was indicated that the number of learners in each grade ranges between 18 and 23 with a Grade 7 class having 21 learners, and 24 learners in the Grade 7 Natural Sciences classroom. Averagely, she offers lessons for 34 hours a week.

It is evident that both schools had a reasonable number of learners in the grades to allow teachers to provide special attention to each learner during the lesson presentation. The numbers in the classrooms during lesson presentation were not according to the precautionary
measures put in place for the health and safety regulations at schools for learners during the outbreak of COVID-19.

The second part, Section B of the questionnaire deals with the school profile which outlines the resources and infrastructure in place. The questions deal with the following:

- The total number of the classrooms;
- Total number of learners;
- Total number of teachers;
- Availability of a staff room;
- Provision of electricity;
- Access to internet; and
- Availability of a science laboratory with Science apparatus.

Then the last part, Section C of the questionnaire comprises of views on pedagogical practices in Science of ten questions that sought to answer the research questions and were as follows:

- General understanding of science as a subject and the way it is taught;
- Critical information on Scientific Knowledge System (SKS);
- Teachers’ knowledge of the Indigenous Knowledge System (IKS);
- The teachers’ methodology in the learning and teaching situation;
- Preservation of nature;
- Knowledge of Science process skills in the classroom;
- Inquiry process skill knowledge for learners;
- Knowledge of conducting experiments; and
- An overview of the CAPS document for Natural Sciences.

4.2.2 Conducive Teaching and Learning Environment (C-TLE)

4.2.2.1 Human resources

Both School A and School B could be regarded as small schools as their learner enrolment included 211 and 164 learners respectively. They (the schools) qualify for a Head of Department (HOD) post number 6 and has no deputy principal.
4.2.2.2 Resources

A normal functioning primary school comprises of eight grades, thus grade R to 7. As per data collected, School A has at least 6 classrooms and an office whereas School B has seven (7) classrooms and an office. The later statement clearly indicates that there is a shortage of classrooms at both schools. Furthermore, there is no staff room and laboratory. According to Maharajh et al (2017) appropriate resources are required at schools to ensure efficient and effective implementation of curriculum implementation. Electricity is supplied at school and no provision of access to Internet or Wi-Fi at the school premises. Could be detected.

4.2.3 Pedagogical Content Knowledge (PCK)

This section investigated the diverse methods and ways of teaching utilised by teachers to construct knowledge in a science classroom situation. Teachers do not use the same methods of teaching as they are exposed to learners with diverse capabilities. This further requires them to be versatile in ensuring that they cater for all the learners in a classroom to enable them to accumulate knowledge.

4.2.4 Knowledge of Science

According to M1, a Scientific Knowledge System (SKS) includes but is not limited to changing liquid into gas. Thus, when boiling water, water evaporates in the form of vapour. According M2, SKS aims to build knowledge about the world. M2 strongly believed that it brings meaningful knowledge, and the knowledge is tested so that it can be proven to be reliable. A practical example given is the transfer of heat using radiation wherein the sun heats the atmosphere using electro-magnetic waves.

M2 explained Science as the study of what happens around our world and why that happens. Fithriyyati et al. (2018) agree that Science is a discipline that is closely associated with everyday life and comprises several natural phenomena in the research conducted. M1 from School A explained science as the study of chemistry, plants and animals.
4.2.5 Inquiry investigations

M1 indicated that the topic dictates how Science is taught but further illustrated that it encompasses more practical work. M2 believed that Science is not taught the same way as other subjects as by its nature it is experimental and is learned best by performing experiments to prove the theories in Science.

4.2.6 Conservation

It is believed by M1 that plants, animals, and other places of interest should be preserved for the future generation. M2 maintained that IKS contributes to modern Science and technology. Preservation of nature will enhance lifelong meaningful education to the future generation. Living organisms need to be able to reproduce so that they will always be available to the future generation. Management of the available resources is necessary.

4.2.7 Usage of prior knowledge to construct new knowledge

The moral values and customs of the community must be incorporated in a classroom situation to allow learners to engage actively in a lesson where their cultural knowledge forms the basis of scientific knowledge to be learned and taught in the classroom was not explained. IKS has an impact on society as the plants and animals that are endemic are used to cure different ailments in those specific areas.

4.2.8 Learning through inquiry

As outlined by M1 practical activities include experiments and investigations. Experiments are performed in the classroom to help learners to understand the work easily as learners will be using the method outlined in the activity to do the practical work with or without the assistance of science teacher. Science teachers must always supervise learners in the laboratory when
performing experiments for health and safety reasons. M2 strongly believed that allowing learners to perform experiments and prove scientific theories can incorporate scientific process skills as they will be observing and recording the changes during the process.

Practical activities entail learning through observation and that motivate learners to actively be involved in the lesson as they will discuss all the changes happening in the investigation they perform. Learners must focus throughout the lesson as they must report on all the changes that happened whilst performing the experiment. Investigations allow learners to be creative and innovative, and to further experience first-hand information of what the topic entails.

4.2.9 Usage of process skills

Practical work, thus experiments and investigations, could enable teachers to use the Science process skills practically in the classroom during the lesson presentation. This could ensure that the learners become knowledgeable on what steps to follow to present a scientific report that includes the science process skills.

4.2.10 Evolution of scientific theory

Scientists too perform experiments to acquire more knowledge and skills, and further their understanding of Science by proving their own theories and those of others. Scientists rely on factual information that has been proven in the laboratories.

4.2.11 CAPS document

M2 outlined that CAPS document serves a guideline on what learners need to know and understand and is more concerned with content coverage. It is not user-friendly to learners and teachers as it does not encourage them to be critical thinkers. CAPS typically brings about significant changes on methods of assessments, contact time between teachers and learners in
the classroom and new teaching approaches. The unprecedented trimming of the curriculum permits educators to disregard most of the information in the policy document as schools do not operate using the same schooling models. A modification on curriculum therefore necessitates change on the role played by teachers at schools (van der Nest, 2012).

4.3 LESSON OBSERVATION

Two educators who were conveniently selected as target population and had to be observed presenting lessons. In a Science classroom, diverse pedagogical practices used during the lesson presentation are incorporated for the construction of knowledge. The knowledge of learners is influenced by how teachers teach science in the classroom. The selection of pedagogical practices used by teachers to construct knowledge also affects the interest of learners to understand the subject matter.

Learners learn best and participate actively when practical activities are performed and scientific facts or knowledge in the textbooks are proven performing investigations using scientific apparatus. Primary school learners need to be able to identify common Science apparatus in a Science laboratory. The safety precautions in a Science laboratory that must be followed are crucial to ensure that learners are always safe and not expose them to danger when handling apparatus. Science process skills become very handy when performing experiments.

Table 4.1: Checklist for M1 lesson observation at School A

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Y/N</th>
<th>Tallies (Frequency)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lesson plan</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>1.1</td>
<td>Topic to be presented</td>
<td>Y</td>
<td>1</td>
<td>The main title – solar energy and life on Earth. Multiple topics were presented to the learners. Solar energy and life on Earth and water cycle were covered.</td>
</tr>
<tr>
<td>1.2</td>
<td>Duration</td>
<td></td>
<td>30 minutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| 1.3 | Method of teaching | Y | Lecture method  
Question and answer method |
| 1.4 | Teaching aids | Y | 2  
3 | Textbook  
Chalkboard |
| 1.5 | Reflection | N | Learners are not corrected for making mistakes. |
| 2. | Medium of instruction |   | English |
| 2.1 | Language used by the teacher | Y | Both English and Sepedi |
| 2.2 | The use of native language | Y | 3 | The teacher explained some concepts in Sepedi. |
| 3. | Scientific concepts | Y | Not all concepts were explained e.g. water cycle |
| 3.1 | Explanation of concepts | Y | The teacher never explains how concepts are defined – important facts in a scientific explanation of terms are neglected. |
| 3.2 | Misconceptions by the teacher | Y | 4 | The teacher has certain misconceptions. |
| 4. | Science process skills | Y | The teacher used pictures to illustrate the water cycle. |
| 4.1 | Practical activity | N | No practical activity was performed in class.  
Learners were not shown the steam from the boiling water though the process was explained to them. |
| 5. | Involvement of learners in the lesson presentation | Y | 3 | Learners were actively involved during the lesson. The teacher encouraged participation by asking any of the learners to respond the questions posed. |
| 5.1 | Do learners ask questions or given an opportunity to ask?  
How many times? | N | Learners were not given opportunities to ask questions. |
| 5.2 | Do learners answer the questions correctly? | Y | 34 | The teacher gave an opportunity to learners to correct each other before intervening. |
| 6. | Assessment |   |   |
6.1. Are learners asked if they understood?  N  Learners were not asked if they understood.
6.2. Are learners assessed informally to ascertain if they understood?  N  No activity was given to the learners.

Table 4.2: Checklist for M2 at School B

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Y/N</th>
<th>Tally (Frequency)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lesson plan</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>1.1.</td>
<td>Topic to be presented</td>
<td>Y</td>
<td></td>
<td>Recap about the previous lesson was done. The topic for the lesson was heat transfer.</td>
</tr>
<tr>
<td>1.2.</td>
<td>Duration</td>
<td>Y</td>
<td></td>
<td>1 hour</td>
</tr>
<tr>
<td>1.3.</td>
<td>Method of teaching</td>
<td>Y</td>
<td>3</td>
<td>Lecture method Question and answer Discussion</td>
</tr>
<tr>
<td>1.4.</td>
<td>Teaching aids</td>
<td>Y</td>
<td></td>
<td>Textbook only for the teacher, and learners did not have any textbook.</td>
</tr>
<tr>
<td>1.5.</td>
<td>Reflection</td>
<td>Y</td>
<td></td>
<td>Notes were written on the chalkboard for the learners.</td>
</tr>
<tr>
<td>2.</td>
<td>Medium of instruction</td>
<td>Y</td>
<td></td>
<td>English</td>
</tr>
<tr>
<td>2.1.</td>
<td>Language used by the teacher</td>
<td>Y</td>
<td>2</td>
<td>English and Sepedi</td>
</tr>
<tr>
<td>2.2.</td>
<td>The use of native language</td>
<td>Y</td>
<td>25</td>
<td>The teacher used the native language more often than the teaching and learning language.</td>
</tr>
<tr>
<td>3.</td>
<td>Scientific concepts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.</td>
<td>Explanation of concepts</td>
<td>Y</td>
<td></td>
<td>Factual information to look up for in a definition of a concept.</td>
</tr>
<tr>
<td>3.2.</td>
<td>Misconceptions by the teacher</td>
<td>N</td>
<td></td>
<td>The teacher was more knowledgeable and could give learners more practical examples in constructing knowledge</td>
</tr>
<tr>
<td>4.</td>
<td>Science process skills</td>
<td>Y</td>
<td>8</td>
<td>Taught but the steps not identified.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Boiling water;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Sitting around the fire;</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>---</td>
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<td></td>
</tr>
</tbody>
</table>

- Drying yourself with a towel not plastic; and
- Having a braai using sausage roll, chicken and red meat.

### 4.1. Practical activity

**Just an explanation of the processes:**
- Conduction;
- Radiation;
- Convection; and
- Absorption.

### 5. Involvement of learners in the lesson presentation

**Y 3**

Learners were given a chance to think critically and come up with answers. All learners were actively taking notes during the lesson and the teacher always confirmed if they are taking notes.

#### 5.1. Do learners ask questions or given an opportunity to ask? How many times?

**Y 1**

The learners were asked to establish the answer to the following question: What really happens for water in a kettle to boil?

#### 5.2. Do learners answer the questions correctly?

**Y 14**

Learners easily responded to the questions and at times they were even able to engage in constructive discussions.

### 6. Assessment

**Y**

Two informal assessments

#### 6.1. Are learners asked if they understood?

**Y 4**

Learners were asked whether they followed what was going on.

#### 6.2. Are learners assessed informally to ascertain if they understood? Classwork/ Homework

**Y 2**

Classwork – definition of concepts

Define the following terms:
- Conduction;
- Convection;
- Radiation;
- Insulator; and
- Conductor.

A project (practical activity)

- Take two plastic bottles;
- Cover one bottle with a white cloth and the other with a dark colour (preferably a black cloth);
- Place them where they are exposed to the sun; and
Then after some time feel the cloth.

Both activities were given a timeline to finish.

4.4 RESEARCH QUESTIONS ANSWERED

The research questions are answered next.

What pedagogical practices do teachers use in a Science classroom?

This research question was answered during the lesson presentation when teachers used diverse pedagogical practices to cater for the individuality of the learners in the construction of knowledge. The inclusion of an indigenous knowledge system, thus the moral values of the society were incorporated in the lesson presentation to enable active participation of learners in the lesson. Rapini et al. (2018) clearly state that the efficacy of lesson planning is evaluated from the learning outcome on critical thinking skills, teachers’ activities, and students’ activities amongst other things. It was just so unfortunate that the process skills were discussed theoretically, and that created a limitation in learners becoming critical thinkers who can reason logically based on information observed during experimentation.

Learners were clouded with more information within a short period of time. Lessons that were supposed to take place at least three to five days, were presented within an hour. The pressure brought about by the outbreak of the pandemic and completion of prioritised topics to be treated due to trimmed curriculum could have been the reason for the rush through the topics.

The non-usage of the inquiry method in the presentation could have been due to a lack of the necessary resources. The teachers need to be creative by utilising innovative resources in place of the real scientific resources found in a science laboratory. An inquiry method is the unique pedagogical practice that distinguishes Science from other subjects as it involves learning through practice. This kind of method enhances the memory of learners to recall facts during assessment periods.
What is the influence of Science processing skills on teachers’ approaches to planning for their teaching?

The teachers failed to plan their lesson properly in advance and that compromised the construction of scientific knowledge as process skills were not practically used during the lesson. The assessment given to the learners to do at home by M2 showed the importance of the inquiry method in teaching the learners Science processing skills. Learners will gain learning experience like scientists in investigating and finding natural phenomena, as well as their accompanying concepts (Maryani & Fatmawati, 2015). M1 utilised photographs or rather diagrammes from the textbook to illustrate the processes involved in her lesson presented on the water cycle. Although it is not performed by the teacher and learners in the classroom, procedurally it incorporates some process skills like observing, interpreting, and drawing a conclusion.

Non-supervision of learners in performing the experiment properly assisted by the teacher whenever they encounter challenges hinders the correct accumulation of these processing skills. Their inclusion in the assessment confirmed that Science cannot be taught the same way as other subjects as it requires investigation to confirm scientific facts. The inquiry method tries to link the learners with the construction of their own knowledge and furthermore advances learners’ participation and yields a significant learning (Blessinger & John, 2015). Conducting experiments in the laboratory creates a lifelong memory in the learners to remember all facts when they are assessed.

How do process skills influence the construction of scientific knowledge in Science?

Learners tend to increase their level of understanding when they observe processes whilst performing experiments. This could assist them in drawing up correct conclusions. Scientific process skills increase the level of understanding of Science processes and help learners to
reason constructively. The scaffolding of information allows learners to grasp the content easily and enables them to understand the scientific concepts easily.

The presentation of Natural Sciences lessons always requires the explanation of processes and that creates room for the process skills to be incorporated in the lesson plan even if there is a shortage of resources. Teachers tend to theoretically explain processes to the learners not exposing them to real practical activities but expecting them to recall the incidents as they are likely to have happened in their lifetime. Research done by Nkanyani et al. (2019) clearly indicates that teachers portrayed poor knowledge of the context on explicit aims and assessment strategies, further chose insufficient and extraneous instructional approaches. Teachers regard themselves as control figures in the classroom and therefore applied a dominantly teacher-centred approach without involving learners actively in the construction of their own knowledge.

M1 from School A used a diagramme presentation from the textbook to explain the water cycle and that aroused curiosity in the learners to understand the logical sequence of processes as they occur. It could have been more exciting if the practical demonstration of the processes using improvised materials was done in the classroom with the learners. Educators need to be skilled on how to develop their own resource materials; creation of classroom resources; and how to use project-based learning (Badugela, 2012) which promote co-operative learning amongst learners. Furthermore, Halverson (2007) argues that young learners are naturally curious and continuously discover all that is found around them. Science teaching should provide opportunity for learners to intensify their natural curiosity and expand their conceptual knowledge.

The curriculum for the primary school focusing on Natural Sciences involves more of what is happening in and around the world. It relates more likely to our everyday life activities and it could easily be taken for granted that every learner is knowledgeable about it. The aspects to be learned in Natural Sciences Grade 7 include Life and Living (LL), Matter and Materials (MM), Energy and Change (EC), and Planet Earth and Beyond (PEB) (DBE, 2011a). So, this implies that what is learned in class is not immune to what is done within our communities.
After a short discussion with learners about why which colour will be hotter when exposed to the sun and the motivation thereof, the teacher M2 failed to get the accurate response from the learners. The practical assessment given to them aroused curiosity in the learners to get the correct answer and showed intense excitement to perform it at home. The activity given to the learners is more appropriate and is backed up by Ripani et al. (2018) who clearly state that the learners need not be given the learning concepts openly, but they must actively to discover it by themselves. Research conducted by Fithriyyati et al. (2018) ratify that investigations in Sciences provide an environment to discover and pursue information in response to the inquisitiveness.

The teacher highlighted the fact that precautionary measures had to be followed in conducting experiments alone as there could be dire consequences. When required the learners must seek the assistance and supervision of the parents at home. Effective teachers are reflective in their practice, frequently aware of what is going on, and then regularly adjusting and adapting their teaching practice to ensure learner attainment in constructing knowledge correctly (Nkanyani et al., 2019). Effective teachers are innovative, risk takers and make decisions to enhance their performance and that of their learners.

4.5 SUMMARY OF FINDINGS OF LESSON PRESENTATION IN GRADE 7 NATURAL SCIENCES

Aspects pertaining to lesson presentation are shared next.

4.5.1. ASPECTS DISCOVERED DURING LESSON PRESENTATION

4.5.1.1 Teachers’ use of language

Teachers from both schools code-switched to their home language instead of using the LoLT as prescribed in the CAPS documents. LoLT is their second language (L2) and it emerged that the learners failed to participate fully whenever the teacher asked a question using English.
Throughout the lesson, M2 from School B kept on asking the learners using their home language, saying “le a kweshisha” meaning: Do you understand? And for the learners to understand, the teachers explained the subject matter in Sepedi for them to understand.

M1 from School A indicated, “… le di dirile ka ga Grade 4, ga ke na nako” and further said that it was revision. The lamentable part in both scenarios is that learners are assessed using English during the formal assessment and surely the teacher will not be available to explain the questions in Sepedi. Subsequently, learners will not be able to understand the questions and ultimately perform poor.

4.5.1.2 Use of practical activities and Science language

Science language is a bit different to the LoLT used in South African schools and teachers need to be able to be knowledgeable about it. The correct pronunciation of scientific terms and elaboration thereof will enable learners to fully comprehend them will improve their scientific knowledge system. Practical activities allow learners to construct scientific process skills which will positively enable learners to develop love and interest in science. According to Fithriyyati et al. (2018) learners can explore the natural activities found in everyday life through the scientific inquiry approach.

4.5.1.3 Learners’ involvement in the lesson

Teachers actively involved the learners during the lesson by frequently asking them questions. M1 constantly asked lower order and middle order questions that deprived the learners from engaging in a discussion as the questions included what sources of water are, mentioning the types of consumers and defining each of them. Taking into cognisance learner performance in South Africa (DBE, 2013 & 2014), questioning in assessing accumulated knowledge can be used as a monitoring tool whereby one evaluates learners’ thinking, experiences and shortfalls regarding construction of knowledge.
M2 allowed learners to engage in discussions that made them to incorporate their indigenous knowledge with what was learned in the classroom. This made the learners realise that Science as a subject is not a complicated subject but requires thorough understanding of processes and logical reasoning to support the facts. In the study done by Ngubane (2014), the use of lower order questions that requires specific answers by educators does not grant learners a chance to integrate and make sense of new knowledge to improve their understanding. Furthermore, there are other implications for school facilities such as laboratory, libraries as well as the number of learners in each classroom attached to it.

4.5.1.4 Use of Science concepts

New concepts were introduced by the teachers that learners had to learn. Practical examples were given to explain the scientific terms easily so that learners could relate to the concepts. As advocated by Subayani (2016) primary school teachers come from diverse backgrounds of high schools and professional education, but they must master different subjects that are necessary to be taught in primary school. A misconception was created by M1 during the lesson wherein she indicated that evaporation occurs as the sun heats the earth and the steam forms the water droplets that we call clouds. A misconception is a wrong idea, view or understanding which is different from the concept agreed upon or deemed correct by experts (Ibrahim, 2012). Misconceptions can be differences in beliefs held by individuals and consensus among scientists; it is a mistake to mention examples of concepts, errors to link between concepts, and immature understanding of concepts. The later statement is wrong as evaporation occurs when the sun heats water found on earth. Furthermore, as the water in the seas, ocean, and rivers, heats, it changes from liquid to gas (water vapour); then water vapour is released into the atmosphere where it is cold and vapour condenses to form clouds.

Primary understanding of science needs to be verified based on common comprehension of scientists so that errors in understanding the concept (misconception) do not occur (Subayani, 2016). The explanation of the water cycle had some gaps in scientific processes that occur. Yutina (2016) argues that the domination of construction of scientific knowledge could be
addressed and teacher’s dominance in the classroom could be reduced through the usage of inquiry method. The subject matter does not include only a system of facts, but consists of doctrines, regulations and techniques that are generally applied in pedagogical practices.

4.5.1.5 Learner assessment

At the end of the lesson, teachers must find out if their aims and objectives of the lesson are achieved by assessing knowledge of the learners on what was learned. The question and answer method that was used may not be enough to reflect on the lesson presentation as learners need to write. DBE (2011) states that learner assessment and their learning is fundamental to the teaching and learning process. However, the assessment approach, mostly the question- and-answer approach, common in many classrooms tends to be less effective for Science learning as compared to inquiry approach.

Bantwini (2017) believes that effective assessment should be carefully, thoughtfully, and intentionally planned to achieve its goal. Thus, there must be worksheets that provide details on what must be done. M1 never planned to give the learners any assessment, but presented the lesson using the question-and-answer method from the beginning of the lesson to the end. Teachers often rush through the syllabus whenever they are under much pressure and assess learners less often.

The contact time with learners lost during the level 1, 2 and 3 lockdown put a strain on the normal functioning of the teachers and that compromised the effectiveness and efficiency of constructing knowledge by the learners. Magano (2006) contends that changes in syllabus through adjustment in policy documents may lead to countless changes from the teachers in the approach used to teach and the way learners learn in the classroom.
The following tables represents the data collected:

**Table 4.3: M1’s Presentation**

<table>
<thead>
<tr>
<th>Duration</th>
<th>30 minutes (08h00-08h30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive notes</td>
<td>M1 started by indicating to the learners that the lesson for the day is just revision for what has been in Grade 4, 5 and 6.</td>
</tr>
<tr>
<td></td>
<td>The teacher started asking learners questions about the main source of energy on earth, how animals get energy, the different types of consumers i.e. herbivores, carnivores and omnivores.</td>
</tr>
<tr>
<td></td>
<td>Then the teacher indicated that water is needed by plants and animals to survive on earth. M1 started asking questions related to the water cycle.</td>
</tr>
<tr>
<td></td>
<td>The questions included:</td>
</tr>
<tr>
<td></td>
<td>• What are the water sources?</td>
</tr>
<tr>
<td></td>
<td>• Which planet does not have life on it? And why is it so?</td>
</tr>
<tr>
<td></td>
<td>The sun supports life – warmth to living organisms.</td>
</tr>
<tr>
<td></td>
<td>Planet without life – Jupiter (no oxygen, no water, no plants, no animals)</td>
</tr>
<tr>
<td></td>
<td><strong>Three stages of water</strong></td>
</tr>
<tr>
<td></td>
<td>Sources of water – well, dam, river, ocean, rain, lake, spring and sea.</td>
</tr>
<tr>
<td></td>
<td><strong>Water cycle</strong></td>
</tr>
<tr>
<td></td>
<td>The water cycle diagramme was drawn on the board and the learners were asked to identify different items and processes in the cycle. A further definition was given for each process that was identified.</td>
</tr>
<tr>
<td></td>
<td>• Evaporation was defined as the change of state of water (liquid) into water vapour (gas). An example was given as to when boiling water in a kettle and when it (water) boils, the steam is released.</td>
</tr>
<tr>
<td></td>
<td>The steam represents gas. Furthermore, it was mentioned that evaporation occurs as the sun heats the earth.</td>
</tr>
<tr>
<td></td>
<td>• The steam forms the water droplets that are called clouds.</td>
</tr>
<tr>
<td></td>
<td>• Then precipitation occurs when the rain falls, and water runs back to the sources of water e.g. sea and ocean.</td>
</tr>
<tr>
<td>Reflective notes</td>
<td>Learners were seated diagonally in pairs on a desk that is about two metres long. There was enough space for the teacher to move around desks to assist the learners. All learners wore masks and the sanitiser booth was just outside the door and another one at the teacher’s desk for washing hands.</td>
</tr>
<tr>
<td></td>
<td>All learners had textbooks in front of them for reference purposes.</td>
</tr>
<tr>
<td></td>
<td>The teacher indicated at several times that whatever was taught that day was just revision as it was dealt with in the previous grades.</td>
</tr>
<tr>
<td></td>
<td>The teacher often code-switched to give clarity to certain facts.</td>
</tr>
</tbody>
</table>
The use of the chalkboard created a challenge for the educator as the dust emanating from erasing some information to make space on the board left in the dusty classroom especially the front part of the classroom. The teacher failed to introduce the topic of the day to the learners and this showed lack of planning for the lesson presentation. Instead, the teacher rushed through several topics. More information was given to the learners over a short period of time. The teacher had to sanitise herself and often her hands seemed dirty of dust from the chalkboard. No assessment activity was given to the learners, instead the teacher asked the learners to take out their activity exercise book to do the corrections for homework. It was sometimes difficult for the teacher to hear what the learners’ responses were for the questions as their masks made it difficult for them to be audible. The learners assisted in writing the possible answers on the chalkboard. No social distancing was observed.

| Teaching method | Lecture method.  
|                | Question and answer method. |
| Scientific pedagogical practices | Theoretical presentation of the water cycle on the board thus a drawing showing the water cycle. |
| Type of scientific pedagogic practice | None. |

### Table 4.4: M2’s presentation

<table>
<thead>
<tr>
<th>Duration</th>
<th>One hour (12h40-13h40)</th>
</tr>
</thead>
</table>
| Descriptive notes | The teacher started asking the learners about what was done in the previous lesson.  
The teacher requested the learners to differentiate between a conductor and an insulator.  
  - A conductor is a material that conducts heat and electricity; and  
  - An insulator is a material that does not conduct heat and electricity.  
With reference to a pot on a stove, the teacher asked learners to explain why the pot is made from different materials. That led to a discussion as learners had different ideas:  
  - L1 (learner 1) responded that it is because they do not want to get burned; and |
L2 indicated that pot is made of steel and only the handles are plastic; steel is a conductor and plastic is an insulator. So, when the pot is cooking, heat will be transferred from the stove to the pot easily and the food cooks. Then after cooking, when you remove the food from the stove or check if the food is cooked, you use the handles made of plastic as it will not be hot.

The teacher asked whether the handles will not be heated. Most learners’ response was yes.

The teacher explained that the handles will be heated but were not hot as they could still touch it. It was further elaborated that the explanation for the insulator should clearly be stated as a material that does not conduct heat and electricity easily.

The topic of the day was introduced as heat transfers and the three methods of heat transfer were mentioned and explained as follows:

Conduction is heat transfer between solids and solids/solids and liquids/solids and gases. When water is heated in a kettle the hot water rises from the bottom i.e. near the metal element (a conductor) that is heated to make the water hot because hot water weighs less than cold water (conduction). The water is heated until it reaches the point where it boils (bubbles rotating in circular movement), creating convection current.

Convection is heat transfer between liquid and gases.

Radiation is heat transfer that uses electromagnetic waves. Thus, the process happens in a vacuum as no matter is involved. A vacuum is an empty space without matter and matter could be anything that occupies space and has mass. Heat from the Sun, warms the Earth and every matter in it. Heat is absorbed from the Sun.

Absorption occurs in different ways:

Light strikes the surface and gives energy to it.

Using a towel to dry after taking a bath using cotton or fabric not plastic is preferred. Plastic does not absorb water and cotton is material that absorbs water and can get wet.

The teacher asked learners which meat will cook the faster when comparing beef sausages and chicken. Learners were asked to expatiate their answer. The learners responded as follows: sausage but were unable to expatiate their answer.

The teacher explained that the sausage has a wrapping around that absorbs heat fast, the beef is thinly sliced and cooks faster than chicken, and then chicken pieces are mostly thicker, so they cook slowly.

Class activity:
Define the following terms:
- Conduction;
- Convection;
- Radiation;
- Insulator; and
- Conductor.

Feedback was given to the learners, but their books were not controlled as the Natural Sciences period was over and the other teacher had to get into the classroom.

**Home activity**

The teacher asked the learners to take two plastic bottles of any size, and cover them with different materials. One bottle to be covered with a white cloth and the other one with a black or dark blue cloth. The two covered bottles must be put in the sun for about two hours. After two hours the learners must feel the outer surfaces of the bottles and record their results.

**Reflective notes**

Learners were nineteen (19) in class and two (2) learners were absent from school. Learners were seated in rows that are clustered together with little or no space for the teacher to move around. There were more chairs and tables in class than the total number of learners.

The teacher code-switched very often during the lesson presentation, using the vernacular language for learners to participate.

Learners were responding to the questions actively after an explanation done in their home language.

All learners were taking notes actively during the entire period and the teacher often reminded them of doing so. Furthermore, the teacher apologised to the learners for not having made copies available to them.

Learners were given an assessment task based on what was learned and the duration for the task was just 5 minutes. The time was extended to 8 as some learners were unable to finish on time.

Feedback was given to the learners and learners’ own definition was encouraged as that showed that they understood what was taught. Learners were asked randomly to give answers and some of them were unable to pronounce the common words and scientific words properly.

The teacher emphasised the key words on each definition.

The teacher was not able to control learners’ books.

The practical home activity was not structured correctly.

**Teaching method**

- Question and answer
- Lecture
### Scientific pedagogical practices

<table>
<thead>
<tr>
<th>Scientific pedagogical practices</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of scientific pedagogic practice</td>
<td>Experimentation</td>
</tr>
</tbody>
</table>

### 4.6. Summary of the findings

In this study the researcher explored multiple pedagogical practices teachers use engaging Science learners in the classroom specifically at Moroke Circuit. The study was conducted to find out how scientific knowledge is constructed to the learners in a classroom situation. Wealth and prosperity of the country depends mostly on the scientific workforce in the scientific fields of study (Kibet et al., 2012). This became evident recently during the outbreak of COVID-19 when the scientists worked tirelessly to get the vaccine for the pandemic and could soon find the remedy for the entire nation.

Learners’ performance in science subjects is a concern to the parents, teachers and the departmental officials because the remedial measures still yielded negative results. Strategies employed bring little or no impact to the challenge faced. This indicated that the root cause of the challenge had not been identified hence the performance challenge still exists. The influence of Science process skills in the construction of scientific knowledge in a Science classroom was closely observed.

The research findings were identified from different perspectives, thus teacher-related factors and the contextual factors. The teacher-related factors included the level of education, planning, lack of specialised content, language of instruction, assessment methods and science language. The contextual factors are curriculum changes (trimming of the subjects), lack of time, teaching workload, lack of resources and infrastructure. The analysis of the research findings has shown that little research has been done in South Africa on pedagogical practices in a Science classroom as compared to other countries. Advanced Western societies have considered scientific process skills as one of the most significant part of curricula (Mătă, 2016). The models that have been used in the construction of knowledge in a Science classroom have been
developed based on research done in other countries and seem to have very little impact in South Africa based on the contextual factors faced with in most public primary schools.

4.6.1. Teacher-related factors

Teacher-related factors are those factors that originate from individual teachers and affect teaching and learning in the classroom. These particular factors are controlled by the teachers. Teacher-related factors are shared next.

4.6.1.1 The level of education

It is quite evident that the level of education and content knowledge are related to each other based on the construction of knowledge to the learners. A teacher who has been trained extensively after acquiring a minimum requirement of becoming a teacher, thus matric plus three years’ training (M+3) has broader knowledge and is able to explain concepts in different ways for learners to understand. Even though the results above state that teachers are professionally qualified, it is factual that some teachers still are at entry level. Academic teacher development enhances deep content knowledge on science and have a positive effect on performance of the learners.

According to Spaul (2013) teachers at entry level qualification may have a negative effect on learner performance. The quality of education cannot surpass the quality of a teacher. Mostly, the teacher can be as good as his or her level of education regarding the content knowledge. Development in education broadens ones’ intellect and puts them at an advantage to diversify classroom instruction method. Teacher development should remain a top priority for educators as more knowledge is acquired whenever they are furthering their studies.
4.6.1.2 Lesson planning

Planning is the most imperative part of preparation for the lesson presentation in class. It allows the teacher to be prepared of ways to construct the knowledge to the learners by making sure that all the required resources are available. The resources include the teaching aids, assessment sheet or any other item that will enhance the teaching and learning situation. According to Limatahu (2017) lesson plan, worksheets, learning materials science process skills test sheet and teaching model are the essentials resources required by science teachers in the classroom.

Whenever the teacher fails to prepare thoroughly for the lesson presentation, shortfalls are displayed and this disadvantage the learners from acquiring more knowledge. The teacher becomes disorganised and seem to encounter difficulties in scaffolding the information in a structured manner.

4.6.1.3 Language of instruction

According to South African Schools Act, schools must design a language policy that will become a directive to all learners and teachers on LoLT. Most public schools in South Africa prefer English as their medium of instruction in teaching and learning. Teachers often use the native language in the society to teach. And this shows as if the learners do understand forgetting that all the assessment are in English and the teacher will not be allowed to clarify or explain questions during formal assessment tasks like examinations and tests. Learners become adversely disadvantaged due to the language that is used on assessment and ultimately perform poor. Learners struggle to read and learn in English. Therefore, lack of proficiency in English inhibits communicate their thoughts and engage in a discussion effectively (Hlabane, 2014).
4.6.1.4 Science language

Vocabulary used in Science is different from other subject as most of the concepts are not in English, commonly used as a medium of instruction in teaching and learning. Most concepts in Science are difficult to pronounce as they are in Latin. Learners need to be able to understand the concepts relating them to English. The word photosynthesis is made up of ‘photo’ which means light and synthesis meaning manufacturing. So, it is imperative first to understand the language used in science to be able to define the concepts and scientific processes. Science language requires one to analyse data from diagrams, graphs or tables, communicate them in words, further distinguish and apprehend the theories, then be able to apply them (Hlabane, 2014).

4.6.1.5 Assessment methods

In Science learners are assessed in different ways. Apart from the normal activities that are done in every subjects, Science learners have to perform experiments to prove the theories in their textbooks that scientists have discovered. No experiments are done, but theoretically teachers explain the facts regarding those experiments. This simply implies that learners are not exposed to the scientific materials and cannot discover the scientific concepts individually. The excitement of the nature of Science where learners discover concepts on their own is tarnished. This makes it difficult for learners to grasp all the information as they just must fit in the data to reproduce it during formal assessments. Findings also indicate that the Natural Science teaching observed hardly encouraged inquiry abilities in learners, as they learnt through dissemination of recognized knowledge. They lacked practical activities which promote deeper learning of pedagogical content knowledge in science and did not afford learners opportunities to engage actively (Bantwini, 2017). Learners at primary school level are still regarded as young children and learn more effectively by doing, experimenting or modelling, so practical activities will improve their thinking ability.
4.6.1.6 The educator's lack of specialised content

The findings from this study show that teachers who are just having knowledge to teach just the syllabus are unable to clarify concepts to learners. Teachers must relate to the indigenous knowledge system the learners have already acquired from the community. Linking Science knowledge with practical examples applicable to the learners assist in the successful acquisition of content knowledge successfully of the learners. The Science processing skills are practical, investigational, and systemic skills laying foundation for Science (Suyidno et al., 2018). Lack of specialised content knowledge limits teachers to concentrate only on what is in the prescribed books and they as well may choose what to teach to the learners. There are certain skills that can be acquired in studying further within the field of specialisation, hence the curriculum if reviewed often to keep up with the technological changes.

4.6.2. CONTEXTUAL FACTORS

Contextual factors are those factors that are not within the control of the individual teacher. And furthermore teachers could not be able to address them on their own as much as they may be aware of them except to request assistance from the relevant stakeholders. Contextual factors are shared next.

4.6.2.1 Infrastructure

Schools require proper infrastructure consisting of classrooms, staff rooms, science laboratory and a library to run effectively. A primary school comprises of eight grades, thus Grade 1 to 7, and Grade R. So, in total at least eight classrooms are required at any institution, one staff room, a science laboratory, a library and an office. Both the targeted schools do not have proper infrastructure in place.

School A has multi-grade classrooms wherein two consecutive grades are taught in one classroom. The situation dictates to the school to have their own strategy to resolve their own
educational challenges in the best way they could. Insufficient supply of educators creates serious chaos at school wherein teachers become overloaded with work and may ultimately end up teaching subjects, as they were trained for at institutions of higher learning.

4.6.2.2 Curriculum changes

Research has revealed that countries compete successfully with the global world by always reviewing their education system. According to Ngema (2016) curriculum changes hinder the teaching experience as new specific outcomes must be achieved utilising modern strategies as compared to the previous curriculum. For a successful implementation, if the curriculum changes, educators must be trained to adapt to the new changes. Teachers’ teaching experience often becomes null and void as the changes are affected, because all teachers need to adapt to changes in the curriculum. Teacher development is crucial to keep up with the curricula needs of the education system in place at that present moment.

As the curriculum changes, old topics are removed to make way of new topics that are aligned to the technological changes in the global world to enable the learners to compete successfully. At times, the curriculum may be trimmed to enable teachers to cover only the essential topics that could enhance learners’ knowledge. Loss of contact time between teachers and learners during this recent year, 2020 prompted the South African education system to trim curriculum. The topics that were accumulative by its nature in Natural Sciences and Technology were allocated less time or the DoBE removed knowledge that learners either had acquired in their previous grade or would learn in the next. Teachers are not adequately trained or consulted when the changes are made regarding the curriculum (Moodley, 2013), and the latter statement creates confusion such that teachers are demotivated to implement as required.

4.6.2.3. Lack of time

Knowledge construction by teachers communicated to learners is done in a way that prior knowledge serves as foundation to construction of knowledge to be learned. The outbreak of
the pandemic during the first term of the academic year, 2020/2021, created pressure on the department to ensure that the year is saved at the expense of teachers and learners. More time has been lost during lockdown level one where all citizens were not allowed to move around unless if it was for the provision of essential services and education was not one of them. Schools were closed.

Learners need not be congested with too much information unnecessarily as that will have a negative impact on the retention of information for future assessment purposes. Successful learning is realised when the working memory can process new data and further retain it using graphics to make way for new information (Artino, 2008). Unstructured construction of knowledge to learners causes more damage than accumulation of knowledge.

4.6.2.4 Teaching workload

Teachers must be organised by planning properly for their lesson, and it requires a lot of effort to cater for all learners in the classroom. Different strategies are essential for the diverse learners in the classroom. A lesson becomes successful whenever most of the learners comprehend the subject matter. The mammoth amount of work that teachers are faced with at their schools inhibits them from showing the expertise in the subjects they have been trained for. Teachers are unable to plan thoroughly for their lessons as they may be teaching more subjects in which some did not receive Higher Education and training. Due to an increased workload, teachers are unable to assist and assess learners regularly as required.

4.6.2.5 Lack of resources

Resources include and are not limited to infrastructure, textbooks, teachers and teaching aids. Resources aid the teachers in the classroom to teach effectively and efficiently. Moreover, the resources enable learners to learn without any hindrances, Resources are materials that enhance the teaching and learning situation by creating a conducive situation in which all the participants become actively involved. Lack of the necessary resources inhibits the potential in
both learners and teachers in constructing knowledge. During the national lockdown that was declared in March 2020, the need for online learning reached its peak. The institutions that had the necessary technological resources were able to provide support to their learners by sending them the lesson presentations and assessment tasks via different social services.

The issue of infrastructure is still a problem to many public schools. The new standard operating procedures at schools require learners to be 20 in a normal classroom, but that is not adhered to by many schools due to the contextual factors they faced.

The schools often have shortages of textbooks or no textbooks for learners at all. The latter statement limits the teachers in issuing the assessments to learners and spend more time in teaching as the teacher has to write notes on the chalkboard. Many schools do not have overhead projectors and computers to use for lesson presentations. These technological devices play a vital role in Science education regarding the experiments that must be performed in the classroom. Teachers resort to theoretical method of teaching practical investigations (Muzah, 2011). Many schools do not have a Science laboratory or even Science kits, so technology could assist the learners in identifying the science apparatus easily. Practical investigations heighten the learners’ interest in Science and helps them acquire the Science process skills. Experiments further increase discipline to study and they also help learners to solve problems. The importance of practical investigations in Science cannot be over-emphasised as positive results are shown. However, Science lesson presentation continues to be teacher-centred and instructed in a way which does not facilitate creative thinking (Lebata, 2014).

4.7 CONCLUSION

This chapter presented the results of the research study questions that comprised of the main question and two sub-questions. The completed open-ended questions on the questionnaire and lesson observations, confirmed that teachers did not always do what they are supposed to do although they were aware of what is expected of them. Learners in the early phase of their education are compromised in terms of the way knowledge is constructed. The construction of process skills is not taught completely. In the next chapter the main conclusions of the research
will be drawn. The limitations of the research will then be highlighted and recommendations for improving construction of scientific knowledge using science process skills indicated.
CHAPTER 5
FINDINGS, LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter discussed the findings, and the research questions were answered. The purpose of conducting this research was to investigate the diverse pedagogical practices used by teachers in a Science classroom, the effect of the Science Process Skills (SPS) and the construction of scientific knowledge utilising the process skills. This chapter presents the summary of the findings of the study, limitations for this study, recommendations in the study and the implications of the study.

5.2 SUMMARY OF THE FINDINGS

In this study the researcher explored multiple pedagogical practices teachers use engaging Science learners in the classroom specifically in the Moroke Circuit. The study was conducted to find out how scientific knowledge is constructed by the learners in a classroom situation. The wealth and prosperity of the country depend mostly on the scientific workforce in the scientific fields of study (Kibet et al., 2012). This became evident recently during the outbreak of Covid-19 where the scientists worked tirelessly to get the vaccine for the pandemic and could soon find the remedy for the entire nation (World Health Organisation, 1 July 2020 – media briefing).

Learners’ performance in science subjects is a concern to the parents, teachers and the departmental officials such that remedial measures still yield negative results. Strategies employed had no or little impact on the challenges faced. The later statement indicates that the root cause of the challenge has not been identified, hence the performance challenge still exists.
The influence of the Science process skills in the construction of scientific knowledge in a Science classroom was closely observed.

The research findings were identified from different perspectives, thus teacher-related factors, and contextual factors. Teacher-related factors included the level of education, planning, and lack of specialised content, language of instruction, assessment methods and Science language. The contextual factors that exert an impact on successful teaching of Science are curriculum changes (trimming of the subjects), lack of time, teaching workload, lack of resources and infrastructure. The analysis of the research findings has shown that little research has been done in South Africa on pedagogical practices in a Science classroom as compared to other countries. Advanced Western societies have considered scientific process skills as one of the most significant parts of the curricula (Mată, 2016). The models that have been used in the construction of knowledge in a Science classroom have been developed based on research done in other countries and have very little impact in South Africa based on the contextual factors faced within most public primary schools.

I totally agree with the research conducted by Houseal et al. (2014) that involvement of all stakeholders in education, more especially students and teachers in collaboration with the experts being scientists or subject education specialists, could enhance the content knowledge growth and the understanding of and about scientific inquiry. That will consequently even improve their attitude towards Science. It is in the culture of individuals that whatever the learners experience, they will not forget. Getting the role players in the construction of knowledge involved could create a platform for a solid foundation in Science processing skills. Scientific inquiry was further supported by Tsybulsky and Oz (2019) with the project-based method enhancing professional teaching that makes provision for positive experiences that empower teachers and learners by becoming more confident to overcome challenges as they arise. The SPS and content knowledge in the construction of Science knowledge are very crucial and could be attained by using the right pedagogical practices which are diverse in nature.
5.3 LIMITATIONS OF THE STUDY

Research findings answered the research questions, but still show elements of limitations. The study focused on a limited target population in the Moroke Circuit. Only two teachers completed the open-ended questionnaires. The research tools and components were not varied as only the teachers were targeted although the learning and teaching situation is referred to as a tripartite education system that forms a triangle, including teachers, learners and parents.

Even the departmental officials, thus subject education specialists, are not included in this research, therefore data collected lack information from experts. The study was conducted at only two primary schools and a limited number of teachers participated as only Science teachers in Grade seven participated.

Visitations to schools were done under very strict operating procedures because of Covid-19 outbreak. The health and safety regulations to be followed at schools require social distancing to be observed and frequent washing of hands and/or sanitising hands after touching surfaces. It became challenging to interact with the targeted population group as precautionary measures had to be always observed.

5.4 RECOMMENDATIONS FROM THE STUDY

Recommendations follow next.

5.4.1 Provision of infrastructure

A normal primary school must have eight classrooms with sufficient personnel, a staff room, an office, a science laboratory, a library, and proper ablution facilities in place. Schools with small enrolment of learners’ experience challenges due to the education model that is used for the provision of educators at schools. The ratio utilised for post establishment does not allow efficient and effective running of a school as schools with small enrolment, although all grades
end up having four teachers including the principal. This further creates the clustering of grades that leads to multi-grade teaching for classroom management purposes.

**5.4.2 Specialisation**

Teachers at primary schools can teach any subject regardless of whether they have been trained for that specific subject or not. The main reason for lack of foundation in learners is created at primary schools as the most basic knowledge regarding subjects of interest is not properly managed. Ultimately learners always find it difficult to perform best or develop interest in certain subjects.

Teaching Science involves content knowledge and process components of Science, and both are equally essential (Limatahu et al., 2016). Content consists of subject matter and science concepts whilst process components consist of essential Science skills that need to be acquired (Inan & Aydemir, 2014). Science as subject is somehow different from other subjects as it involves more practical activities and scientific language that requires special skills. And if the teachers do not possess SPS, learners will never be able to acquire them. Teachers will then develop diagnostic reports that will give rise to remedial strategies to be implemented to assist learners with learning barriers.

**5.4.3 Provision of lesson plans**

The prescribed books must include step-by-step guidance of how the lesson can be taught and the necessary resources that could assist the teachers in the construction of knowledge to the learners. The approved textbooks should at least have a package consisting of the following: learners’ book, a worksheet booklet, teacher’s guide, a DVD of the experiments and lesson plans in it. This could ease the burden on the teachers as less time could be spent in planning the lesson.
5.4.4 Teacher development

The Department of Education (DoE) should make provision for courses that involves pedagogical practices to be used in a Science classroom. These courses must be attended as part of the orientation for Science educators and could be conducted annually with the assistance of the SES. Efficient training should include all the necessary changes in curriculum to allow teachers to give quality education in terms of the curriculum. Extensive training in Science teaching knowledge for teachers positively contribute towards learners’ improved knowledge in Science education.

5.4.5 Science centres

The DoE in partnership with other institutions could build up Science centres with all the necessary equipment at different circuits to assist the schools under their jurisdiction. Experiential learning encompasses but not is limited to enquiry-based learning; yields enhanced content knowledge and attitudes toward Science among middle school students (Houseal et al., 2014). The later statement encourages teachers to actively involve learners in data collection that involves SPS, and further makes Science more enjoyable and fun subject to engage on.

The centres must always be managed by the SES and be accessible to all the schools within that geographical area. The use of necessary scientific tools enable learners from memorising facts to recalling what was performed and the procedures thereof (Houseal et al., 2014). This will somehow lessen the burden from the department to provide infrastructure at schools and schools from purchasing their own equipment as they are expensive. The centres will be used to perform practical activities and with the help from subject specialists learners will be able to acquire SPS and become critical thinkers who are able to reason scientifically based of facts.
5.4.6 Teacher Science Indaba

Nature has taught every individual that the most significant impact on teaching and learning is by getting involved. Teachers must contribute actively on curriculum as they are the implementers and have experience on the interactions with the learners in the classroom. They somehow have a better idea on what is required to change the status quo but do not have the authority to affect any changes. Teachers’ voices and inputs play a significant role during decisions related to the implementation of not just pedagogical matters but also curriculum development (Gultepe, 2016). As per the later statement peer-to-peer discussions might help redesign teachers’ approaches, events or activities to be designed to give teachers experience of Science process skills, while connecting teachers to a broader scientific research project.

5.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Recommendations for further research are shared next:

- The role played by Subject Education Specialists (SES) in schools in teaching and learning;
- The tertiary curriculum in relation to the curriculum taught in schools; and
- Construction of Science process skills in elementary and primary school education.

5.6. CONCLUSION

This research study explored the pedagogical practices in a Science classroom in the Moroke Circuit. The study was conducted to answer the question: what pedagogical practices do teachers use in a Science classroom? Multiple factors that influence the use of pedagogical practices were identified, and cannot be limited to those only identified in this study. Recommendations made in this study could be used by DoE to ensure that the relevant Science process skills are acquired at primary level to enable the learners to develop a love for and interest in Science. They will ultimately perform better in Science subjects. However, the later statement does not mean that those are the only recommendations for the study. So, further
studies within the same field of study could reveal more facts on how best Science process
skills could be incorporated throughout the construction of Science content knowledge.
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Appendix A: Letter to Limpopo Department of Education

District Director
Sekhukhune East District

Sir/Madam

APPLICATION TO CONDUCT RESEARCH IN DESIGNATED SCHOOLS IN MOROKE CIRCUIT FOR MASTER IN EDUCATION DEGREE

I am conducting research for Master of Education at the University of South Africa. The title of my research study is *PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT*. I am humbly requesting authorisation to involve some of your Natural Sciences educators from Moroke Circuit to partake in the study.

The process will involve completion of a questionnaire and lesson observation during Natural Sciences lesson presentation at designated schools. My assurance to you is: there will not be any class disruptions during the study research process, and all information provided will be coded to prevent identification of participants and your school in the report for this study.

This research study is conducted under the supervision of Dr. M.P. Rankhumise. Enquiries concerning this research could be forwarded to me or my supervisor using the following links:

<table>
<thead>
<tr>
<th>Dr. M.P. Rankhumise</th>
<th>Ms Sekonya RH</th>
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<td>Department of</td>
<td>Makgopa Primary School</td>
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<td>University of Pretoria</td>
<td>Dilokong Circuit</td>
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<tr>
<td>Tel: 012 – 382 9015</td>
<td>Mobile: 072 818 8080</td>
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<tr>
<td>E-mail: <a href="mailto:RankhumiseMP@TUT.ac.za">RankhumiseMP@TUT.ac.za</a></td>
<td>E-mail: <a href="mailto:shatadimogau@gmail.com">shatadimogau@gmail.com</a></td>
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Yours faithfully

----------------------------------
R.H. Sekonya
Appendix B
Letter to the Circuit Manager

The Circuit Manager
Moroke Circuit

Sir

I am undertaking research for Master of Education at the University of South Africa. The topic for my research is *PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT*. I therefore request authorisation to allow Natural Sciences educators at schools under your jurisdiction to partake in this study.

The proceedings will comprise of a completion of a questionnaire and lesson observation in Natural Sciences classroom at those schools. My assurance to you is: there will not be any class disruptions during the study research process, and all information provided will be coded to prevent identification of participants and schools in the report for this study.

This research is conducted under the supervision of Dr. M.P. Rankhumise. Enquiries regarding this research could be forwarded to me or my supervisor utilising the following contacts:

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<td>E-mail: <a href="mailto:shatadimogau@gmail.com">shatadimogau@gmail.com</a></td>
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Yours faithfully

__________________________________________
R.H. Sekonya
Appendix C
Letter to schools

The Principal

Dear Sir/Madam

I am embarking on research for Master of Education at the University of South Africa. The topic for my research study is pedagogical practices in a Grade 7 science classroom. I am requesting authorisation to engage with Grade 7 Natural Sciences educators from selected schools to partake in the study.

The proceedings will comprise of completion a questionnaire and lesson observation whilst teaching Natural Sciences in Grade 7 at your school. My assurance to you is there will not be any class disruptions during the study research process, and all information provided will be coded to prevent identification of participants and your school in the report for this study.

This research is engineered under supervision of Dr M.P. Rankhumise. Enquiries regarding this research could be forwarded to me or my supervisor utilising the contacts below:

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Yours faithfully

____________________________
R.H. Sekonya
Appendix D
Consent letter to participants

Sir/Madam

I am embarking on research for Master of Education at University of South Africa. The title of my study is PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT. I am asking for authorisation to include some of you, Natural Sciences educators to take part in the study.

The proceedings will include completion of a questionnaire and lesson observation for Natural Sciences at your school. The completion of the questionnaire could at least 15 minutes of your time. My intention is to observe at most no more than three lesson presentations.

My assurance to you is that there will not be any class disruptions during the study research process, and all information provided will be coded to prevent identification of participants and your school in the report about this study.

You are free to pull out from the study whenever you intend to.

This research is engineered under the supervision of Dr M.P. Rankhumise. All enquiries regarding this research could be forwarded to me or my supervisor utilising the contacts below:

<table>
<thead>
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<th>Miss R.H. Sekonya</th>
</tr>
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Yours faithfully

____________________________
R.H. Sekonya
Appendix E
Consent form for teachers

Project topic: PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT.

I have read the information regarding this research. I have been informed about all aspects of the study and all questions I asked were clarified to my contentment.

I agree to partake in this research project and realise that I can pull out from the project whenever I so wish.

I also agree that the research data collected for this study may be published on condition that that my name, and my school are not identifiable.

Participant: ___________________________ Date: ___________________________

Researcher: ___________________________ Date: ___________________________
APPENDIX F

LETTER REQUESTING ASSENT FROM LEARNERS IN A PRIMARY SCHOOL TO PARTICIPATE IN A LESSON OBSERVATION FOR A RESEARCH STUDY

Title of study: PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT.

Dear Learner

I am embarking on a study entitled PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT at the University of South Africa. I was given authorisation to conduct this study in your school. I would like to request that you partake in my study. This study seeks to explore methods that your science teachers use to construct scientific knowledge. This study will be beneficial to you and many other learners in different schools in developing love and interest in Science.

This letter seeks to elaborate to you how you will be involved. There may be certain words which you are unacquainted with and may not know in this letter. Please request an adult to explain any of these words that you do not know or understand. You may take a copy of this letter home to think about my invitation and talk to your parents about this before making a final decision.

I will be observing the lesson presentation in your classroom whilst learning and teaching takes place. The purpose of lesson observation is to explore pedagogical practices in Natural Sciences used by teachers constructing scientific knowledge in learners to make them acquire the necessary skills in science. You will not be directly involved in the study but will form part of teaching and learning process. You will not be required to fill any form but will be observed while learning occurs.

Finally, a report will be written for this study, but your name or any other identifiable information about you will not reflect in the report. You solely have the right to choose not to be part of this research. If you choose to be involved in the study and later feel uncomfortable to proceed, you may stop taking part at any time. You will not be blamed or criticised for pulling out of the study. Upon completion of my research, I shall give feedback on the findings by sharing my experiences, thus helpful and interesting things I found out in my study. You will be the special guest to come and listen to my talk.

You are requested to sign the form on the next page if you decide to partake my study. Enquiries about this study could be directed to your parent or rather ask an adult to call me at: 0728188080. You are not compelled to sign the form until you are content of being part of this study.

Researcher: R.H. Sekonya Phone number: 0728188080

Please make sure that you are clarified on issues of concern before signing this assent form.
ASSENT TO PARTICIPATE IN THIS STUDY

I, _______________________________ (participant’s name), confirm that I am fully aware of the nature, procedure, potential benefits and anticipated inconvenience of participation in this research study.

I have received explanation and understand the study as explained in the information sheet.

I solely agree to be part of this study.

I do comprehend that my involvement is voluntary and that I am free to pull out at any time without punishment.

I am aware that the outcomes of this study will be processed into a research report, journal publications and/or conference proceedings. My participation will be kept confidential.

I agree to the usage of a recording device during lesson observation.

Participant Name & Surname : ________________________________ (please print)
Participant Signature : ___________________________ Date : __________________

Researcher’s Name & Surname : ________________________________ (please print)
Researcher’s signature : ___________________________ Date : __________________
APPENDIX G
A LETTER REQUESTING PERMISSION

Dear Parent

This letter seeks to request your authorisation to allow your child to take part in a study I, Sekonya R.H, am conducting a study as part of my research project as master’s student. The title of the research is **PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT**. Permission to conduct research for the study was granted by the Department of Education and Ethics Committee of College of Education, UNISA. I purposefully identified teachers at the school where your child attend schooling as a participant because of the expertise in Science.

More information about this project will be shared about the project and your child’s involvement to participate in the study. The importance of research in education is well recognised. Your child will not be directly involved in the study but will be in the classroom which will be observed during a lesson presentation by Natural Sciences teacher. The information collected could be contribute positively to education system development and educator development. Moreover, findings could lead to future research with the aim of providing recommendations on how to improve the construction of knowledge in Science.

Participation in this study is voluntary. Furthermore, you may decide to withdraw your child from this study at any time without negative consequences.

Upon your approval to let your child to participate, please note that the lesson observation will be audio-recorded to enable accurate collection of information and proper transcription. Upon completion of transcription process, I shall return to your school to provide a share my findings regarding helpful and interesting things discovered. All information collected shall be considered completely confidential. No form of personal identification will appear in any publication resulting from this study and any identifying information will be not be presented on the report. However, through your permission, anonymous citations could be used. Data collected during this study will be reserved on a password protected computer for 5 years. Risks are not anticipated towards your child as a participant in this study.

Any additional information or questions to aid you in reaching a decision about your child’s participation, please contact me at 0728188080 or by e-mail at shatadimogau@gmail.com.

Your approval for your child to be part of this study will be appreciated. If you approve of my request, I humbly ask you to sign the consent form on the next page.

Yours sincerely,

…………………………………………
Sekonya R.H
PERMISSION TO ALLOW MY CHILD TO PARTICIPATE IN THIS STUDY

I, ____________________________ (parent’s name), confirm that I give my consent to allow my child to take part in this research. The nature, procedure, potential benefits and involvement of my child in participating in this study was explicitly explained.

I have read (or have received explanation) and understand the purpose of the study as explained in the information sheet.

I am prepared to allow my child to take part in the study.

I understand that participation is voluntary and my child can withdraw from participating at any time without penalty.

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

I agree to the recording of lesson observation.

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

Parent’s Name & Surname : ____________________________ (please print)

Parent’s Signature : ____________________________ Date: ____________________________

Researcher’s Name & Surname : ____________________________ (please print)

Researcher’s signature : ____________________________ Date: ____________________________
Appendix H: Questionnaire for Natural Sciences teachers

Do not write your name or anything that would identify you on this questionnaire. It is an anonymous questionnaire. Completing this questionnaire, you are consenting to participate in the research.

Purpose: The main purpose of this questionnaire is to gather different philosophies about teaching and learning of Natural Sciences. Information gathered will be summarised and included within the research reports. Information collected will be used purely for academic purposes. Participants and their schools shall not be identified.

General information and instructions:
- Respond to all questions.
- Use spaces provided to answer questions.
- There are no wrong or right answers. Your opinion is of utmost importance.
- You will not be graded based on your responses.

Section A: Biographical information
What is your gender?________________________________________________________________________
What is your age?__________________________________________________________________________
What is your teaching experience (in years)?____________________________________________________
What is your highest qualification?________________________________________________________________
What are your major subjects?__________________________________________________________________________
Which subjects do you teach at this school (indicate the grades and number of learners)?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
What is your workload per week?_____________________________________________________________________
What is the number of learners in your Natural Sciences class?_____________________________________________________________________

Section B: School profile
Resources and infrastructure:
What is the total number of the classrooms?_______________________________________________________
Do you have a staff room?_______________________________________________________________________
Do you have electricity?________________________________________________________________________
Do you have access to internet at school?_____________________________________________________________________
Do you have a science laboratory?_____________________________________________________________________
If yes, does it have all the necessary equipments? _______________________________________________________

Section C: Views on pedagogical practices in science
What is Science? Give your own explanation
__________________________________________________________________________________________
__________________________________________________________________________________________
Is Science taught the same way as other subjects? Explain why or why not?
__________________________________________________________________________________________
__________________________________________________________________________________________
How can you explain a scientific knowledge system? Use a practical example.

Is an indigenous knowledge system important in Natural Science teaching? Explain your answer.

How can you make sure that scientific processes are incorporated in your lesson presentation?

It is believed that in nature we need to preserve what we have so that it becomes available to the future generation. Do you believe in this statement? Provide a reason for your answer.

What do you think are practical activities in Science? And what do they entail?

A scientific knowledge system includes using factual information to draw conclusions on scientific aspects. Are learners able to use their imagination and creativity in practical investigations?

Why do scientists do experiments?
What is your overview of the CAPS document?

Thank you for your participation in this study.
**Appendix I**

**Observation schedule**

<table>
<thead>
<tr>
<th>Participant</th>
<th>:—</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of observation</td>
<td>:—</td>
</tr>
<tr>
<td>Starting time</td>
<td>:—</td>
</tr>
<tr>
<td>End time</td>
<td>:—</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration</th>
<th>Descriptive notes</th>
<th>Reflective notes</th>
<th>Teaching method(s)</th>
<th>Ability to use scientific pedagogical practices</th>
<th>Type of scientific pedagogical practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>


To: The Principal  
From: District Director  
Sekhukhune East District  

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN SCHOOLS WITHIN THE SEKHUKHUNE EAST DISTRICT  

The above matter refers.  

1. Kindly be informed that Sekonya Ramadimetje Hermina, a Masters Student at University of South Africa (UNISA) is granted permission to conduct above Research at your school.  

2. Conditions attached to the permission are:  
   - Participation is voluntary  
   - Information collected will only be used for study and remain confidential.  
   - No names should be written on questionnaire  
   - Participants are free to withdraw anytime during the process  

NB: DATA COLLECTION AND ADMINISTRATION OF QUESTIONNAIRE MUST BE DONE ONLY DURING BREAKS AND AFTER TEACHING HOURS  

3. The District Director wishes you well as you continue to assist her.
Subject: PERMISSION TO CONDUCT RESEARCH IN SCHOOLS WITHIN THE SEKHUKHUNE EAST DISTRICT
83 Aloe Street, 2314 Extension4, Aloe Ridge west, BURGERSFORT, 1150, P/Bag X 9041, BURGERSFORT 1150

Vision: our vision is to equip the people of our province through the provision of equality, lifelong education and training with value, knowledge and skills, that will enable them to fulfill a productive role in society.
EDITING CERTIFICATE

Dr C.G.A. SMITH

PhD (English)

Language practitioner: editing and proofreading

Cell: 0727661428

This is to certify that the language of the following document has been edited:

PEDAGOGICAL PRACTICES IN A GRADE 7 SCIENCE CLASSROOM: A CASE OF PRIMARY SCHOOLS IN THE MOROKE CIRCUIT

Author: by

Mrs R.H. SEKONYA

Date of this statement:

8 March 2021